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PRINCIPLES OF MAKING A COMPUTER SYSTEM FOR A CADASTRAL EVIDANCE AND BUILDING A DATA BASE FOR THE TOWN ENVIRONMENT

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Abstract: Known as GIS (Geographical Information Systems), the instruments of visualizing and analyzing the geographical information ``constitutes today a field with a spectaculars evolution. The special GIS operations over the spatial information make from these instruments not only some efficacy instruments for making maps, but especially, irreplaceable instruments for analyzing the information that refer to the terrestrial surfaces. Also, the existent information can be reused, due to the fact that one of the main purposes of introducing the GIS technology consists in creating – by conversion in digital form – some efficient possibilities of maintaining and updating the information. During the last quarter of century, the GIS applications have been extended quickly into the following fields: natural resources, energy, transports, business, and public safety.

Key words: system, geographic information system (GIS), programs, methods, procedures, application.

1. ADMINISTRATING THE PLACES

The administration and management of the places are base on the existence of a correspondent computers system.

It is called the **information system** a technical and organizational assemble of persons, equipments, norms and methods having as purpose to collecting, validation, stocking, treating and displaying the data and.(Fig. 1.1.)

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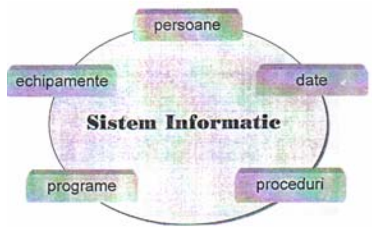

Fig. 1.1. Structure of information systems

A information system (IS) includes many main components as follows :

➢**Persons.** It can be distinguished many categories of persons involved in existing an IS:

o *Users*. These are the ones who assure the exploitation of the system, their activity being related mainly to its communication with the environment (*introducing the data and extracting the reports*);

o *Annalists*. Their role consists in analyzing the system and projecting the changes that must be done in the purpose of increasing its efficiency and functionalities;

o *Programmers*. Any computers system presumes the automatic elaboration of the data made by the computer based on a package of programs written by the programmers;

o *Responsible (system menageries)*. They are persons who organize, manage and coordinate the activity of a system.

o **Equipments.** The main equipment is the electronic computer. It also must exist a seria of equipments linked to it necessary for:

o *Collecting and introducing the data* (keyboard, digitizer, scanner etc.);

o *Stocking the data* (magnetic disk, optical disk, magnetic bands, etc.);

o *Visualizing and extracting the data* (monitor, printer, plotter etc.).

➢**Data corrections**. By definition, a computer system elaborates the data. These are stocked into collections accessible for the electronic computer and organized after specific rules.

➢**Programs**. They assure the automatic elaboration of the data in according to the specific algorithms in which it is used the system.

➢**Procedure and methods**. These are constituted from using instructions, manuals, norms, etc. through which it is implemented a certain working technology.

2. GEOGRAPHIC INFORMATION SYSTEMS

Definition: *An information geographic system (GIS) is an assemble of **persons, equipments, programs, methods and norms (rules)** having as purpose to **collect, stock, analyze and visualize the geographic data.*** (Fig. 2.1.)

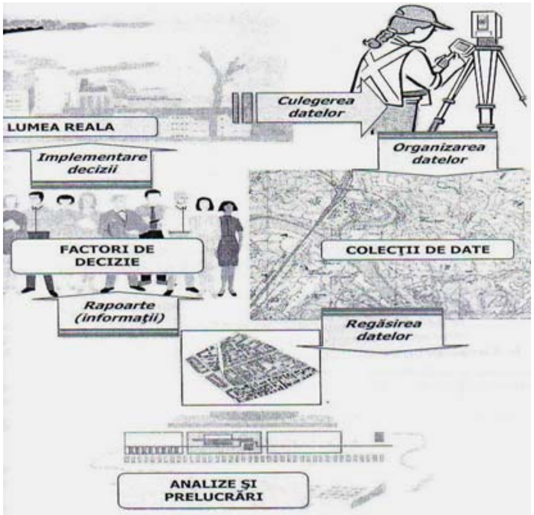

Fig. 2.1.

The main purpose for introducing the GIS technology consists in increasing the efficient possibilities for maintaining and updating the data.

2.1. Fields of using a GIS

- Local public administration – Local Councils, County councils, Prefectures, City Halls;
- Municipal utilities – phone networks, water, gaze networks, etc.;
- Constructions – placing, modeling, interacting material need;
- Cadastral need – creating, maintaining and exploiting the cadastral data bases at rural, urban and national level ;
- Cartography – making thematic maps, etc.

A geographic information system is constituted mainly in five components (fig.2.2.):

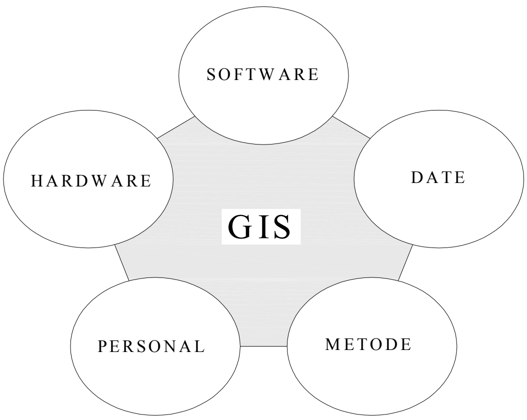

Fig. 2.2. Components of a GIS

2.2. Functions of a GIS

- Capturing and introducing the data (input)
- Manipulation (elaboration)
- Administration
- Interrogation and analyze
- Visualization

2.3. Stages for implementation and using of a GIS

Mainly, the implementation and exploiting a GIS is developed in the following stages:

- *Defining the requests.* It involves a detailed study of the user's requirements. After this study there are established the quantitative and qualitative features of the final products (precision, structure, representing scale) and it is estimated the data volume;
- *Establishing the system functions*. Being known the requirements, it is necessary to be specified the functions which must be accomplished by the system for fulfilling its objectives.
- *Projecting the data base*. Into the GIS the data are stocked in thematic layers. It is necessary to be defined these layers and features (attributes) of the data stocked in each of them.
- *Choosing and procuring the equipments and programs*. Among different possibilities for implementing a GIS must be chosen the variant that assures the totality or majority of the functions established as being necessary in conditions of maximum efficiency.
- *The personalization of the programs at the application requirements*.
- *Loading the data base. It consists in making the digital map by completing the layer data.*
- *Exploiting the GIS*. This is developed in three main directions: **updating, analyse, reports**:

3. STRUCTURE OF A G.I.S. APPLICATION

The GIS technology is used in all fields for which the spatial information is relevant, so the fields that use the geographic map for stocking, analyze and representing.

No matter what is the field, any GIS application includes a spatial data base (digital map) and a program (soft) that exploit these data base.

The digital map must contain the spatial data specific to the field of the application. In order to furnish the useful information, the data base must be actual, that means to represent correctly the terrain (geographic space) which is continuously in changing.

The soft contains many analyze functions of spatial data contained into the digital map and of visualizing the resulted information, specific to the application field.

3.1. Accomplishing the digital map

The digital map must be made by valorizing all the existent resources based on a good analyze of these content and the involved costs, following to assure the necessary quality, in conditions of maxim efficiency. Into the fig. 3.1 it is presented a general scheme of principle of sources that can be taken into consideration for making the digital map.

Acquisitioning the data is the process of conversion of the data for the shape in which it is exists in one that can be used by a GIS.

In order that the spatial data can be obtained from a great variety of sources, it must be done the difference between acquisitioning new data and of the existent one.

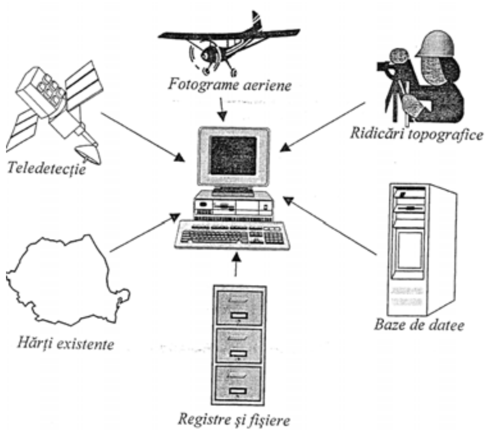

Fig. 3.1

From the point of view of the content, the digital map is made according to the schime of principle shown into the fig. 3.2.

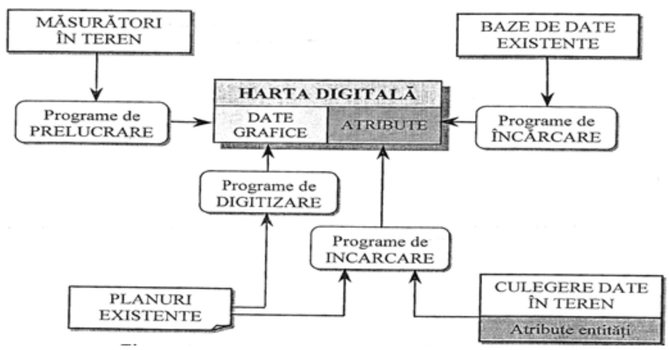

Fig. 3.2.

Each source of data presume the existence of some programs specialized through which it should bring these data into the shape of digital map.

3.1.1. Acquisitioning the new data by using the GPS

The present constellation is constituted from 34 operational satellites. The altitude to which there are situated the satellites is of almost 20200 km and the period of revolution is of 11 hours 58 minutes. Each satellite emits a message for determining its spatial position.

The GPS system is made of **3 main segments** (fig.3.3.):

- Spatial segment;
- control segment;
- user segment.

The first two segments are in exclusively under the control of the system getter (DoD-Department of Defense - USA).

The NAVSTAR-GPS satellites transmit time signals synchronized on two frequencies, position parameters of the satellites and additional information as satellites state.

This satellites constellation guaranties the simultaneous visibility to at least 4 satellites, from any point from the earth and if the satellites crosses through the zenith of the observer, then this satellite will be visible for almost 5 hours.

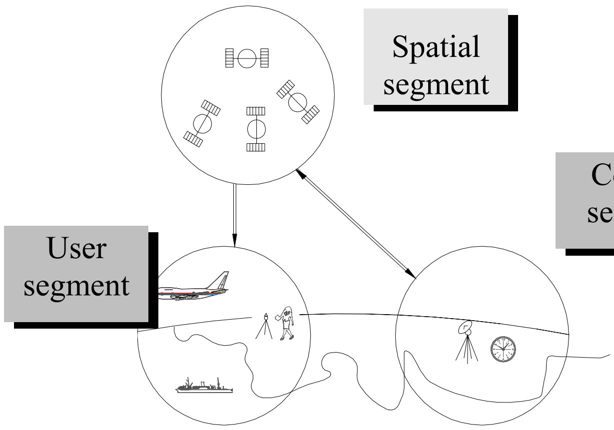

Fig.3.3. Segments of GPS system

The satellite is constituted in two parts:

1. Transport System
2. Navigation System

Structure of GPS signal

The main task of the satellites is to emit signals, which can be reception with adequate receptors. For this the satellite is foreseen with clicks (oscillators), a microprocessor and an antenna. These are assured with energy from the solar batteries.

The GPS satellite is a high precision oscillator with a frequency of 10.23 MHz (frequency band L).

Principle of GPS measurements

The GPS receiver measures the type necessary of a signal for being propagated from the satellites to the receiver.

The distance satellite-receiver (fig.3.4.) can be determined by multiplying this time with light speed (c).

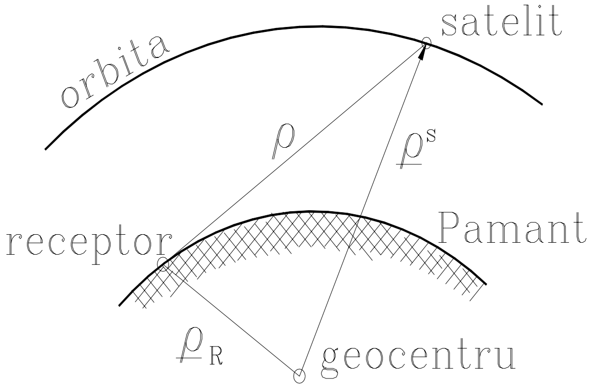

Fig. 3.4. Principle of GPS measurements

$$\rho = \tau \cdot c \qquad (1)$$

ρ = distance;

c = light speed;

τ = delay between the code generated and reception code;

The measurements of distance made by the receiver are affected by the clock error of the satellite and receiver, and these are called pseudo-distances.

By using synchronized clocks measuring a single distance towards the satellite we can determine the position of the receiver somewhere on a central sphere having the raze equal to the measured distance.

By making the simultaneously measurements to the two satellites the position of the receiver will be on a cirque that represents the place of intersection of the two spheres centered on these satellites.

In principle the simultaneously determinations of distances to three satellites assure enough information for being able to determine a fixed position in three dimensions.

3.1.2. Data models in digital map

In a digital map, all four components of a geographic data are expressed digital through values organized in a specific structure, forming a geo-database. This contains data that define the position and shape of the represented entities (graphical data) and also data that are expressed the features of these entities (attributive or textual data).

There are used two main models for organizing the digital maps:

- Into ***raster model*** the represented territory is divided in many cells, which are especially squares, having all the same dimension.
- Into the ***vector model*** it is considered that any geographic entity can be represented as a *point*, or a *line* (or arch), or as a *area* (or polygon). With a point it is represented punctual phenomena (for example altitudes). The lines are formed from

many points linked between them and they represent for example administrative limits or any other limits. An area is delimited by lines and it is used to be represented entities or phenomena for which the area is semnificative (administrative territories, lakes, types of vegetation, etc.)

For the digital map of the information system for administrating the towns it will be used the vector model.

In both models the geographic data of a certain territory are organized on many *layer*s or thematic *coverage* (fig. 3.5.).

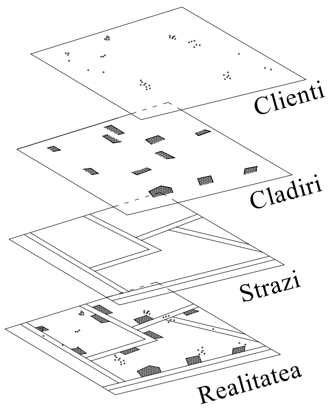

Fig. 3.5. Layers in digital map

The digital map of the territory is represented by the amount of all defined layers. It could be build a derived map elaborated from a layer or a certain combination of existent layers.

3.2. Projecting the data bases

To project the data bases contains the two main aspects:

- The first aspect, called the ***logic one***, refers to the creation of a conceptual model of the data that will be kept into the collection of data base. There are known many techniques for modeling through which the designer can be structure his relative ideas at the conception of the data base. The most used ate the modeling of the relationships of entity-attribute *(EAR: Entity-Attribute Relationship)* and modeling by normalization.
- The second aspect, called **physic one**, refers to the definition of the practical conditions in which it will function the data base and boarding some problems as: time of access, the dimension of data base, necessary of mass memory, the used administration system, the necessary equipments, etc.

For the necessities of the information system for towns administration, there are proposed as main entities the followings: LOT, BUILDING and OWNER.

CONCLUSIONS

Elaborating the digital maps and introducing the GIS systems into the sectors of the local communities should increase the level and quality of their decisional process.

Having a large applicability, and starting from information necessary to each citizen and to projecting the environment, from the marketing strategies to the resources administration, the GIS marked a revolution into the way of boarding the problems.

The quality information means quality decisions. And GIS offers these possibilities, transforming some simple data in information and offering access to them.

BIBLIOGRAPHY

[1]. Dima, N. , *Geodesy*, Universitas Publishing, 2006.

[2]. Dumitru, G. , *Information Geographic System*, Blue Publishing, 2001.

[3]. Herbei, O., *Mathematics cartography, elaborating and laying down the maps,* Eurobit Publishing, Timişoara. 2002.

[4]. Neuner, J. , *Global Positioning Systems,* MatrixROM Publishing, Bucharest, 2000.

[5].*** *Information Systems of cadastral evidence* – Post Graduate course, UTB – Faculty of Geodesy, Compress Publishing, Bucharest, 2004.

MODERN MEANS FOR SIMULATING THE BEHAVIOR OF THE ROCK MASSIF AT OCNA DEJ SALT MINES

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SUSANA ARAD **,
DANIEL HOJDA *,**
LEONARD LUPU *,**
OVIDIU MOLDOVAN ***

Abstract: The use of simulation patterns for studying the unsteadiness occurred inside the rock massif is very important for a good estimation of the future behavior of the whole massif. The numerical experiments try to shape the development of phenomenon starting from the analytical pattern, transposed into a shape suitable, for the implementation on modern calculation systems. Consequently there have been developed numerical patterns which represent an advanced means for studying the physical phenomene.

1. GENERAL ASPECTS

Additional to the direct methods used for lab testing, for the purpose of simulating the behavior of the salt rock massif there has been used a geo-technical software based on Hoek Brown failure criterion. This criterion has been generally accepted and is being used all over the world with result which meet the engineering needs. There are still some uncertainties and sometimes results are not so accurate, reason for which numerical patterns and software to calculate the limit balance are being used.

Hoek and Brown [4] introduced their failure criterion in an attempt to provide input data for the analyses required for the design of underground excavations in rock. The criterion was derived from the results of research into the brittle failure of intact rock by Hoek and on model studies of jointed rock mass behaviour by Brown. The criterion started from the properties of intact rock and then introduced factors to

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reduce these properties on the basis of the characteristics of joints in a rock mass. The authors sought to link the empirical criterion to geological observations by means of one of the available rock mass classification schemes and, for this purpose, they chose the Rock Mass Rating proposed by Bieniawski [6].

The authors have proposed equations for the principal stresses with the view to characterizing the massif in a more convenient way that equations between tangential a normal stresses.

$$\sigma_1 = \sigma_3 + \sigma_{rc}\left(m_b \frac{\sigma_3}{\sigma_{rc}} + s\right)^a \quad (1)$$

where m_b is a reduced value of the material constant m_i and is given by equation

$$m_b = m_i \exp\left(\frac{GSI - 100}{28 - 14D}\right) \quad (2)$$

s and a are constants for the rock mass given by the following relationships:

$$a = \frac{1}{2} + \frac{1}{6}\left(e^{-GSI/15} - e^{-20/3}\right) \quad (3)$$

$$s = \exp\left(\frac{GSI - 100}{9 - 3D}\right) \quad (4)$$

The basic relations used to simulate stress based on the generalized Hoek-Brown criterion start from of the principal stresses given by equation (1).

We used notation in above relation:

σ_1- major principal stress at failure;

σ_3- minor principal stress at failure;

m_i and s– material constants (s = 1 for intact rock);

GSI- Geological Strength Index;

σ_{rc} – uniaxial compressive strength of the intact rock.

D - a factor to allow for the effects of blast damage and stress relaxation.

According to Mohr-Coulomb criterion, the shearing stress τ for a normal given stress is got by equation (5). Since most geotechnical software is still written in terms of the Mohr-Coulomb failure criterion, it is necessary to determine equivalent angles of friction φ and cohesive strengths C for each rock mass and stress range.

$$\tau = c' + \sigma \tan \phi' \quad (5)$$

All these values can get by an estimate with the help of a straight line of the mean of certain values for the minor principal stresses, σ_3.

There are being plotted the diagrams for the major and for the minor principal stresses for Hoek and Brown and the equivalent of the Coulomb criterion.

For the case of rooms and pillars at salt rock from Ocna Dej Salt Mine, closed form solutions for both the Generalized Hoek-Brown and the Mohr-Coulomb criteria have been used to generate hundreds of solutions and to find the value of that gives equivalent characteristic curves. '

Considering all the said observations, we have been used this simulation method with the parameters and the properties of salt rocks under analysis implemented in the expert software Roclab. RocLab program includes tables and charts for estimating the uniaxial compressive strength of the intact rock elements (σ_{ci}), the material constant m_i and the Geological Strength Index (*GSI*) which depends on the massif disturbance due to blasting operations and relieve stress. It situated between 0 for the untouched in situ massif and 1 for the highly distributed massif.

2. EXPERIMENTAL STUDY - MEASUREMENT OF THE MECHANICAL CHARACTERISTICS OF THE SALT ROCK

For the case of salt located at Ocna Dej salt mine, the critical stress when the first fissuring may come out is within the range 10,266 and 13,362 MPa obtained through calculus.

In the Table 1 the main characteristics of the rock salt located within the area of Ocna Dej salt mine are presented. These characteristics have been determined in the laboratory and *in situ.*

Table 1

No. of sample	σ_{rclab} [MPa]	Characteristics in the massif [MPa]				Expansion threshold [MPa]	σ_{lldc} [MPa]	σ_{lldt} [MPa]
		σ_{rcm}	σ_{rtm}	C_m	σ_{critic}			
1	30,196	12,743 ÷ 16,992	0,789 ÷ 1,161	3,178 3,782	14,186 17,375	14,05	19,5850	0,8154
2	21,940	9,259 ÷ 12,346	0,573 ÷ 1,012	2,301 2,778	9,871 12,624	14,25	13,3353	1,3090
3	30,810	13,003 ÷ 17,338	0,805 ÷ 1,422	3,243 3,901	13,861 17,728	15,65	19,6510	0,8270
4	33,856	14,288 ÷ 19,052	0,884 ÷ 1,562	3,551 4,287	15,231 19,480	14,90	18,4092	0,9230
5	36,760	15,514 ÷ 20,686	0,960 ÷ 1,696	3,856 4,654	16,538 21,151	13,75	21,9060	1,2783
6	26,360	11,125 ÷ 14,834	0,688 ÷ 1,216	2,765 3,338	11,859 15,167	12,94	12,5930	0,4170

We can conclude that:

- Strength to tearing at uniaxial compression is between (21,94 ÷ 36,76) MPa with a mean of 29,35 MPa.
- Tearing resistance to traction is between (1,257 ÷ 2,154) MPa, with a mean of 1,705.
- The salt located at Ocna Dej salt mine displays a tearing resistance to shearing between (4,25 ÷ 8,11) MPa for a normal shearing stress and (3,91 ÷ 6,81) MPa for the tangential shearing stress
- The level of salt cohesion situates within large limits, depending on the method used to determine this level. So, the level of cohesion determined by Mohr method situates between (2,39 ÷ 4,42) MPa, with a mean of 2,353 MPa. The level of cohesion determined by testing to shearing situates between (4 ÷ 5,11) MPa.
- During a triaxial compression, the salt cohesion situates between (7 ÷ 8) MPa. A mean value or the value gained during testing to shearing shall be used to calculate stress because it has been founded out that salt usually tears off during shearing.
- The flow ratio which displays values between (0,58 ÷ 0,77). With the help of this flow ratio it has been possible to calculate the long standing limit resistance between (12,59 ÷ 21,9) MPa, and the long standing resistance to traction between (0,417 ÷ 1,309) MPa.

3. EVALUATION OF SALT MASIFF STRENGTH USING ROCLAB

We have made simulations for the test items sampled from the salt rocks of Ocna Dej mining field, starting from the resistance to compression got during lab testing .Knowing the strength to tearing at uniaxial compression of rocks derived from the geological and mechanical characterization of salt, there have been performed simulations for each value of σ_{rc} shown in the summary Table 1.

We select the GSI index from chart given by program, like in Figure 1. For the case of simulations when the GSI values situate within the range (85-90), one could notice the best behavior when GSI = 85, i.e. an almost untouched rock massif, suitably structured by internal connections, with cubic shaped blocks structured following the three axes crossed by few discontinuities.

The constant of material m_i, shown in the generalized criterion, has been considered according with the recommendations valid for this criterion and corresponding to salt rocks, in compliance with the geological and morphological structure of salt. We have performed simulations for m_i at 10 and 12 and have noticed that recorded the best behavior at $m_i = 12$.

The use of the factor of disturbance D is aimed at assessing the manner of massif excavation. The influence of factor D can be quite wide and considered within the range (0-1). When D = 0, the massif is untouched, undisturbed on slightly disturbed (this situation doesn’t generally correspond to salt) and goes up to a very bad blasting operation performed on hard rocks. We have selected a D = 0.1 (we considered that this value gives off more realistic results).

By using the software RocLab based on the mathematical pattern proposed by Hoek-Brown we got the strength of the salt rock inside the massif, Figure 2.

Consequently one can notice that if we consider both the natural fissures inside the salt massif and the fissures induced by drilling-blasting operations during salt mining, the characteristics of salt inside the massif (pillars-panels) are more diminished compared to the one gained in the laboratory.

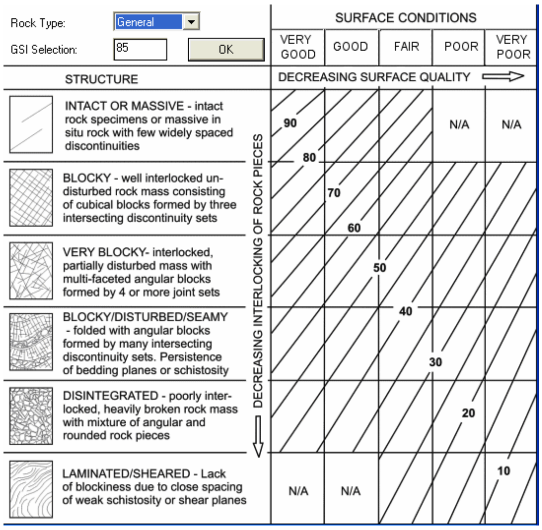

Figure 1. Pick of the GSI value

Also, the pattern we have used show the first fissures in the supporting elements (pillars, panels) when salt is mined out by dry methods. This thing is not wished for as at the very moment when cracking tearing occurs, this process cannot be stopped any longer and the whole stability of the supporting elements menaced.

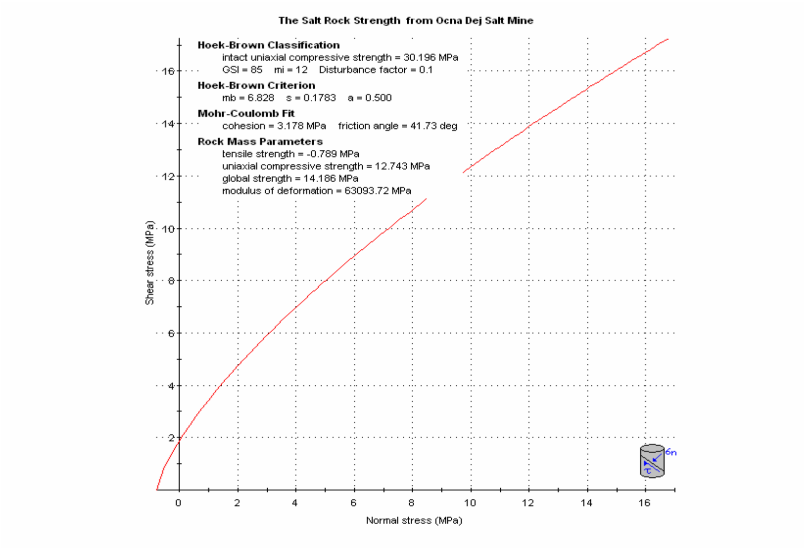

Figure 2. Analysis of Salt Rock Strength from Ocna Dej Mine using RockLab

The basic relations used to simulate stress based on the generalized Hoek-Brown criterion start from of the principal stresses, where m_b is the reduced value of the constant of material m_i and is given by equation (2).

4. CONCLUSIONS

By comparing the rheologicaly determined mechanical strengths with the ones gained by using Hoek-Brown failure criterion, everybody can notice that their values are quite close; this means that the devised pattern can be successfully implemented in real life situations.

The resistance to traction, compression and cohesion register close values, previously gained with the help of the two procedures: laboratory and modeling simulation.

Consequently one can notice that if we consider both the natural fissures inside the salt massif and the fissures induced by drilling-blasting operations during salt mining, the characteristics of salt inside the massif (pillars-panels) are more diminished compared to the one gained in the laboratory.

BIBLIOGRAPHY

[1]. Arad, V., 2004, *Rock Mechanics*, The didactic and Pedagogical Publishing House, Bucharest

[2]. Arad, S., **Arad, V.,Veres, J, Moraru, R, so on.**, 2006. *Study of the land unsteadiness during mining of salt in solution based on the simulation of the state of stress*, Proc. of Intern. Sym.MPES2006, Torino, Printed in Italy by FIORDO S.r.l., pg. 1347- 1352

[3]. Arad, V., 2006, *Mechanical of Salt Rock*, (in press)

[4]. Hoek, E., Carranza-Torres, C., Corkum, B., 2002. *Hoek-Brown failure criterion*, Rocscience Inc., Toronto, Canada

[5]. Hoek, E. and Brown, E.T. 1980. *Empirical strength criterion for rock masses*. J. Geotech. Engng Div., ASCE **106** (GT9), 1013-1035.

[6]. Bieniawski Z.T. 1976. *Rock mass classification in rock engineering.* In Exploration for Rock Engineering, Proc. of the Symp., (ed. Z.T. Bieniawski) **1**, 97-106. Cape Town, Balkema.

[7]. Jeremic, M.L. 1994. *Rock mechanics in salt minig*, A.A. Balkema, Rotterdam.

[8]. Stamatiu, M., et al. 1959. *The issue of the sizing of pillars at salt mines in Romania*. Publishing House of the Romanian Academy, Bucharest.

[9]. Stamatiu, M., et al. 1962. *Rocks Mechanics*. The Didactic and Pedagogical Publishing House, Bucharest.

ANALYSIS REGARDING THE GEO – MECHANICAL CHARACTERISTICS OF AGGREGATES EMPLOYD IN THE DN 66 INFRASTRUCTURE REHABILITATION

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Abstract: The 66 national roadways have on the section comprised between Simeria and Tg. Jiu, a length of 180 km, making the link between Gorj county and Hunedoara county. To rehabilitate DN 66 roadway, the geo – mechanical characteristics of employed rocks were determined, according to the standard STAS 1667/76. According to the admissibility conditions the rocks are belonging to B class from SR 667/2001, so they can be used for roadway works.

1. GENERAL CONSIDERATIONS

The National Roadway DN 66 provides the connection from the central to the southern area of the country, passing through cities of Simeria, Hateg, Petrosani, Bumbesti Jiu and Tg. Jiu.

DN 66 roadway connects the above – mentioned counties by the Gorge of Jiu river, representing a significant cross – sectional way which passes through Vâlcan and Parâng mountains, deepened in epimetamorphic and mesometamorphic crystalline schist.

Coming out from the Jiu river Gorge, DN 66 traverses the Petrosani depression, located between Retezat Mountains, Parâng Mountains and Vâlcan Mountains, thorough the city of Petrosani, with a prolongation in HAteg depression, located between Retezat Montains in South Sebes Mountains in Est and Poiana Rusca Mountains at West. In the Northern side of Hateg depression, separated, from this one at the Northern summit by the city of Hateg, is located the Strei depression, comprised between Poiana Rusc[Mountains, Sebes mountains and Mures river Valley.

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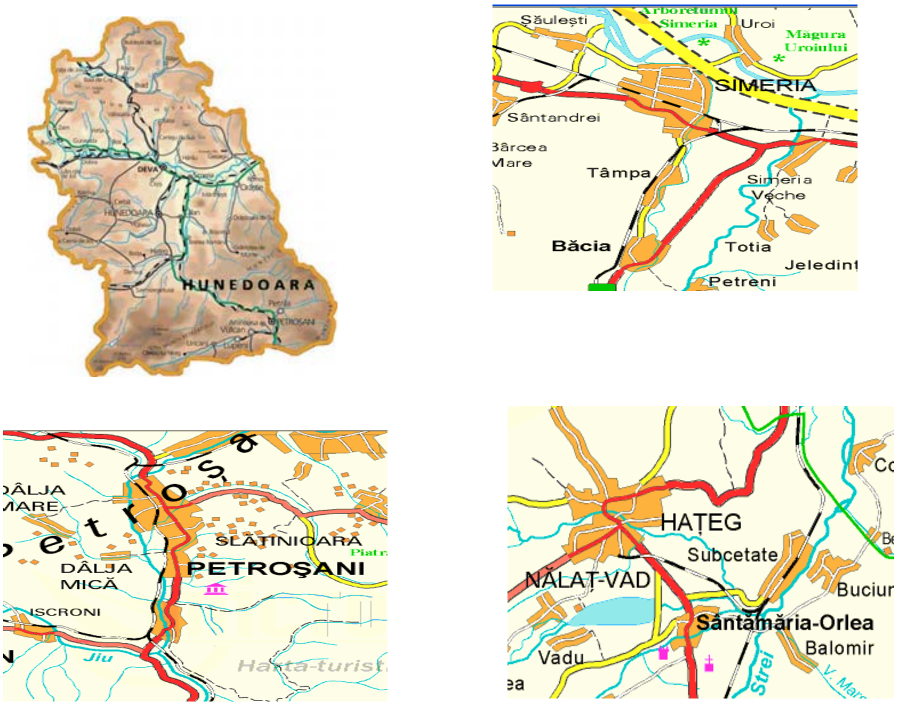

Figure 1 Map of Hunedoara County an DN 66 roadway

2. GEO – MECHANICAL CHARACTERIZATION AF AGGREGATES

Building and maintaining roadways involves the use of high quantities of row materials, from which the most significant weight is detained by the natural aggregates. In these circumstances, the accurate assessment of the natural aggregates quality is a basic requirement. According to the geo – mechanical characteristics of each aggregate are mentioned in standards, together with the limit values for the physical and mechanical characteristics considered for each aggregate type, the alternatives of use in the roadway sector are set.

The specific tests to carry out on natural aggregates are mentioned in standards, together with the limit values for the physical and mechanical characteristics considered for each field of application.

The natural aggregates issued from ballast – pits (sand, gravel, ballast) are having wide application field in roadway building and maintenance and there are most frequently obtained from river or bank ballast – pits, operating temporarily or permanently.

The rocks used in obtaining natural stone products are classified in five classes A, B, C, D, E, according to their main physical and mechanical characteristics, namely>

- apparent porosity at normal pressure;
- compression strength in dry state;
- wear, with Los Angeles machine;
- crushing strength by dry state compression;

- strength to frozen – defrozen test.

Natural rock products employed in roadway works should originate from:

- magmatic rocks (granites, granodiorites, riolites, dacites, trahites, diorites, andesites, gabbros, basalts, diabases, melaphyrs)<
- metamorphic rocks (gneisses, amphybolites, quartzites, crystalline limestones);
- sedimentary rocks (limestones, dolomites, sandstones, breccias)

The rocks should be:

- homogenous regarding their structure, their petrographic and mineralogic composition;
- without obviously visible physical or chemical alteration marks;
- free of pyrite, limonite or soluble salts;
- free of micro – crystalline silicon, which can reacts with the alkalies contained in cements.

It is prohibited the use of natural aggregates containing granules, issuing from soft, britlle, friable, porous rocks, higher than:

- 10 % for crushed stone;
- 5 % for chippings.

The rocks employed to obtain natural stone products, classified according their intrinsic characteristics, for roadways, and must be included in classes, according to table 1.1.

Table 1.1

Characteristics	**Rock class**					**Testing methods**
	A	**B**	**C**	**D**	**E**	
	Admissibility conditions					
Apparent porosity at normal pressure, %, max.	1	3	5	8	10	STAS 6200/13
Compression strength in dry state, N/mm^2, min.	160	140	120	100	80	STAS 6200/5
Wear with Los Angeles machine, %, max.	16	18	22	25	30	STAS 730
Crashing strength in dry state compression, %, min.	70	67	65	60	50	STAS 730
Strength to frozen-defrozen test: - gellivity coefficient (μ_{25}) ,%, max. - frozen sensitivity (η_{d25}), %, max.	 3 25					STAS 730

For the rocks that are not fulfilling the conditions from table 1.1., the class of the rocks is determined by the apparent porosity or the wear with Los Angeles machine, decisive being that who indicates the lower class. The rocks not respecting the frozen – defrozen strength admissibility conditions should not be employed for roadway works.

The geo – mechanical characteristics obtained and the admissibility of rocks and aggregates are synthetized in tables 1.2 and 1.3.

Table 1.2. Geo – mechanical characterization of basic rocks

Characteristic	Rock type	Improved by SR 667/2001	Achieved Baru Mare Ballast pit	Achieved Ponor Ballast pit	Achieved Tg.Jiu – Iezureni Ballast pit
Apparent porosity at normal pressure, %, max.	1.	3	4,79	2,88	2,34
	2.		6,02	2	1,82
	3.		2,08	2,59	3,63
	4.		-	5	2,14
Compression strength in dry state, N/mm^2, min.	1.	140	96,5	107,6	110,9
	2.		138,9	99,6	161,6
	3.		105,5	109,2	-
	4.		-	105,3	-
Wear with Los Angeles machine, %, max.	1.	18	15	18,5	17,4
	2.		16	19,5	18
	3.		-	-	-
	4.		-	-	-
Wear strength, Deval apparatus, %	1.		3,41	3,1	2,56
	2.		2,5	2,35	2,1
	3.		-	-	-
	4.		-	-	-
Quality coefficient, min.	1.	15	12,73	12,9	15,62
	2.		16	17,2	19
	3.		-	-	-
	4.		-	-	-
Compression strength of rocks in saturated state, N/mm^2, min.	1.	90	94,5	95,4	98,4
	2.		130,1	90,9	145,4
	3.		95,6	91	-
	4.		-	95,4	-
Gellivity coefficient (μ_{25}) ,%, max.	1.	3	0,12	0,9	0,9
	2.		0,25	1,01	1,15
	3.		0,18	0,5	-
	4.		-	0,81	-
Frozen sensitivity (η_{d25}), %, max.	1.	25	4,55	14.4	18,2
	2.		12,74	10,54	10,02
	3.		10,29	18,58	-
	4.		-	12,53	-

Table 1.3 Geo-mechanical characterization of grades

Characteristic	**Grade [mm]**	**Improved by SR 667/2001**	**Achieved Baru Mare Ballast pit**	**Achieved Ponor Ballast pit**	**Achieved Tg.Jiu – Iezureni Ballast pit**
Wear with Los Angeles machine, %, max.	4 – 8	20	17	18,2	19,6
	8 – 16		18,5	17,95	19
Wear strength, Deval apparatus, %	-	-	-	-	-
Quality coefficient, min.	-	15	-	-	-
Crashing strength by compression: - in saturated state, %, min. - in dry state, %, max.	4 – 8	60 15	92,69/24,8	-	72,14/14,8
	7 – 16		-	77,09/14,04	-
	8 – 16		93,15/20,4	-	81,47/14,20
	16 – 25		95,26/19,2	-	-
	16 – 31		-	81,71/13,85	-
Dipening coefficient after saturation, min.	4 – 8	0,8	3,73	-	4,87
	7 – 16		-	5,49	
	8 – 16		4,56		5,73
	16 – 25		4,98	-	-
	16 - 31		-	5,908	-
Strength to the iterative action of sodium sulphate, 5 cycles, %, max.	3 – 7	3	-	0,56	-
	4 – 8		-	-	0,75
	7 – 16		-	0,52	-
	8 – 16		0,84	-	0,54
	16-25		0,52	-	-

3. CONCLUSIONS

1. Consequently to the laboratory tested carried out, certain conclusions, regarding the rocks and aggregates obtained in Baru-Mare, Ponor-Hateg and Tg. Jiu-Iezureni ballast-pits and employed in DN 66 roadway infrastructure, can be drawn.

Mineralogical and petrographical analysis are emphasizing the types and content of each mineralogically defined compound:

- GRADE 0 – 4 mm> quartzite 65 %, amphibolite 8 %, muscovite 3 %, quartz granoclasts 16 %, calcite 8 %;
- GRADE 4 – 8 mm : quartzite 20 %, amphibolite 22 %, sandstone 45 % (quartz, sillicated cement, muscovite), calcite 8% :

• GRADE 8 – 16 mm> quartzite 56 %, amphybolite 27 %, sandstone 3 % (quartz, sillicated cement, muscovite), granite 3 %, limestone 2 %, phyllite 2 %.

2. The framing conditions of these rocks obtained by blasting (50 – 120 mm) are of B class, according to table 1.1., SR 667/2001, applicable for roadway works.

Analysing the values comprised in tables 1.2. and 1.3., it comes that the rocks from the three mentioned ballast-pits find themselves in the admissibility conditions imposed by actual standards and legal requirements and, consequently, they can be employed in the rehabilitation work of DN 66 roadway.

4. REFERENCES

[1.] Arad, V. – *Mecanica rocilor,* Editura Didactică şi Pedagogică, Bucureşti, 2004;

[2.] Arad, S., Arad, V., Chindriş, Gh. – *Geotehnica mediului,* Editura Polidava, Deva, 2000;

[3.] Arad, V. – *Geotehnică minieră,* Editura Tehnică, Bucureşti, 1995

[4.] Mutihac, V. – *Strucutra geologică a teritoriului României,* Editura Tehnica, Bucureşti 1990;

[5.] *** - SR 667/2001

[6.] *** - STAS 1667/76

THEORY OF INTEGRAL MODELLING – A METHODOLOGY OF RHEOLOGICAL DESCRIPTION OF A SEDIMENTARY ROCK – MASS

MIHAELA TODERAŞ*

Abstract: Carrying out of underground excavations entails the appearance and occurrence of some movements of the rock – mass around them. The movements are influenced not only by the geo-mining factors, but, mainly, by the geo – mechanical characteristics of the rock – mass: structural features and resistance and deformation characteristics, the nature of reversability and irreversability of deformations. We describe a possibility of rheological description of a sedimentary rock – mass through utilization of theory of integral modelling.

Key words: anisotropy, stratification, heterogenity, reversibility and irreversibility deformations, integral modelling, tensors, creep nuclei.

1. INTRODUCTION

The movements are influenced not only vy the geo-mining factors, such as: depth, geometric parameters of the working, sinking method, but, mainly, by the geo – mechanical characteristics of the rock – mass: structural features (heterogenity, anisotropy, stratification) and resistance and deformation characteristics, the nature of reversability and irreversability of deformations.

2. RHEOLOGICAL DESCRIPTION TROUGH UTILIZATION OF THEORY OF INTEGRAL MODELLING

In view of description of those movements by means of an analytic model, function of the geo – mechanical parametres specified, a rock – mass of sedimentary nature made up of n layers has been taken into account. Each of those layers is heterogenous, orthogonal, anisotropic, having various moduli of elasticity. On the basis of this reason the general deformation ε in any point of the rock – mass is result of the sum of elastic deformation ε^{e}, and those rheological irreversible $\varepsilon^{r\,i}$, namely:

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$$\varepsilon = \varepsilon^{e} + \varepsilon^{ri} \tag{1}$$

or in the integral form:

$$T^{(n)}_{\varepsilon_{ij}}(t)\,\delta_{ij} = T^{(\pm n)}_{E_{ijlm}}\,T^{(n)}_{\sigma_{lm}}(t) + \int_0^t K^{\pm(n)}_{ijlm}(t-\tau)\,\sigma^{(n)}_{lm}(\tau)\,d\tau \tag{2}$$

in which: $T^{(n)}_{\varepsilon_{ij}}, T^{(n)}_{\sigma_{lm}}$ are tensors of the deformation, respectively of the stress for the component (n) of the rock – mass; $T^{(\pm n)}_{E_{ijlm}}$ is the tensor of parameters of elasticity of rocks with various moduli for the components (n) of the rock – mass; $K^{(\pm n)}_{ijlm}(t-\tau)$ is the tensor of the creep nuclei, expressing the rheological deformations; δ_{ij} is the Kroneker's symbol.

From relation (1) the components of stress tensor were obtained, as being:

$$T^{(n)}_{\sigma_{lm}}(t)\,\delta_{ij} = C^{\pm(n)}_{lmij}\,T^{(n)}_{\varepsilon_{ij}} - \int_0^t R^{\pm(n)}_{lmij}(t-\tau)\,T^{(n)}_{\varepsilon_{ij}}(\tau)\,d\tau$$
$$\varepsilon_{ij} = 0 \quad ; \quad i \neq j \tag{3}$$

in which: $R^{\pm(n)}_{lmij}(t-\tau)$ are the resolvants of the creep integral nuclei, named accordind to (3) ***relaxation nuclei***.

As representation of Euler type, the balance equations are the following form:

$$T^{(n)}_{\sigma_{lm,xm}}\,\delta_{lm} + \rho\,\gamma_l = \rho\,u^{(n)}_{l,tt} \tag{4}$$

After the derivations of (3) and substitution in (4) yields:

$$C^{\pm(n)}_{lmij,x_m}(x_i)\,T^{(n)}_{\varepsilon_{ij}}(t) - \int_0^t R^{\pm(n)}_{lmij,x_m}(t-\tau,x)\,T^{(n)}_{\varepsilon_{ij}}(\tau)\,d\tau + C^{\pm(n)}_{lmij}(x_i)\,T^{(n)}_{\varepsilon_{ij}}(t) -$$
$$- \int_0^t R^{\pm(n)}_{lmij}(t-\tau,x_i)\,T^{(n)}_{\varepsilon_{ij},x_m}(\tau)\,d\tau + \rho\,\gamma_l = \rho\,u^{(n)}_{l,tt} \tag{5}$$

Following a determined time interval, the deformations of the rock – mass reach certain values maintaining constant.

Tensor of those final deformations may be expressed by means of the components of U_l movements in the form:

$$T^{(n)}_{\varepsilon_{ij}}(t) = \frac{1}{2}\left(U^{(n)}_{i,x_j} + U^{(n)}_{j,x_i} + U^{(n)}_{n,x_i} \cdot U^{(n)}_{n,x_j}\right) \tag{6}$$

Therefor, on the basis of relation (6), the equation of the tensor of the general deformation from the n rock – layer, becomes:

$$\frac{1}{2}C^{\pm(n)}_{lmij,x_m}(x_i)\left[U^{(n)}_{i,x_j}(t)+U^{(n)}_{j,x_i}(t)+U^{(n)}_{n,x_i}(t)\cdot U^{(n)}_{n,x_j}(t)\right]-$$
$$-\frac{1}{2}\int_0^t R^{\pm(n)}_{lmij,x_m}(t-\tau,x_i)\left[U^{(n)}_{i,x_j}(\tau)+U^{(n)}_{j,x_i}(\tau)+U^{(n)}_{n,x_i}(\tau)\cdot U^{(n)}_{n,x_j}(\tau)\right]d\tau+$$
$$+\frac{1}{2}C^{\pm(n)}_{lmij}(x_i)\left[U^{(n)}_{i,x_jx_m}(t)+U^{(n)}_{j,x_ix_m}(t)+U^{(n)}_{n,x_ix_m}(t)\cdot U^{(n)}_{n,x_j}(t)\right]- \qquad (7)$$
$$-\frac{1}{2}\int_0^t R^{\pm(n)}_{lmij}(t-\tau,x_i)\left[U^{(n)}_{i,x_jx_m}(\tau)+U^{(n)}_{j,x_ix_m}(\tau)+U^{(n)}_{n,x_ix_m}(\tau)\cdot U^{(n)}_{n,x_j}(\tau)+\right.$$
$$\left.+U^{(n)}_{n,x_i}(\tau)\cdot U^{(n)}_{n,x_jx_m}(\tau)\right]d\tau+\rho\,\gamma_1=\rho\,U^{(n)}_{1,tt}$$

If in the equations system (7) the terms determining the rheological deformations of the rock – mass are elimined and the fact that the rocks have various moduli of elasticity is neglected, the basic equations of the movements within the limits of elastic deformations are obtained.

In the case in which we consider that the parameters of elasticity of the rock – mass are identic too, meaning rock – mass of continuous homogeneity, unlayered, the equations system will become identic with that of the traditional theory of elasticity, namely:

$$\frac{1}{2}C_{lmij}\left[U_{i,x_jx_m}(t)+U_{j,x_ix_m}(t)+U_{n,x_j}(t)\cdot U_{n,x_ix_m}(t)+\right.$$
$$\left.+U_{n,x_i}(t)\cdot U_{n,x_jx_m}(t)\right]+\rho\,\gamma_1=0\left(\rho\,U_{l,tt}\right) \qquad (8)$$

The system of integro – differential equations determining the movements of nay layer which makes up the rock – mass taken into account.

We specify that the first and the third term of the system (7) express the reversible elastic deformations of the rock – mass; the second and the fourth terms are the irreversible rheological deformations.

3. CONCLUSIONS

Such a model resolvable by digital way gives the possibility to study the behaviour of deformation; to assess the final movements and deformations around the mining workings during a determined period of time.

BIBLIOGRAPHY:

[1]. Goldenblat, I.I., *Nacaturâe voprosâ mehaniki deformiruemâh*, Moskva, 1955.

[2]. Minichev, I.T., *Ein integral model der rheologischen vertormungen des Gebirges*, The 4th International Congress of Rock Mechanics, Montreux, Suisse, 1979.

[3]. Toderaş, M., *Cercetări referitoare la caracterizarea comportamentului reologic al rocilor din bazinul Valea Jiului şi implicaţiile acestuia în asigurarea stabilităţii lucrărilor miniere orizontale principale*. Universitatea din Petroşani, 1999.

CONSIDERATIONS REGARDING THE CORRELATION OF BASIC MINING PARAMETERS IN THE GEOMINING CONDITIONS FROM JILȚ BASIN

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Abstract: Nowadays the factors affecting the demand in the opencast mining industry arc the, result to the energetically market mechanisms, being influenced by the material and financial resources, bath available and potential.

1. ASSESSMENT CRITERIA FOR MINING PARAMETERS IN QUARRIES.

In the present juncture, the demand factors arc the result of the combined action energetically market mechanisms, being affected, by, material and financial, and resources available or potential, by salaries, prices, consumption level and traditions.

The quantitative and qualitative dimensions of the demand and his fluctuation over variant time lapses arc determined by factor acting individually or as a whole, with direct or indirect effects, an average or long term.

The restructuring process is imposed by:

• Insufficiently oriented investment programs;

• need for maintaining the, link with modern technologies, preserving raw materials as well as the environment;

• need for a better valorisation of human potential.

In the opencast mining sector, the reshaping strategies arc focused mainty towards:

• The modernization of existing equipments and technologies, in order to decrease the material expenditures, to improve the technical facilities and the output quality;

• The concentration of certain investment funds in research and development

Activities, contributing consequently to a higher valorisation level of the product and to facilitate an expeditions answer to any request on the market;

• availing the un favourable social impact related to output capacities reduction, through programs aiming to redirect the employed labour force.

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• financial strategies able to provide an increase of the mining unit's gain and profit.

2. DEFINING A QUARRY'S OUTPUT CAPACITY

The output capacitz of a quarry represents the quantity of raw mining mass exploited in a time unit; it can be expressed in tons or cubic meters per day, month or year.

The dependency between the total raw mining mass Qmm, m^3/year, and the commercial mineral output qu, t/year, is given by the fallowing relationships:

$$Q_{\min} = \frac{Q_u}{\gamma} + Q_S \ (\mathrm{m^3/min}) \tag{1}$$

and

$$Q_S = Q_U \quad K_{rt}.(\mathrm{m^3/year}) \tag{2}$$

Where:

Ỵ - volume weight of the commercial mineral, t/m^3;

K_{rz} – current opening – up coefficient

Consequently:

$$Q_{\min} = \frac{Q_u}{\gamma} + Q_s + Q_u K_{rt} = Q_u\left(\frac{1}{\gamma} + K_{rt}\right) \tag{3}$$

The output capacity of a quarry is determined by several technical and economical factors, from who there should be mentioned:

• the commercial mineral's nature;
• Its importance within the national economy circuit;
• the magnitude of the mineral deposit;
• the output selling price;
• the production cost per mined out ton, considering also, the, opening – up expenses;
• geological conditions of the mineral deposit;
• the mining method applied;
• the capital specific and absolute magnitude of expenditures for developing the quarry;
• the level of investment needed to acquire the land surfaces.

The output capacity in commercial mineral of a quarry is not a fixed value, it can change in a certain range whose boundaries arc a minimal value, and a maximal one, in which the deposit can be profitable to be exploited. Outside this range, the exploitation wills indure significant losses.

The output capacity influences all the future's quarry indicators, mainly the cost of the mining products. It comes that law content deposits arc exploitable only at

High or very high level output capacities.

There exist two criteria for assessing the output capacity;

- the valorisation cost criteria;
- the criteria of mining possibilities offered by the deposit and mining techniques.

Considering the cost criteria, the optimal output capacity con is assessed as the value corresponding to minimum costs obtained on the entire life cycle.

When applying this criterion it is recommended to start from the structure of expenditures per output unit, expressed as a function of the yearly output capacity.

Imposing the condition of minimum for this function, the optimal value Q_{OU} of the yearly output capacity Q_U can be determined.

A quarry's output capacity will always be related to the commercial reserves and to those effectively exploited in the quarry.

With respect to the quantity of commercial reserves, the output capacity can also be assessed considering the rational duration of the quarry, on which length the repayment of investments can be achieved at acceptable levels.

High output capacities arc requiring high level investments of low levels on longer duration of mining. Selecting one or another regime will depend on the demanded of the national economy and the variations of products sale prices.

In a general manner on optimal output capacity, Q_{OU} is established corresponding to a minimum cost per extracted ton and considering on overage sale price.

Usually, the designed output capacity Q_{OU} represents 80% from the capacity to be provided by the basic mine workings and major equipments available; consequently, if becomes possible to increase the output without further investment expenditures.

3. THE HOURLY CAPACITY OF BUCKET WHEEL EXCABVATORS

The process of rock excavation from the massif is influenced by;

- dimensions, shape and technical state of the cutter;
- rocks nature and strength;
- work management level.

The excavator's capacity highly, depends on various factors which can be included in four categories:

a) Technical and operational characteristics of the excavator

- Number of buckets on the wheel;
- a bucket's volume;
- number of discharges per minute;
- the wheel's diameter;
- the displacement speed of the wheel holder bar;
- the filling degree and the cliseharging degree of the buckets;
- the wear degree of knife and picks;

- the equipment's length of service.
b) Geometrical characterises of the rock mass
- granulometry;
- volume weight;
- cohesion and shearing strength;
- adherence of the rock mass;
- moisture content and plasticity;
- the friction coefficient;
- cutting strength.
c) Geometrical elements of the mining bench.
- height of the outing bench;
- total height of the bench;
- high wall angle of the bench;
- working block's width.
d) Labour force training level and work management
- excavator's operator skills
- location of the excavator in the face;
- Knowledge of the optimal timing for knife and picks replacement.

Further, the factors affecting particularly the hourly capacities of excavators will be presented.

The wheel's rotation speed (N)

This parameter is limited by the bucket's discharge time, namely the time lapse required for the bucket to cover the arch comprise between the take-over bin limits. The value of the centre angle (2) corresponding to this arch depends on the excavator's cutting capabilities. For angles of $\pm 18^{o}$ made by the whet holder bar with horizontal line (see figure 1) at which the take-over bin's margins have angle of 50^{0} with the horizontal line, the value of angle α will be:

$$\alpha = 180^{0} - 2\,(50^{0} - 18^{0}) = 44^{0} \quad (4)$$

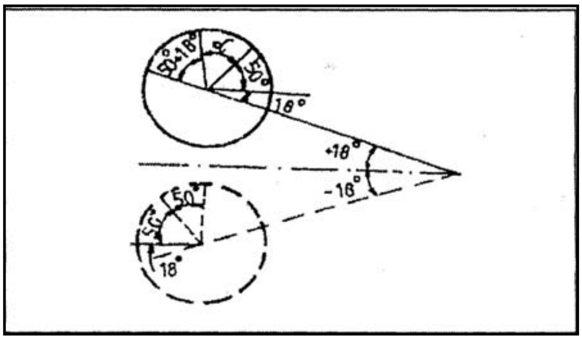

Fig. 1. Deduction of angle α from the boundary locations of the wheel holder bar.

For higher values than 44^0, the excavated material will be set on the take-over bin walls, if the wheel holder bar's angle with the horizontal line will have the values of $\pm 18^0$.

The rotation speed (N) of the wheel is assed based on the following parameters:

- the length L of the circle arch corresponding for bucket's discharge;

$$L = \frac{2\pi R\alpha^\circ}{360^\circ} = \frac{\pi \cdot 44^\circ R}{180} 0{,}244\pi R = 0{,}768R \quad (5)$$

- Bucket's discharge time:

$$tg' = \frac{L}{v_r} \quad (6)$$

where;

tg – discharge time;

v_r – peripherical speed of the wheel;

$$V_r = \frac{\pi RN}{30} \quad (7)$$

$$tg = \frac{0{,}244\pi R}{V_r} = \frac{0{,}244\pi R}{\frac{\pi RN}{30}} = \frac{7{,}32}{N}$$

k = 4÷ 5 – embarrassment coefficient of bucket's discharging;

h_l = maximum bucket's depth;

g = 9.81 m/s^2

Equalising the values of tg, w obtain:

$$\frac{7{,}32}{N} = \sqrt{\frac{2he}{g}}$$

$$N = \frac{7{,}32}{k}\sqrt{\frac{9{,}81}{2h_l}}$$

If the wheel's rotation speed limited to 4-5 rot/min, the increase of excavator's hourly output would be possible only by increasing the bucket's volume and the number of buckets on the wheel.

The alternative of increasing the volume of bucket's is net feasibly in the specific conditions from the quarries in Jilț basin the low thickness of barren streaks arc negatively affecting the bucket's filling coefficient.

Certain advantages can be obtained by increasing the number of buckets on the will, although this solution is limited, while increasing the wheel's diameter implies a higher resistant force at the wheelies periphery.

As a direct consequence, higher operating powers would be required and also heavier operating equipments, which finally would lead to a complex structure of the wheel holder bar.

The wheel radius is to be determined as a function of the resistance force:

$$P = \frac{M\omega}{102\eta} = \frac{RF\omega}{102\eta} = \frac{FV}{102\eta} \quad (8)$$

$$R = \frac{P \cdot 102 \cdot \eta}{F\omega} \quad (9)$$

Where: M – spinning moment kg-m:
- ω - angular speed, rad/s;
- η - efficiently;
- R - wheel radius, n;
- F - resistance force, kgf;
- V - peripherical speed, m/s.

The swivelling speed of the whet holder bar (v_h)

While, for the case fixed bar excavators, the excavated material thickness varies in a sickle shape, providing a constant value for the hourly excavator's output implies to control the wheel holder bar's swivelling speed.

The wheel holder bar's swivelling speed ($v_h = v_o$) needed for a complete bucket filling, in the bar position corresponding to the excavator's displacement axis, is directly dependent to the maximum possible output Q_c provided by the cutting device capacity of the conveying equipment, according to the following relationship:

$$V_O = \frac{Q_C}{60..S_{O.}.h} \quad (10)$$

where:

$$Q_C = \frac{Qz}{k_a}$$

where:

Q_Z – theoretical productivity, from the excavator's technical
K_a - loosening coefficient of the rock in the bucket;
Vo – computed value of the swivelling speed;
S_O – excavated material's thickness.

Together with the swivelling speed, the excavated material's thickness is also rectified, employing the relationship below:

$$S = \frac{Q_C}{60.V_O - h}$$

While the automated adjustment of the bar swivelling, speed is carried out proportional with the cosinus of Q angle of horizontal rotation, the maximum value of Q_c angle of which maximum swivelling speed is reached, is computed with the following relationship:

$$\varphi_C = arc\ \cos\frac{V_O}{V_{\max}} \qquad or \qquad V_{\max} = \frac{V_O}{\cos\varphi} \tag{11}$$

If the value of φ_C angle is lower than φ_1, the bar rotation angle, the swivelling speed in final position equals V_{max}

If the limit swivelling angle in a direction (left or right) is lower than value, the swivelling speed adjustment will be carried out until the wheel holder bar reaches its final position.

In the first case, the variable rotation angle ($\varphi_{\text{var}} = \varphi_C$) at variable speeds reaches the computed value φ_C, and in the second case the variable angle tends to the final angle φ_1 .

The swivelling speed mean value (V_n) will be assessed for the left and right side of the washer, according to the excavator's displacement axis, and then for the entire washer with the following relationships.

$$v_{m1} = \frac{v_0}{2\varphi_{\text{var}}} \cdot \ln\frac{1+\sin\varphi_{\text{var}}}{1-\sin\varphi_{\text{var}}}$$

$$v_{m1} = \frac{v_0}{2\varphi_2} \cdot \ln\frac{1+\sin\varphi_2}{1-\sin\varphi_2}$$

$$v_m = \frac{v_{m1}\cdot\varphi_{m2} + v_{m2}\cdot\varphi_{m2} + 2v_{\max}\left(\varphi_2 - \varphi_{\text{var}}\right)}{\varphi_1 + \varphi_2} \tag{12}$$

The cutting speed of the wheel (Vr)

This parameter can have variable values, corresponding to certain constructive characteristic of the excavator, such as:

- The size of wheel's diameter : D,m
- Number of discharges per minute: s
- Number of buckets per wheel : Z
- Number of revolutions per minute: n, rot/min

The computation relationship is the following:

$$V_r = \frac{\pi \cdot D \cdot N}{60} = \frac{\pi \cdot D \cdot n}{60 \cdot Z} \quad (13)$$

The angular speed is determined by employing the relationship below:

$$\omega_r = \frac{\pi \cdot n}{30} \quad (14)$$

Between the two speeds the following relationship exists:

$$V_r = \omega_r \cdot R \quad (15)$$

If the angular speeds are high, the buckets do not have enough time for a complete discharge.

The geomechanical rock characteristics are basic elements in highwall stability assessment. When determining the cutting strength value of the rock, the loading and discharging degree of buckets has a direct influence on the haulage power of excavated material to the dischargement point.

The washer's (under bench) height

This parameter's value depends on the barren intercalations thickness and also on the thickness of coal located in the litho logical column, being hardly to optimize for a unomogenous bench.

For the geological conditions present in the Jilt basin deposit, the working benchers are generally unomogenous. Duet o this reason, it is not feasible an optimal distribution of the bench height in working washers, but an average productivity can be achieved for every specific case.

Taking into consideration the physical and mechanical characteristic of rocks, for bench heights comprised between 12 m and 20 m, there are presented typical working schemes employed in the open – pits from Jilt Basin (see figure 2).

The average hourly output achieved by the excavator, working by any scheme presented, can be determined with the fallowing relationship

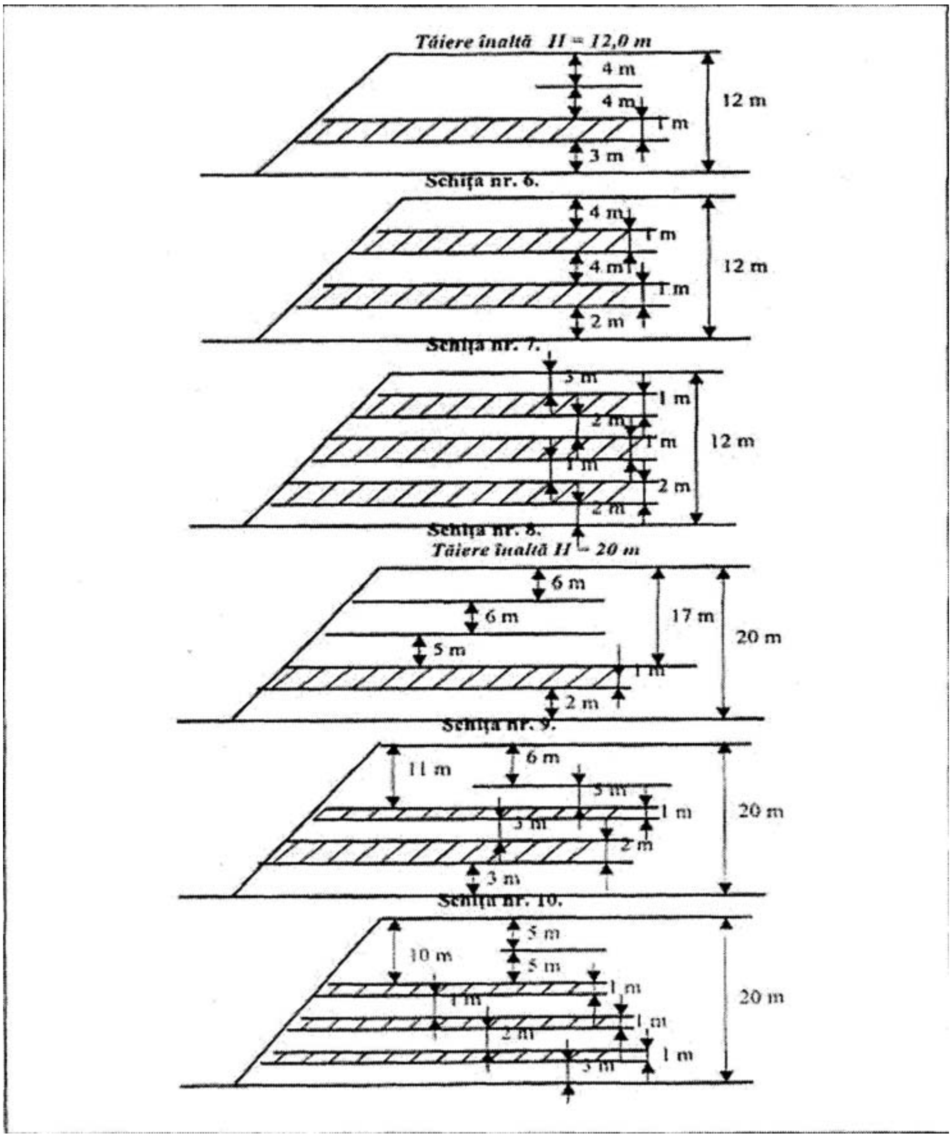

Fig. 2. Typical working schemes employed in Jilt basin

$$Q_m = \frac{H}{\sum_{I=1}^{I=N} \frac{h_i}{\eta \cdot Q_I}} \left[m^3 / h \right] \qquad (16)$$

Where: H – total height of working benches;
Q_1 – handy output provided by the supplier;
H_i - height of washers (or under benches).

The thickness of the excavated material (5)

The instantaneous excavator's productivity directly depends on the excavated material's height (h), his thickness(s) and the swilling speed (v_o). For the area passing through the displacement axis, the equation below is applicable;

$$Q_i = F \cdot V_0 \cdot 60 = s_0 \cdot h \cdot V_0 \cdot 60 \text{ [m}^3\text{/h]}$$

Based on this relationship, the link between the excavated material thickness and the washer's height at which the theoretical productivities achieved can be determined.

$$s = \frac{Q_i}{60 \cdot h_0 \cdot V_0}$$

The change of excavator's hourly productivity according to the excavated material's thickness takes place only between certain limits , because this parameter has a maximum limit imposed by the bucket's sizes, and for on excavated material height (h)and a swivel ling angle (Q), the swivelling speed (v_o) it limits the excavated material thickness.

The maximum excavated thickness is computed as it follows.

$$s_0 = \sqrt{\left(\frac{D_e}{2}\right)^2 - \left(\frac{D_e}{2} - h\right)^2} - \sqrt{\left(\frac{D_i}{2}\right)^2 - \left(\frac{D_i}{2} - h\right)^2}$$

where: D_R - wheel's diameter measured of the bucket's cutting edge;
Di - inner diameter of the wheel's ring;
H - excavated material's height.

The width of the excavated material (b)

In order to maintain a constant hourly productivity it is required to adjust the excavated material's thickness and the swivelling speed of the wheel holder bar (v_b).

The bar's swivelling speed, for a swivelling angle j measured to the excavators' displacement axis, will be given by:

$$v_\varphi = \frac{v_0}{\cos\varphi}$$

where: v_0 – swivelling speed in the displacement axis
v_φ - swivelling speed in position

This imposes that the swivelling speed in □ to be maximum half of the maximum speed swivelling speed recommended in the equipment supplier guide.

Between the number of discharges per minute (n), the swivelling speed (v_b) and the excavated material's thickness (b) the following relationships can be established.

$$b = \frac{v_b}{n}$$

$$b_{\min} = \frac{v_0}{n}$$

To obtain a constant hourly productivity, the adjustment will be carried out for $\varphi = 0^0 - 60^0$

$$b_{\max} = \frac{v}{n} = \frac{2v_0}{n}$$

The width of the excavation block

According to the following relationship, the excavation's block's width (A) directly influences on the excavator's hourly productivity:

$$Q_T = \frac{sbAv_b \cdot 60}{L} \quad [mc/h] \qquad (17)$$

where:

s – excavated material's thickness, m;
h – washer's height, m;
A – excavation block's width, m;
(v_b) – the wheel holder bar's swivelling speed, m;
L – length of the arch corresponding to the total swivelling angle (□);
$A_{\varphi 1}$ - block's width on the massif side;
$A_{\varphi 2}$ - block's width on the excavated side;
R – wheel's radius, measured until the cutting edge limit;
$A_{\varphi 1} = R \sin \varphi_1$
$A_{\varphi 2} = R \sin \varphi_2$

The length of the arch described by the wheel holder bar during the excavation process is:

$$b = \frac{\pi R(\varphi_1 + \varphi_2)}{180^0}$$

The excavated block length will be:

$$A = A\varphi_1 + \varphi_2 = Lb_0 \sin\varphi_1 + Lb_0 - Hctg\, i$$

where L_{b0} - the wheel holder bar's horizontal length

H - total height of the bench;

i – the high wall angle of the bench

CONCLUSIONS

Achieving the restructuration of a quarry's activity involves updating the mining perimeters in order to direct the investment funds towards to exploit new resources.

While the methodology of assessing the dimensional parameters of the mine (mining perimeter surface area, output capacity, commercial reserve) as a first stage of the design process is no more actual, it is imposed to apply analytical methods based on mathematical models, methods allowing the correlation of the significant parameters in economical efficiency conditions. According to this conception, the following approach should be followed:

- The optimal dimensions of the elementary production unit and the technological parameters are established according to the geological and mining conditions also considering the investment's economical indicators
- The dimensional parameters of the mining field are to be determined in the final stage, considering the existing demand on the coal market;

Perimeters reshaping requires a detailed analysis of the economical results being sustained by the following issues:

- The possibility of applying mining technologies fitted for higher than 2 km face length;
- The possibility to exploit reserves located in neighbour mining fields, having high opening-up ratios, for whom economical efficiency not be provided if exploited individually
- Transportation distances reduction
- Provision of dumping areas until the inner dumping will become feasible;
- Efficient exploitation of the reserves from the pillars located at the exploited mining perimeter's limits.

Criteria's for perimeter updating are established as a function of geological and mining conditions and the assumed level of economical results, being classified in:

- Technical and mining criteria
- Economical criteria

The technical and mining criteria considered when assessing the mining perimeter are determined are determined by the following factors:

- Stratigraphical, tectonic land hydrological factors of the deposit;
- Management factors (staff and personnel structure, quarry organization, etc.)
- Technological factors (equipment employed, surface area affected, conveying distances, etc)

The economical criteria will consider the hourly output significantly higher by modernization excavators.

REFERENCES

[1]. Boyte, A., *Proiectarea tehnologiilor de lucru in cariere*, Litografia U.T. Petrosani, 1997.
[2]. Fodor, D., *Exploatarea zacamintelor de minerale si roci utile prin lucrari la zi*, vol.I, II, Ed. Tehnica, Bucuresti, 1996, 1997.
[3]. Dobritanu, Ghe. *Referat de doctorat* Nr. 3 Petrosani 2006.

CONSIDERATIONS CONCERNING THE DETERMINATION OF TOP COAL CAVING HEIGHT

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Abstract: This paper involves the main criteria, which defines the establishment of the top coal caving height as a technical and economical criterion, geomechanical criteria and other derivates from these.

Key words: top coal; coal caving; top coal caving height; top coal stability; technical and economical optimisation.

1. GENERALITIES

The top coal caving height is the parameter that influences very deeply the technical and economical efficiency of the top coal caving mining methods. In this way, we must present this parameter implication in the mining output capacity of the face. Thus, it could be seen that, for the constant length of the coal face, the advancement speed of the face and the top coal height are two main factors that determine the coal output face capacity, which increases at the same time with the increasing of these parameters. On the other hand, the top coal height increasing implies a coal face speed decreasing (fig.no.1). That signifies that the coal output capacity value doesn't have a linear increasing with the top coal height (fig.no.2).

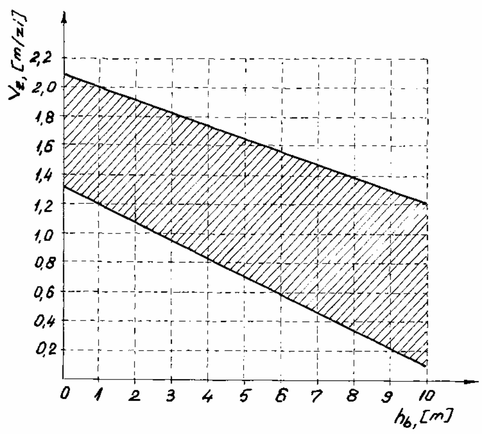

Fig.1. The face advancement speed decreases at the same time with the top coal height increasing (depending on the mining technology and the coal face length)

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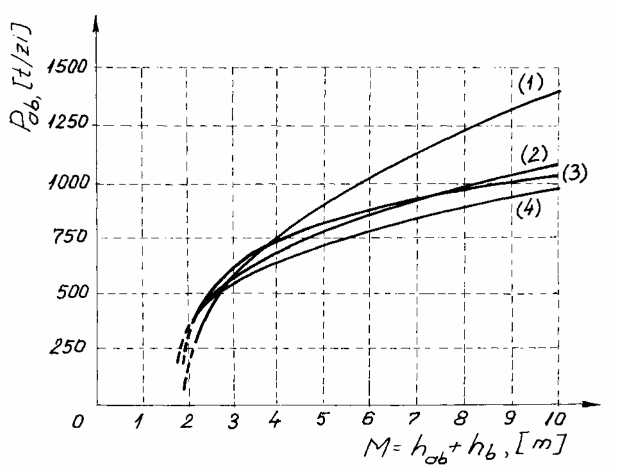


Fig.2. The coal output of the face in function of coal seam thickness for some mines from Hungary [6]: 1) Vasas; 2) Mecsek; 3) Kossuth; 4) Zobàk

Therefore, from the previous mentioned above we ascertain that the top coal height and the face advancement speed are some parameters with reverse-proportionally dependency, for which there must be found an optimum correlation from a technical and economical point of view depending on a face output increasing, taking into account the other criteria.

A fundamental economic advantage of the top coal height increasing is done by the physic and economic preparatory workings indicators reducing; more precisely, from a coal seam panel there could be mined a bigger coal reserve, with the same preparatory workings volume and implicitly with the same costs.

The excessive decreasing of the face advancement speed has a major contribution in the followings negative phenomenon arising: coal and rocks degradation around the coal face and around the preparatory workings (having as a result the mining pressure increasing, the decreasing of the excavations' stability and the increasing of the probabilities of rocks falling down arising in the faces and preparatory workings); the increasing of the endogenous fire arising risk, because of the increasing of the contact period between oxygen and the free surface of massive coal or broken coal lost in the gob; the increasing of the gas methane emanation from the rocks and coal strata in the preparatory workings network and the gob, because of the accentuate fracturing of them. Therefore, it could be said that in the underground every negative phenomenon, which puts in danger the security of the personnel, equipments and workings is accented during the time, respectively at the same time with the face advancement speed decreasing [6].

In the case of some coal seams and very unstable surrounding rocks, with a relative high strength, the natural (gravitational) caving of top coal and the surrounding rocks is difficult to make. In these conditions there must be acted using various techniques for reducing the strength: humectation of rock mass; pressure water injection; shake blasting, etc.

Between others, Jha and Karmakar [3] consider that the top coal height plays a very important role in the performances obtained with this mining method; if the thickness of the top coal is reduced, then the coal dilution increases because the roof rocks arise in the drawing doors; if the thickness is excessively greater, then the roof control becomes more difficult. As consequence, after these authors, the top coal caving leads to the best results when the top coal height ranges between 3m and 8m.

In conclusion, the top coal height optimisation is a very complex problem, which depends on several technical and economical analysis criteria and which, finally, must lead to the adoption of a value for the top coal height which makes a balance between all the advantages and disadvantages produced by the top coal increasing [6].

2. TECHNICAL AND ECONOMICAL OPTIMISATION OF TOP COAL HEIGHT

One between the technical and economical methods of the top coal height is the analytical method. In principle, after this method, there must be determined a general function that represents the production cost $\sum C(L_{ca}, l_{ab}, h_b)$, in lei/tonne, obtained to the panel level. This function results from the division of the total costs $\sum C_T(L_{ca}, l_{ab}, h_b)$ to the panel coal reserve:

$$\sum C(L_{ca}, l_{ab}, h_b) = \frac{\sum C_T(L_{ca}, l_{ab}, h_b)}{L_{ca} \cdot l_{ab} \cdot [h_{ab} + h_b] \cdot \rho \cdot \frac{\eta}{1-D}}, \text{ [lei/tonne]} \quad (1)$$

where: L_{ca} is the panel length, in m; l_{ab}-coal face length, in m; h_{ab}-face height, in m; h_b-top coal height, in m; ρ - apparent coal density, in t/m^3; η - coal mining recovery; D-dilution rate.

The cost function, which depends closely on the mining method and technology, could have the general form $\sum C(L_{ca}, l_{ab}, h_b)$, involving several constants C_1, C_2,…, C_n, which include the specific costs with materials, energy, amortisement and labour, economic preparatory workings indicators, work loads, etc.

For some certain practical cases of the top coal caving faces some terms of equation (1) aren't presented, thus this function presents a particular form that involves a reduce of the number of terms. This simplified representation of production costs results from the supposition that certain parameters are constants, being included in that equation in the medium value form.

In order to solve the optimisation problem of the mining method parameters by analytical method, there must be put in the condition that the function $\sum C(L_{ca}, l_{ab}, h_b)$ has a minimum value; the coal unit cost obtained with a certain mining method and technology must be minimum; that signifies that the partial derivatives of the function, reporting to the variables L_{ab}, l_{ab} and h_b vanish:

$$\frac{\partial \sum C(L_{ca}, l_{ab,} h_b)}{\partial L_{ca}} = 0; \quad \frac{\partial \sum C(L_{ca}, l_{ab}, h_b)}{\partial l_{ab}} = 0; \quad \frac{\partial \sum C(L_{ca}, l_{ab}, h_b)}{\partial h_b} = 0 \quad (2)$$

The relations (2) form an equation system with three unknowns L_{ca}, L_{ab} and h_b. Because that equation system, created for certain mining situations, is very complex and couldn't be solved analytically, it is preferred to make a sensibility analysis of the equations system reporting to the optimisation variables. Taking into account the fact that certain parameters contained by the model (as: drawing speed of the caved coal, coal recovery rate, coal dilution, etc.) depend on the top coal height, the previous equations became more complicated. For the Jiu Valley thick coal seams, with gentle and medium dips, mined with wall faces, a similar analysis is made by G.Chiril in his Ph.D. thesis [1] (fig.no.3,4 and 5).

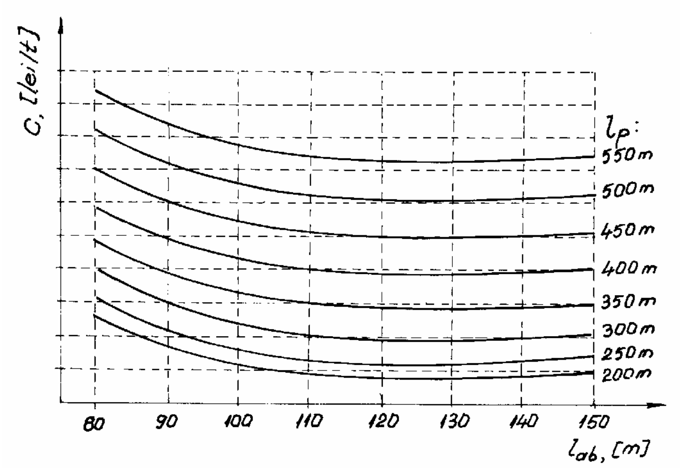
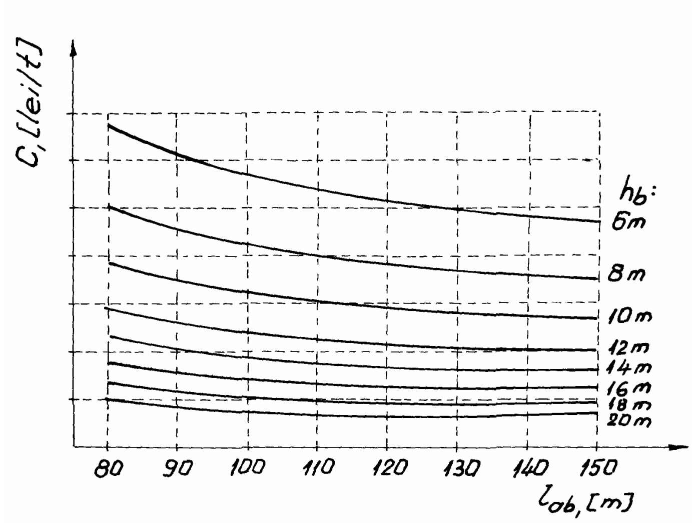


Fig.3. Costs variations c in the case of mechani-zed top coal longwall faces for: coal caving step w=1.25m; top coal height h_b=20m; panel extension l_p=200m, 250m,…,550m (l_{ab} is the longwall face length)

The equations (2) involve the costs generated by the driving and maintenance of the preparatory workings, amortisements and the equipments face maintenance, labour, energy, materials, etc.

Fig.4. Costs variations c in the case of mechani-zed top coal longwall faces for: coal caving step w=1.25m; panel extension l_p=200m; top coal height h_b=6m, 8m,..,20m (l_{ab} is the longwall face length)



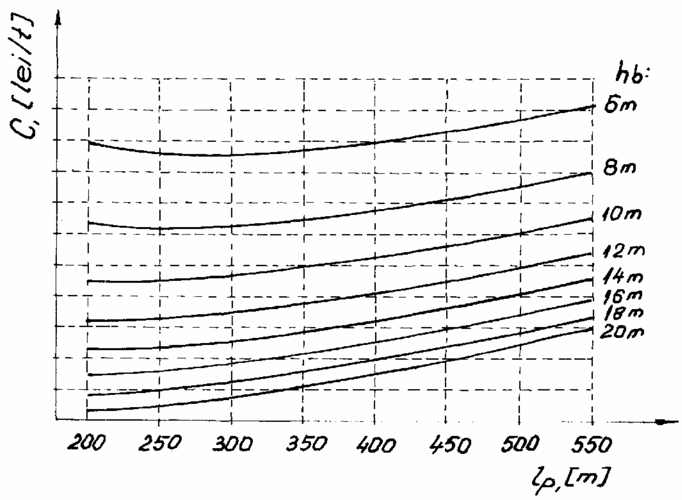


Fig.5. Costs variations *c* in the case of mechanized top coal long-wall faces for: coal caving step w=1.25m; longwall face length l_{ab}=130m; top coal height h_b=6m, 8m, .., 20m (l_p is the panel extension)

Taking into account the complexity of the production process, the labour costs result from a detailed analysis of them. Therefore, the duration of the production cycle involves the following periods of: coal front specific repeatable operation complexes; repeatable operation complexes superposed in front of face and coal caving line; repeatable operation complexes specific for the coal caving zone; non-repeatable operation complexes [6].

The main factors, which influence the cycle in the coal front of face, are the followings: the technology, equipment and face work conditions, the worker number and their qualification. Also, the secondary factors that affect the cycle in the caving zone are: the top coal caving height and the broken coal drawing speed (depending on the broken coal granulometry). More than that, the coal drawing duration depends on the volume of the coal reserve that must be evacuated (determined by the top coal height), the broken coal drawing capacity and the number of simultaneous drawing points, conditioned by the caving line conveyor capacity and the main gate conveyer capacity.

If in most of the previous factors it's not possible to act essentially, because these depend directly on the coal face technology or on the coal characteristics (in the case of drawing speed of the broken coal) then, through the reducing of the top coal height there can be obtained the reducing of the production cycle period, with immediate implications on the coal face stagnation and on the negative effects resulted from this.

More frequently, in the concrete conditions of a coal body, because of the complicated tectonics, the panel extension and even the coal face length are naturally limited. Therefore, in the previous equations these dimensions being constants, the equations are greatly simplified; finally, this problem becomes the determination of the variation domain of the top coal height h_b for which the coal production costs are minimum. In this case, the variation of the production costs $\sum C(h_b)$, depending on the variable h_b, shown in fig.no.6, has a minimum point of the cost $\sum C_{\min}$ for an optimum value $h_b = h_{b,\ optim}$. There is shown that there exists a domain [h_{b1}, h_{b2}] where the variation of the costs is insignificant. Therefore, the adoption of a cost value, involved inside of this domain, will take into account other technical criteria.

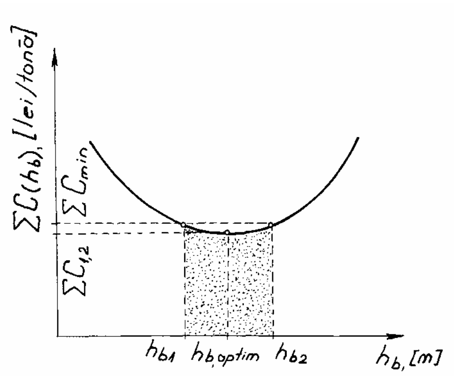


Fig.6. Cost variation in order to top coal height

Because of the complexity of the equations (2), which become more complicated through taking into consideration other variable parameters (recovery rate, dilution, etc.), it is necessary that the sensibility analysis of the cost to the main geometrical parameters of the mining system to be made by taking into account, successively, more value pairs (L_{ab}, l_{ab}) as constants (single variable parameter that will be the top coal height).

The motion models of the top broken coal are in approximate concordance with the ellipsoid drawing theory. The drawing and the operation interval should be determined in accordance with the top coal drawing parameters. In order to the drawings operations to be well involved in the production cycle, it is recommended that the length of top coal caving face to be less than 120m [8].

3. THE CALCULUS OF TOP COAL CAVING HEIGHT TAKING INTO ACCOUNT HIS STABILITY

The top coal caving methods are based on the top broken coal extraction as a consequence of the coal disintegration (as a result of the natural stress redistribution). The top coal is so much stable so as the strengths characteristics of coal are more important and the stress values are more reduced. In addition to these groups of factors, the stagnation period of the coal face act favourable on the point of view of the coal disintegration, respectively on the broken phenomenon of top coal, even though it has a negative contribution on the face support state and on the coal front stability and implicitly on the security rate of the personnel and equipment.

The coal strength is influenced by the following parameters: homogeneity rate of the coal seam; petrographical composition of the seam; sterile intercalations and mineral inclusions and geomechanical characteristics of them, the tectonics and microtectonics of coal body, coal texture, moisture rate, etc.

The stress and strain state of coal and rocks around the face depend on the following factors: the height of the overburden strata and virgin stress of rock mass; sizes of voids resulting from the coal mining (coal front and the top coal height, face span, panel mined extension); rocks cantilever's lengths formed toward the gob; presence of tectonic accidents and old mining excavations in the face proximity; face support capacity, etc.

The top coal stability analysis could be performed indirectly, with the aid of analytical, numerical and physical models or directly, in situ, by the top coal time behaviour monitoring, respectively time monitoring of some top coal deformation parameters (face convergence, top coal horizontal and vertical displacement, time fissures extension, etc.).

In order to the constructed model to represent as well as possible the reality, it is necessary to acknowledge as more data about the situation conditions of coal faces. Finally, in view of completely explaining the top coal and faces behaviour taken in the study it is recommended the analysis, in the same time, of the results obtained from the modelling and from the terrain. These models and calculus algorithms are necessary, especially, in the mining methods and technology design faze, for certain concretes conditions, in view to choose the more adequate face support type, top coal height dimensioning, mining methods parameters determination (top coal caving step, coal face advancement speed, etc.).

The numerical models specific to various calculus methods (finite element method, finite difference method, boundary element method, distinct element method, hybrid element method [2,5]) are the non-destructive models, which ensure the effectuation possibility of non-determinate simulations number. The results obtained from these models could stay as basis in the sensibility analysis of the stress-strain state at some parameter's variation or the determination of some information that could characterize the geomechanical's phenomenon development (dynamical solicitations, rock fault slides, etc.), a technical decision impact on the coal face and preparatory workings supports behaviour, etc. The information obtained from numerical models, together with the results obtained from other investigation sources, complete the description that characterizes the state of "mining system". In view to dimension with the aid of numerical models, in a certain face conditions situation, there are performed more models with top coal caving with various top coal height, which vary inside of a certain variation domain, with certain height increment. Also, it is possible to take into consideration the stress-strain dynamics depending on the panel mining development. Finally, it is made the stability analysis of the top coal for all these models and it is adopted the optimum top coal height after that analysis criterion.

The adopted *analytical models* must take into account some series of conditions, as [6]: if in the upper side of the top coal the roof rock strata are in the compact state or there exists a broken mass of caved rocks, resulted from the previous slices; if the immediate and/or main roof rocks hang down on the top coal in the cantilevers form, it detaches into big or small blocks or it is into a disintegrated state, etc. Depending on this image, there can be constructed different models based on the plates, beams or cantilevers theory, articulated blocks theory, pulverulent mediums theory, etc. Supplementary, it is possible to make the following suppositions: the top coal mass is compacted or traversed by a certain minimum strength planes network (natural or/and induced fissure network) or it is partially or completely disintegrated (it respects the pulverulent medium's behaviour lows). These models could be used at the same time, for the top coal stability analysis, respectively for the top coal height design, and for the calculus of pressure developed on the face support and implicitly for support elements dimensioning.

The development of certain analysis models, without a practical validation, is a pure theoretical exercise. Therefore, the results obtained from the modelling must be duplicated with the information resulted from the terrain experiments. Finally, in view to make a complex analysis for the top coal height dimensioning, after the stability criterion it will take into consideration all of the obtained results, from various calculus models, alongside of the face monitoring data.

Whatever the theory taken into consideration or which should characterize the best terrain situation, the respective analytical method must take into consideration two types of loads that have a determinant impact on the top coal stability, specifically: the active's loads which have the tendency to unbalance the top coal and the resistant loads, which act against to the unbalance. The first ones are represented, principally, by the pressures developed by the uppers rocks (massive or disintegrated rocks) and the top coal weight; the resistant loads ones are represented by the frictional and cohesive forces, by the earth thrust forces generated by the caved rocks and the face support reaction, etc.

Simplifying, the top coal dimensioning after the geometrical criterion of stability is referring to the following two problems: 1) the establishment of a top coal height which makes a certain support type efficient; more precisely, the pressure developed on the support, in the conditions of a certain top coal height, which must not exceed the face support capacity; 2) top coal height determination, in a certain condition of stress state, which make possible the gravitational dislocation of this one.

1) A first problem of top coal stability, from a simplified model, consists in the top coal height determination that the *face support capacity is sufficient* for to resist at roof solicitations.

Tacking into account the previous hypothesis and the geomechanical model conceived by Li Hong-Chang and Zhu Shi-Shun [4], the top coal height must be [6]:

$$h_b \le \frac{P}{K_s \cdot \gamma_c} - 2 \cdot M \cdot \frac{\gamma_d}{\gamma_c} - \frac{G_3}{L_{ab} \cdot \gamma_c} + \frac{N}{L_{ab} \cdot \gamma_c} \cdot \left(\sin\alpha - \cos\alpha \cdot tg\ \varphi\right) \quad (3)$$

where: P is face support capacity, in KN/m^3; K_s–the coefficient of utilisation of the face support capacity (K_s=1.3); L_{ab} –supported length of face roof, m; N- broken rocks thrust, KN/m; F_f-the frictional force between the top coal and the broken rocks, KN/m; M-coal seam thickness, m; G_3 – supplementary load generated by the main roof rocks when this loose the balance, KN/m; γ_c - apparent specific weight of coal, KN/m^3; γ_d - apparent specific weight of rock, KN/m^3; α -the failure plane angle of the top coal, measured from the vertical line.

2) In order to determine the top coal height with the purpose of ensuring the gravitational caving of the top coal, it is necessary to establish a geomechanical model which to simulate the real terrain situation (model analysed with one or many dimensioning models). For the model shown in the figure nr.7 the problem is to analyse the dislocation phenomenon of the top coal along the section *a-a*. Taking into account an analytical method, in the presented model of analysis, in order to have a coal dislocation, corresponding to a caving step, it is necessary that the active forces

(dislocation forces) $\sum F_a$ to exceed the resistant forces $\sum F_r$. This law could be written simply in the form:

$$\frac{\sum F_a}{K_S \cdot \sum F_r} > 1 \qquad (4)$$

where: K_s is a reserve coefficient taking into account the model and date precision used in the model (for example: K_s=1.3-1.5).

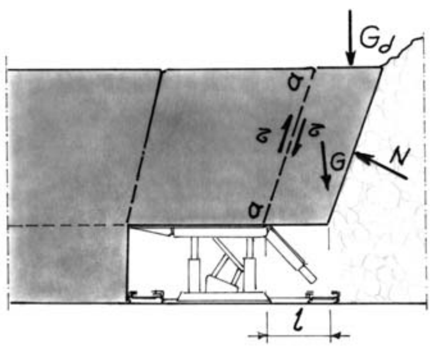


Fig.7. The determination of the top coal height taking into account the coal self-caving capacity

In the model represented in the figure no.7 the *active forces* are compounded from the loads generated by the immediate and main roof and by the proper weight of the dislocated coal volume and the *resistant forces* are the cohesive forces and the friction forces after the plane *a-a* and the thrust forces provided by the broken rocks from gob, etc. (in hypothesis of the rigid body support).

Taking into account the previous principle, a simplified model which supposes that the rocks situated above the top coal are caved (if one or more slices under the roof were mined) and the top coal behaves as a free block that acts on the face support, it is analysed by the Roşioru,I. [7], resulting the following relation for the top coal height determining:

$$h_b \geq \frac{x \cdot 1{,}784 \cdot \gamma_a \cdot H \cdot i \cdot e^{-\pi \cdot tg\varphi}}{C \cdot C_s - x \cdot \gamma'_a} \qquad (5)$$

where: x is the top coal caving step; : γ_a , $\gamma_a^{'}$ - broken rocks and coal apparent specific weight ; H- overburden strata,; C- coal cohesion; φ -broken rocks frictional angle; C_s – weakness structural coefficient; $i = \frac{1-\sin\varphi}{1+\sin\varphi}$.

4. THE TOP COAL HEIGHT DETERMINATION FROM POINT OF VIEW OF COAL RECOVERY RATE AND DILUTION

Considering that criterion it is necessary to adopt a top coal height, correlated with the drawing broken coal parameters thus resulting the biggest coal recovery rate from the top coal and the most reduced dilution of caved coal, resulted from the mixture with the roof broken rocks, in the technical and economical conditions of the analysed face.

Beside the other parameters, the top coal height has a significant influence on the coal recovery rate (loosening rate) and dilution. If the top coal height is higher, the broken coal drawing phenomenon is more difficult to be controlled, which determines an increasing of the coal loosening (fig.8) and an important mixture of cave coal with roof broken rocks. This phenomenon is more accentuated if the face advancement speed is not very well correlated with the period necessary for the top caved coal entirely drawing that decreases the coal recovery rate at the same time with the top coal height increasing.

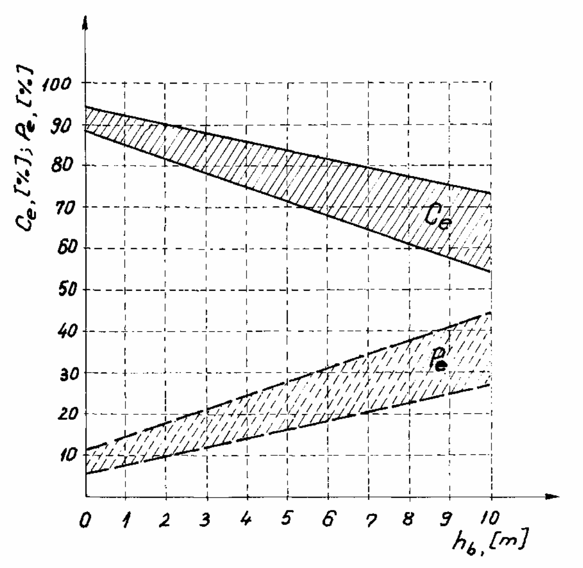


Fig.8. Increasing of coal loosening rate P_e in the same time with top coal height increasing and coal recovery rate C_e decreasing in the same time with top coal height increasing(depending on the mining technology and the coal face length)

The optimisation problem of the top coal height, from the point of view of loosing coal and dilution reduction, is a very complex one and depends, mainly, on the following elements: the caved coal characteristics (granulometry, composition, rugosity, moisture, etc.), the top coal caving step, the failure angle of top coal, the face support type and characteristics, geometry and sizes of broken coal doors, the distance between drawing doors and their position reporting to the top coal, the drawing technique and drawing order of the top coal, etc. Taking into account the multitude of factors that determine the top coal behaviour during the drawing process, we consider that the elaboration of the theoretical models for the top coal height calculus, from the point of view of the coal loosening and dilution, it is very difficult to be achieved, and if it is achieved, it has an very large approximation degree. Therefore, the single researches direction that could lead toward the favourable practical results, are these that take in analysis the data obtained from the modelling of the top coal drawing phenomenon with the aid of the equivalent materials and from terrain monitoring.

REFERENCES

[1]. Chiril,G. *Optimizarea principalilor parametri tehnologici ai metodelor de exploatare cu subminare, aplicate în condiţiile stratelor groase de cărbune din Valea Jiului*, Teză de doctorat, Petroşani, 2001.

[2]. Heib,A. *Modélisation de volume d'influence d'une excavation par longue taille*, Thèse docteur, Nancy, 1993.

[3]. Jha,S.N., Karmakar,H.N. *Thick Seam Mining-Some Experiences and Expectation, International Symposium on Thick Seam Mining*, India, 19-21 November, 1992, A.A. Balkema, Rotterdam, 1993.

[**4]. Li Hong-Chang, Zhu Shi-Shun** *A Research into Underground Pressure in Longwall Face Induced by Use of Sublevel Caving in Thick Seam*, Proceedings of the 12-th Plenary Scientific Session of International Bureau of Strata Mechanics, World Mining Congress, 8-13 July, 1991, Effect of Geomechanics on Mine Design, edited by A.Kidybinski&J.Dubinski, Balkema, Rotterdam, 1992.

[5]. Onica,I. *Introducere în metode numerice utilizate în analiza excavaţiilor miniere*, Ed. Universitas, Petroşani, 2001

[6]. Onica,I. Chiril,G. *Exploatarea cu banc de cărbune subminat în abataje frontale*, Editura AGIR,Bucureşti, 12005

[7]. Roşioru,I. *Posibilităţi de dimensionare a elementelor geometrice ale bancului subminat cu luarea în considerare a caracteristicilor geomecanice ale cărbunilor şi rocilor înconjurătoare - Referat de doctorat nr.3*, Universitatea din Petroşani, 2006.

[8]. Wang Qingkang, Liu Wuhao, Lin Xinhe *The Characteristics of the Ground Pressure Manifestation and the Movement of the Top-coal Mass in the Gently Inclined Working Faces with Top-coal Drawing*, Proceedings of the International Symposium on Modern Mining Technology, Shandong, China, October, 1988.

HOW IMPORTANT IS TO EVALUATE THE UNCERTAINTY OF MEASUREMENT WHEN TESTING CIVIL USE EXPLOSIVES

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Abstract: Recently Romania adopted the European legislation regarding the explosives for civil use Directive 93/15 CEE. In the annex of the directive are established the essential safety requirements which shall be tested applying the harmonized European standards. For this reason the testing facilities shall be updated and the paper describes the researches made in INSEMEX in the Laboratory for Explosives and Blasting Techniques to achieve the level of the requirements provided by the European standard for determination of the resistance to hydrostatic pressure of explosives.

To certify a product means to establish its compliance with a series of specifications. The documentation of the product covers the parameters to le met by the designed product so as to be operational, reliable, healthy and safe for man and environment, cost efficient and so on.

The purpose of tests and measurements is to evaluate a product and say whether the item in question is in compliance or not with the specification.

At the moment when we reports the final result of measurement of a physical dimension, it is compulsory to have a quantitative type indication on the quality of the result so that the persons which are going to use the result can evaluate its trustworthy ness. Consequently is necessary to have available a procedure easy to use, easy to understand and agreed to by everyone for being able to characterize the quality of the result gained after a measurement, i.e. the evaluation and the expression of its uncertainty.

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The idea of „uncertainty” as a numerically expressed attribute is relatively new in the history of measurements, although the error and the analysis of errors represent concepts which have been part of the science of measurements (i.e. of metrology) for a long time and it is widely recognized the fact that after all known or the supposed components of error have been evaluated and the suitable corrections have been applied, a certain level of uncertainty regarding the validity of the result stays, i.e. we have a doubt on how correct this result, might show the value of the measured dimension.

If no information is available on the uncertainty of measurement or whether these information is not correct, we can get a limit situation when a product is considered as being in compliance but actually, this product doesn't exactly meet the stated parameter, i.e. the product is non-compliant and cannot be used safety on it shall display a diminished technical and economic efficiency.

The certification of products for the regulated fields of activity (here also being included the for explosives civil use) involves a high responsibility in issuing the test reports, and the certificates of conformity, and the decision to declare a product as compliant or non compliant shall be grounded on accurate information. The certification of a non-compliant explosive may generate hazardous situations; the rejection of a compliant explosive may generate economic losses.

The same as when the almost universal use of the I.S. has given coherence to all scientific measurements, a concord on the evaluation and express of the uncertainty of measurement allows an easy and correct understanding of a wide range of measurements made for scientific, engineering, trade, industry and legislative purposes.

The ideal method to evaluate and express the uncertainty of a result should have a general character, i.e. applicable to all types of measurements and to all data used during measurements.

The dimension used to express uncertainty shall:

- be logical by itself, it shall derive directly from its component parts, irrespective of the group size of these parts or of their division into sub-component parts;
- have a transferable character, i.e. a the direct use of a result or of a component of an evaluated uncertainty to evaluate the uncertainty of another measurement where the same result is being used.

It is necessary quite often in many industrial applications that the result of a measurement be surrounded by a range which covers the largest part of the distribution of values possible to be assigned to the dimension subjected to measurement.

The ideal method to evaluate and express the uncertainty of measurements shall have to provide such a range with a suitable trustworthy ness or covering probability.

Generally, the uncertainty of measurement covers several component parts which can be divided into two categories in connection to the method used to estimate their numerical dimensions:

A. are the ones evaluated by statistical methods.
B. are the ones evaluated by other methods.

The isn't always an univocal correspondence between the classification with A or B categories and the classification with „random” and „systematic” uncertainties used in the past.

The phrase „systematic uncertainty” should be avoided since it may lead to misinterpretations.

A detailed report of the uncertainty should include the full list of its components and should state. The method used to get the numerical dimensions for each component.

The composed uncertainty shall be characterized by the numerical dimension gained by applying the usual method for combining the available options. The composed uncertainty together with its component parts shall be expressed as „standard deviations”.

Whether it is necessary to multiply the composed uncertainty with a certain coefficient to get the global uncertainty, them it is always necessary to state that coefficient.

When we do measurements and make reference to international standards, further details on the result of the measurement and on its uncertainty are necessary. Several measurements are being performed with periodically calibrated instruments or with instruments found under the incidence of legal metrologic inspection, whether the instruments meet the requirements stated in provisions or in the current normative documents, then the uncertainties of their indications may be inferred from these specifications or from the normative documents.

The basic principle is the following one; when one reports the result of a measurement together with its uncertainty, one should provide several information than normal or shouldn't state „non-applicable”. For example, one should:

a) describe clearly the methods used to calculate the results of measurements and its uncertainty based on the experimental observation and on the input data;

b) give a presentation of all the component parts of the uncertainty and give a full explanation of the manner used to evaluate each component part;

c) give a presentation of the experimental data so that each important stage be easily monitored and the calculation manner be repeated independently whenever necessary;

d) determine all the significant corrections and the constants used during the analysis together with their origins.

Beside the equipment and the staff training the competence of a testing house depends on the idea that it can be clearly stated the trust level of the measurement result, i.e. the calculation of the uncertainty of measurement, together with its indication as an absolute or percentage value, together with the values stated for the measurand.

The mathematical - statistical machinery said by [1] or [2], is very laborious (a lot of working hours) and its implementation in the everyday measurement may not be so easy for the working staff of the testing houses; this is the reason why software for these purposes have been designed.

The Laboratory for Explosives and Blasting Techniques (LETI) from INSEMEX carries out a series of testing, analyses, verifications on the products part of the „civil” use explosives. This field has been regulated by the Law no. 126/1995 concerning the rules of explosive materials with the subsequent changes and additions and by the Directive 93/15/EEC, taken by the Romanian legislation under the HG (Government Decision) no.207/2005.

The organization of LETI meets the requirements of the standard SR EN ISO/CEI 17025 „General requirements for the competences of the testing and calibration laboratories" and uses a well documented, accredited quality system.

LETI has developed 6 packages of testing procedures grounded according to their specific character (in all 32 testing procedures) according to the essential safety requirements stated in the Annex to the Directive 93/15/EEC.

Also, part of these testing procedures includes operating procedures (24) which are used during the preparatory operations.

For carrying out all these testing we have here specific instrumentation and testing apparatus, some of them quite rave or even unique at national level.

This instrumentation covers the evaluation of the uncertainty of measurement for the measuring chains applied.

Even if some resting give results with the logic order, 1 or 0, and no numerical dimensions (for ex. the tested explosive shall initiate or not in certain conditions) the carrying out of these testing in volves preliminary measurements whose uncertainty may affect the logic result 1 or 0 (ignition; non-ignition) with wrong conclusions for the tested product.

For the purpose of evaluation of the measurement uncertainty which occurs during testing of explosive materials (high explosives, detonating cords and detonators) together with the well known testing procedures and by knowing the parameters of the apparatus, there have been drawn out the „Measurement data sheets".

An example for such a sheet is shown below. The example refers to the „Determination of sensitivity to the transmission of detonation".

Measurement data sheet

1. Name of testing/measurement

Determination of sensitivity to the transmission of detonation.

2. Testing/measurement procedure

PI-ETI-02.3. Determination of sensitivity to the transmission of detonation of encartridged explosives.

3. Tested/measured item

AGP powder explosion proof explosive.

4. Preparation of the test item.

The test item means 18 cartridges of explosive, weighting 100±5 g, with a diameter of 30±1 mm, in their original package; 6 cartridges for each test.

5. Environment conditions

No special environment conditions.

6. Principle of the measurement method

The cartridges are set down at a pre-settled distance among them (measured longitudinally).

The explosion of, first cartridge shall have to propagate to the rest of cartridges; it shall have to be complete and it shall have to leave no traces of explosive or package.

7. Measurement chain

- 6 cartridges are set down equidistantly in straight line (the distance between the ends of the 2 cartridges being equal to the diameter of the cartridges) on a level led sand bed;

- The distance between cartridges is measured with the help of a caliper rule.

- The first cartridge is primed at the free end with the help of a detonator no.8 (pyrotechnical or electric detonator) or with the help of another detonator with similar parameters;

- The leading wires of the electric detonator are connected to the detonating cable;

- The detonating cable is connected to the exploder;

- The cartridges are fired;

- The result is checked out.

8. Results

TC = full transmission of detonation.

NT = no transmission of detonation.

9. Balance of the uncertainty of measurement (See table no.1)

10. Manner used to record the result of the measurement and of the uncertainty of measurement.

- TC/NT.

- The results of the measurements cannot be established from a quantitative point of view; they are susceptible to be differentiated from a qualitative point of view.

These sheets record the measuring method used during the testing in question. Finally, if one knows the value of balance of uncertainty, measures to keep the uncertainty of measurement within acceptable limits can be taken. Also it is possible to remove the wrong results difficult to trace in other circumstances.

Consequently, we get a database so we can proceed to the next stage, i.e. modeling the used measuring methods on a PC.

The implementation of the mathematical machinery stated by GUM (2), makes necessary the use of an adequate software.

We searched for the available software on the internet and found several companies in the United States, West and Central Europe, New Zeeland suitable to provide such software.

We made comparisons among all these software and purchased the one which meets the requirements and the practical needs for the testing and measurements carried out in the Laboratory for Explosives and Blasting Techniques at INSEMEX.

Considering the specific character involved by testing of civil use explosives and of the electric detonators, the experts from the Laboratory for Explosives and Blasting Methods have considered a software capable to manage a large database and capable to include the whole mathematical machinery stated by GUM. The performances – price ratio, the possibility for further updating and the exempt of import customs duty pointed to the software presented by Metro data GmbH-Germany.

To meet the needs of the laboratory and considering the project in operation within the framework of the National Research Program „CALIST”, we bought the full version in English of „GUM WORK BENCH 1.3.” made by Metro data GmbH Germany.

Table no.1

No.	***Element that influence uncertainty***	***Description of influence over uncertainty, Observations***	***Type***		***Influence***			***Probability of occurrence 0÷1***
			Systematic	**Random**	**Major**	**Minor**	**Insignificant**	
1.	Equipment for measuring the distance between cartridges.	Accuracy of measurement caliper rule.	X			X		1
2.	Collinear laying down of cartridges	The measured value is an interval when the symmetry axes of cartridges are not collinear.	X			X		$1 \bullet 10^{-1}$
3.	Reading accuracy of the operator	Probability to mistake reading the lines on the ruler of the caliper.		X		X		$1 \bullet 10^{-1}$
4.	Packing manner of cartridges	The explosives of cartridge in paraffin paper have the end often the cartridge with a deviation from cylindricity due to the fold.		X		X		$1 \bullet 10^{-1}$

To save the recorded data, GUM WORK BENCH 1.3. – Metro data GmbH Germany generates an evaluation report on uncertainty divided info several sections:

1. Title and description.
2. Equation of uncertainty.
3. (Quantitative) Data base for all the dimensions of the equations.
4. A description of observations (text and mathematic form).
5. Establishing a correlation among dimensions.
6. The budget of uncertainty.

Dimension	Value	Standard uncertainty	Freedom	Sensitivity coefficient	Contributions to uncertainty	Percentage from uncer-

7. Results
- Value [absolute];
- Extended uncertainty [absolute] or [%]:
- Covering rate (2) – for a normal distribution.
- Covering level %, normal, rectangular, triangular, trapezoidal with halo: 0,3; 0,5; 0,7.

This software allows a versatile handling of the mathematical and the statistical apparatus stated by GUM [2] and offers several possibilities for modeling the phenomena depending on how extended the database is, depending on how control over the dimensions that come up in the budget of uncertainty is being kept.

With the help of the technical sheet, we can determine all the parameters which describe the balance of uncertainty of measurement (quant sized in the model of the equation of uncertainty).

At the end of 2005 we carried out a study report with the help of GUM WORK BENCH 3.1. We evaluated the uncertainty of measurement for certain testing usually made by our laboratory (testing to measure the detonation velocity of detonating cords, testing to measure the mass of explosive necessary for carrying out the testing to determine the resistance to friction).

There follows an example on how to determine the model of the equation of uncertainty necessary for measuring the mass of explosive to carry out the testing with the view to determining the resistance to friction:

- Testing procedure PI-ETI-3.4. „Establishing sensitivity to friction of high explosives and the core of the detonating core.
- Test item: RIOCORD ANTIGRISU 6 g/m – detonating cord;
- Apparatus for use: analytical balance with an accuracy of 0.1 mg.

Model of equation:

$$m_x = m_s + \delta m_D + \delta_m + \delta m_c + \delta_B$$

List of dimensions:

Dimension	***Measuring unit***	***Definition***
m_x	g	Mass of explosive
m_s	g	Pointer of the balance (weight)

0	1	2
δm_D	g	Deviation of the mass indication compared to the standard measurement (because of decalibration as time passes by)
δ_m	g	Difference noticed compared to the standard (correction made by the operator)

δm_c	g	Correction for the eccentric location on scales and because of magnetic effect.
δ_B	g	Correction of floatability (compensating the effect of Archimedean's law – measurements is performed in vacuum not in air)

CONCLUSIONS

With the model of the equation and the budget of uncertainty established for a certain type of measurement, the staff of the laboratory uses an efficient software; consequently the complex problems of mathematical statistics turns info a routine everyday operation.

This application can be used for any type of measurement of any physical phenomenon whether it is possible to determine exactly the equation which models the uncertainty of measurement.

REFERENCES

[1]. *** SR ENV 13005:2003 *„Ghid pentru exprimarea incertitudinii de măsurare".*

[2]. *** SR 13434, *„Ghid pentru evaluarea şi exprimarea incertitudinii de măsurare"* iulie 1999.

[3]. Suzanne Castrup *„A Comprehensive Comparison of Uncertainty Analysis Tools"* - Integrated Sciences Group 14608 Casitas Canyon Rd. Bakersfield, Canada 93306,661-872-1683, scastrup@isgmax.com.

[4]. *** SR 13259-2, *„Ghid privind principiile generale şi statistice pentru certificarea materialelor de referinţă",* Iunie, 1995.

[5]. *** STAS 6085-86, *„Metode de prelevare a eşantioanelor pentru produse în bucăţi".*

[6]. *** SR ISO 5725-1 *„Exactitatea (justeţea şi fidelitatea) metodelor de măsurare şi a rezultatelor măsurătorilor". Partea 1: Principii generale şi definiţii,* Septembrie 1997.

[7]. *** SR ISO 3534-1, *„Statistică - vocabular şi simboluri. Partea 1: Termeni de teoria probabilităţilor şi statistică generală"* Octombrie 1996.

[8]. *** SR ISO 3534-2, *„Statistică - vocabular si simboluri. Partea 2: Controlul statistic al calităţii"* Iulie 1996.

[9]. *** SR EN 13763-1, *„ Explozivi pentru uz civil. Capse detonante şi relee întârzietoare. Partea 1: Cerinţe",* Decembrie 2004.

[10]. *** SR 13250-2, *„Materiale de referinţă. Ghid privind principiile generale şi statistice pentru certificarea materialelor de referinţă"* Iunie 1995.

UNDERLINING THE TYPES OF PROTECTION APPLICABLE TO ELECTRICAL APPARATUS DESIGNED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES

LUCIAN MOLDOVAN [*], MARTIN FRIEDMANN [**], JEANA IONESCU[***]

Abstract: Type of protection – specific measures applied to electrical apparatus in purpose of avoiding the ignition of an explosive surrounding atmosphere..

All electrical apparatus designed for use in explosive atmospheres is protected by at least a type of protection

For an explosion to take place three factors should co-exist at same time. These three factors are represented by explosive atmosphere (flammable gases, vapours, mists, ignitable fibres or dusts), oxygen or an oxidizer substance, and the source of ignition.

A type of protection represents a technical standardised solution by which at least one of the three mentioned above factors is suppressed.

Because the type of protection represents a technical solution, it is very important that it can be associated to electrical apparatus without affecting its functional part.

There are a lot of types of protection enough various to respond the functional part compatibility requirements for different kind of apparatus. It shall be remarked that in some cases the electrical apparatus must be protected with a pair of compatible redundant types of protection (superimposed). Supplementary, an electrical apparatus can be partial protected or party protected with different types of protection; in this case we have associations of various types of protection.

Hazardous areas are classified into zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

- Zone 0 - place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently

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- Zone 1 - place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally
- Zone 2 - place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only

ELECTRICAL APPARATUS DESIGNED FOR USE IN GASEOUS EXPLOSIVE ATMOSPHERES

type of protection

specific measures applied to electrical apparatus to avoid ignition of a surrounding explosive atmosphere.

flameproof enclosure "d"

type of protection in which the parts which can ignite an explosive atmosphere are placed in an enclosure which can withstand the pressure developed during an internal explosion of an explosive mixture and which prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure.

increased safety "e"

type of protection applied to electrical apparatus in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks in normal service or under specified abnormal condition.

intrinsic safety "i"

type of protection based upon the restriction of electrical energy within apparatus and of interconnecting wiring exposed to an explosive atmosphere to a level below that which can cause ignition by either sparking or heating effects.

pressurization "p"

technique of guarding against the ingress of the external atmosphere into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere

encapsulation "m"

type of protection in which the parts which could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited

oil immersion "o"

type of protection in which the electrical apparatus or parts of the electrical apparatus are immersed in a protective liquid in such a way that an explosive atmosphere may be above the liquid or outside the enclosure cannot be ignited.

powder filling "q"

type of protection in which the parts capable of igniting an explosive atmosphere are fixed in position and completely surrounded by filling material to prevent the ignition of an internal explosive atmosphere

type of protection "n"

type of protection applied to electrical apparatus such that, in normal operation and in certain specified abnormal conditions, it is not capable of igniting a surrounding explosive atmosphere

Regarding the types of protection standardisation process can say that in Romania is in course a harmonisation process of national standards to european standards. This harmonisation process represents the transit from the old national standards (STAS 6877) and respectivelly the newer adopted standard serie (SR EN 50000) to the international standard serie SR EN 60079 – identical with IEC serie.

Table 1 Standards which stipulates the requirements for each type of protection

Type of protection		**Title of standard**
Symbol	**Description**	
-	-	SR EN 60079-0:2005 Electrical apparatus for explosive gas atmospheres – Part 0: General requirements
Ex m	Encapsulation	SR EN 60079-18:2004 - Electrical apparatus for explosive gas atmospheres Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus
Ex p	Pressurization	SR EN 60079-2:2005 Electrical apparatus for explosive gas atmospheres Part 2: Pressurized enclosures "p"
Ex o	Oil immersion	SR EN 50015:2003 Electrical apparatus for potentially explosive atmospheres. Oil immersion „o"
Ex q	Powder filling	SR EN 50017:2003 Electrical apparatus for potentially explosive atmospheres. Powder filling "q"
Ex e	Increased safety	SR EN 60079-7:2004 Electrical apparatus for explosive gas atmospheres. Part 7: Increased safety "e"
Ex n	Nonincendive	SR EN 60079-15:2004 Electrical apparatus for explosive gas atmospheres. Part 15: Type of protection "n"
Ex d	Flameproof enclosure	SR EN 60079-1:2005 Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosures "d"
Ex i	Intrinsic safety	SR EN 50020:2003 Electrical apparatus for potentially explosive atmospheres Intrinsic safety 'i'

Electrical apparatus designed for use in gaseous explosive atmospheres is classified in:

- electrical apparatus for group I (mines susceptible to firedamp);
- electrical apparatus for group II (places with explosive gas atmospheres other than mines susceptible to firedamp)

TYPES OF PROTECTION PARTICULARITIES:

Encapsulation "m"

Electrical apparatus with type of protection encapsulation is divided in two levels:

- level of protection "ma"-suitable for zone 0, 1 and 2;
- level of protection "mb"- suitable for zone 1 and 2

Pressurization "p"

Electrical apparatus with type of protection presurization is divided in three categories:

- presurization "px" – reduces the classification from inside of pressurized enclosure from zone 1 to a non-hazardous area or from group I to a non-hazardous area;
- presurization "py" – reduces the classification from inside of pressurized enclosure from zone 1 to zone 2;
- presurization "pz" – reduces the classification from inside of pressurized enclosure from zone 2 to a non-hazardous area.

Nonincendive

Electrical apparatus with type of protection "n" can be used only in zone 2 areas, and is divided in four categories:

- "nA" – non-sparking electrical apparatus;
- "nC" – electrical apparatus which include apparatus that can produce electrical arcs and sparks;
- "nR" – electrical apparatus with restricted breathing;
- "nL" – energy limited electrical apparatus

Intrinsic safety

Electrical apparatus with type of protection intrinsic safety is divided in two levels:

- level of protection "ia"-suitable for zone 0, 1 and 2;
- level of protection "ib"- suitable for zone 1 and 2.

Particularities for some types of explosionproof apparatus

Group II electrical apparatus with the type of protection d, ia, ib, nC, nL is subdivided in three subgroups:

- electrical apparatus for group IIA;
- electrical apparatus for group IIB;
- electrical apparatus for group IIC.

Particularities for all types of explosionproof apparatus:

Each electrical apparatus explosion protected by one of the above mentioned types of protection can be included in one of the following temperature classes:

- T1 – 450°C
- T2 – 300°C
- T3 – 200°C
- T4 – 135°C
- T5 – 100°C
- T6 – 85°C

Referring now to the hazardous area classification, the electrical apparatus admitted in hazardous areas is as follows:

- in zone 0 – electrical apparatus described in SR EN 60079-26:2005 standard;
- in zone 1 – electrical apparatus with type of protection d, e, px, py, q, o, ib, mb, plus the ones admitted in zone 0;
- in zone 2 - electrical apparatus with type of protection n, pz plus the ones admitted in zone 0 and zone 1

In order to select the appropriate electrical apparatus for hazardous areas, the following information is required:

- classification of the hazardous area;
- temperature class or ignition temperature of the gas or vapour involved
- where applicable, gas or vapour classification in relation to the group or subgroup of the electrical apparatus;
- external influences and ambient temperature.

CONCLUSIONS:

This paper brings in front the principles for each type of protection and the criteria for selecting an electrical explosion proof apparatus.

REFERENCES:

[1]. SR EN 60079-14:2004 - *Electrical apparatus for explosive gas atmospheres Part 14: Electrical installations in hazardous areas (other than mines)*

[2]. SR EN 60079-0:2005, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

[3]. SR EN 60079-1:2005, *Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosures "d"*

[4.] SR EN 60079-2:2005, *Electrical apparatus for explosive gas atmospheres – Part 2: Pressurized enclosures "p"*

[5]. SR EN 50017:2003, *Electrical apparatus for potentially explosive atmospheres – Powder-filling "q"*
[6]. SR EN 50015:2003, *Electrical apparatus for potentially explosive atmospheres – Part 6: Oil-immersion "o"*
[7]. SR EN 60079-7:2004, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety "e"*
[8]. SR EN 60079-10:2004, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*
[9]. SR EN 50020:2003, *Electrical apparatus for potentially explosive atmospheres – Part 11: Intrinsic safety "i"*
[10]. SR EN 60079-15:2004, *Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection "n"*
[11]. SR EN 60079-18:2004, *Electrical apparatus for explosive gas atmospheres – Part 18: Encapsulation "m*
[**12]. SR EN 60079-26:2005,** *Electrical apparatus for explosive gas atmospheres – Part 26: Special requirements for construction and test of electrical apparatus for use in zone "0"*

ENCAPSULATION- A TYPE OF PROTECTION RELATIVELY LESS USED BUT WHICH PROMISES MORE

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Abstract: The purpose of the paper is to bring in front the advantages of using the type of protection encapsulation “m” to protect the equipment used in areas with hazard of explosive atmospheres comparatively to other types of protection

1. GENERAL CONSIDERATIONS

The purpose of the paper is to bring in front the advantages of using the type of protection encapsulation “m” to protect the equipment used in areas with hazard of explosive atmospheres comparatively to other types of protection.

The incidence of this type of protection in the context of equipment protection used in dangerous areas (areas with danger of forming explosive atmospheres) kept it in the minority group of types of protection beside the type of protection oil immersion “o”, respectively powder filling “q”.

This type of protection was used especially in association with other types of protection to fulfill secondary parts from which the most important is to obtain the so called non-reparable components.

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2. TYPES OF PROTECTION – GENERAL PRESENTATION

Each standardized type of protection is based on at least one a technical solution which consists in suppression of a factor indicated by the ignition triangle's peaks (fig.1) or safely limits the close area in which the ignition can occur (in case of flameproof protection "d").

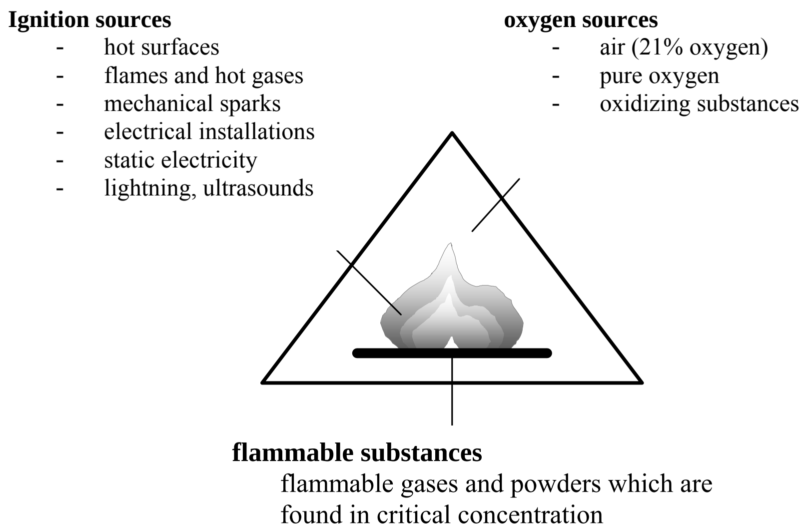

Figure 1 Ignition triangle

Table 1 Technical solutions used by the types of protection.

Type of protection		Technical solution
Symbol	**Description**	
Ex m	Encapsulation	Separate of the electrical equipment or part of it susceptible of producing ignitions of explosive atmospheres in hazardous area
Ex p	Pressurization	
Ex q	Powder filling	
Ex o	Oil immersion	
Ex e	Increased safety	Removal of the ignition source
Ex nA	Nonincendive	
Ex d	Flameproof enclosure	Preventing the propagation / extension of ignition in to all mixture from the hazardous area
Ex nL	Nonincendive	Limits the electrical energy from the circuits that can constitute a source of ignition.
Ex i	Intrinsic safety	

Considering that different types of protection (all) state conditions for operating conditions as well as for construction of equipment certain types of protection will be compatible only with some functional parts table 2 presents a short correlation between the types of protection and functional parts for different equipments.

Tabel 2 Type of protection - functional part correlation.

Type of protection		***Technical solution***
Symbol	***Symbol***	
Ex m	Encapsulation	Electrical machines windings, electrical circuit parts, small components etc.
Ex p	Pressurization	Control panels, analyzers, rotating machines, electrical apparatus; etc.
Ex o	Oil immersion	Small power electrical transformers, distributed control systems; etc.
Ex e	Increased safety	Rotating machines, luminaires, junction boxes; etc.
Ex n	Nonincendive	Rotating machines, luminaires, junction boxes; etc.
Ex d	Flameproof enclosure	Rotating machines, luminaires, junction boxes, On-off buttons, switching gear etc.
Ex i	Intrinsic safety	Monitoring, control, signaling systems, generally low currents electrical apparatus

The type of protection encapsulation “m” belongs to the types of protection category based on the segregation principle (segregates the electrical equipment or part of them susceptible to produce ignitions in explosive atmosphere from dangerous area.

This represents a type of protection in which the parts that can ignite an explosive atmosphere even by sparks or by heating are included in compound, in such of manner that this explosive atmosphere cannot be ignited in normal installing and operating conditions, in defined failure conditions, in any abnormal specified conditions (for “ma” level of protection).

3. ASPECTS REGARDING EVALUATION RESPECTIVELY TESTING OF THE EQUIPMENT, COMPONENTS WITH THE TYPE OF PROTECTION ENCAPSULATION “M”

The main issues for the assessment, respectively testing of equipment and components with the type of protection encapsulation “m” results from the type of protection encapsulation definition.

The assessment and testing of encapsulated apparatus aims to classification in the safety limits regarding the construction and operation to avoid ignition by spark respectively by excessive heating of some surfaces.

Thus, it states conditions for:
- electrical operating condition of equipment-component;
- construction of equipment-component;
  - faults determination;
  - internal free space of encapsulation;
  - width of compound;
  - switching contacts;
  - external connections;
  - protection of live bare parts;
  - primary and secondary batteries;
  - protection devices.
- electrical operating condition of equipment-component;
  - the material of compound

4. ADVANTAGES OF USING THE TYPE OF PROTECTION ENCAPSULATION

- Relative independence referring to qualitative parameters of explosive atmospheres (gases and vapors subgroup) regarding the types of protection intrinsic safety "i" respectively flameproofs protection "d".
- Shows the level of protection "ma" which is ATEX category 1 eligible (accepted for use in Zone 0) with respecting of some supplementary conditions specified in [5] standard resulting the so called "special encapsulation".
- The specific standard for the type of protection encapsulation "m" has a few numbers of pages comparing with the homologues standards for other types of protection frequently used.
- Shows similar methods for the evaluation of heating appreciations (the principal hazardous source in this case) with other types of protection, especially with the type of protection intrinsic safety "i".
- The basic principles for assessment are relatively simple and don't need complex procedures for circuit assessment.
- Even if from practical point of view this type of protection is preferred in case of low current, small components or equipments, this type of protection can be used even to power equipments.

5. CONCLUSIONS

This approach has underlined some of the aspects that support an increase in the "popularity" of the type of protection encapsulation "m".

REFERENCES

[1] **ing. S. Burian, ing. J. Ionescu, dr. ing. M. Darie ing. T. Csaszar, ing. A. Adriana, s.a.** *Aparatură tehnică pentru medii potențial explozive Grupa II - Tipul de protecție securitate intrinsecă*, Editura Europrint Oradea, 2006

[**2] dr. Ing. M. Darie** (Director proiect), s.a. - „*Asimilarea şi implementarea noilor metode de evaluare şi încercare pentru aparatura electrică cu tip de protecţie încapsulare in vederea corelării cu legislaţia europeană şi conformarea cu HG752/2004”* - Contract din cadrul programului national de CEEX nr. 87/2005-2006

[3] SR EN 50014:2003 - *Aparatură electrică pentru atmosfere potenţial explozive*. Cerinţe generale

[4] SR EN 60079-18:2004 - *Echipamente electrice pentru atmosfere potenţial explozive. Partea 18: Construcţia, încercarea şi marcarea tipului de protecţie încapsulare "m"* pentru aparatura electrică (IEC 60079-18:2004)

[**5] SR EN 50284** - *Cerinţe speciale pentru construcţia, încercarea şi marcarea aparaturii electrice din grupa ii de echipamente, categoria 1g*

DEVELOPMENT OF TESTING METHODS FOR THE BLASTING MACHINES INTENDED FOR USE AT THE ELECTRIC IGNITION OF CIVIL USE EXPLOSIVE MATERIALS

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Abstract: The paper shows briefly the new testing methods for the blasting machines intended for use at the electric ignition of civil use explosive materials in order to perform assessment and certification of them

1. TESTING METHOD OF THE INSULATIONRESISTANCE

The apparatus consists of an insulation tester.

Procedure: the terminals of the blasting machine are shortcircuited and a testing voltage is applied between the terminals and the enclosure of the equipment. The insulation resistance is measured and recorded.

2. TESTING METHOD OF THE ELECTRIC STRENGHT

The apparatus consists of an a.c. high voltage variable source and an ammeter.

Procedure: the terminals of the blasting machines are short-circuited and the testing voltage is applied, in series with the ammeter, between the terminals and the conductive parts of the enclosure.

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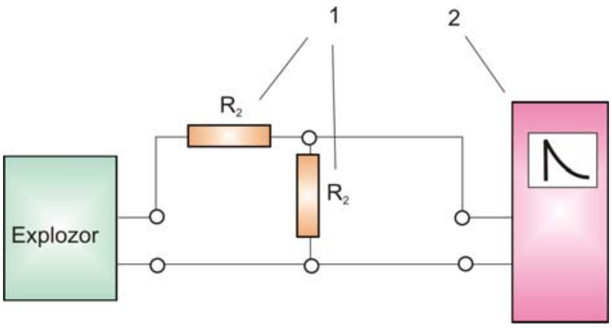
The test report includes the information whether the insulation is broken down during testing. The breakdown of the insulation is shown by a sudden raise of the current strength in the ammeter.

3. TESTING METHOD TO DETERMINE THE OUTPUT POWER

The apparatus consists of the resistance $R_1 + R_2$ corresponding to the maximum resistance of the circuit R_e, able to stand the highest output voltage delivered by the blasting machine and an oscilloscope which shows voltage (U_{osc}) along time, so as to be able to calculate both the current (as U_{osc} / R_2) and the power (as KR_e) of the blasting machine at the maximum resistance of the circuit (R_e).



Procedure: the blasting machine is connected to the resistances R_1, R_2 and the oscilloscope (see Fig. 1). The blasting machine is charged and blasted; the delivered initiating pulse (K) is recorded as oscillogram for a sufficiently long period of time.

Fig. 1 - Diagram to determine the output power

Key:

1 - R_1 and R_2 resistances;
2 - oscilloscope;
Explozor - Blasting machine

4. TESTING METHOD TO DETERMINE THEOUTPUT VOLTAGE

The apparatus consists of a voltmeter to measure the output voltage and a resistor with the value of resistance equal to (R_e) for each configuration.

Procedure: the maximum resistor in the circuit R_e and the instrument are connected to the output terminals of the blasting machine. The blasting machine is initiated. The highest output voltage delivered shall be recovered.

5. TESTING METHOD TO CHECK-UP THE INDICATION ”DISCHARGED BATTERY”

The apparatus consists of a variable voltage supply source and a voltmeter.

Procedure: the battery of the blasting machine is replaced with a variable voltage supply source. The supply source is adjusted to the rated voltage of the battery then the voltage is lowered until the indicator of the blasting machine is triggered. The value of this voltage is recorded.

6. TESTING METHOD TO CHECK-UP THE INTERBLOCKAGE AND THE INDICATOR ”READY TO BLAST

The apparatus consists of a voltmeter to measure the output voltage of the blasting machine at the maximum resistance of the circuit (R_e) directly on the output terminals and a resistor with a resistance equal to (R_e).

Procedure: the resistance (R_e) and the instrument are connected to the terminals of the blasting machine. The ignition is started but the charging is stopped before the moment when the apparatus is ready to initiate and the initiating operation is performed. There are made records whether the blasting machines delivers an output voltage. There is being used the charging procedure recommended by the manufacturer unit the apparatus is fully charged and ”ready for blasting”. The apparatus is initiated and records are made on whether one gets the rated voltage of the blasting machine.

7. METHOD TO TEST THE ACCURACY OF INDICATORS

The apparatus consists of a voltmeter to measure the output voltages of the blasting machine and a resistor with the value of the resistance equal to (R_e).

Procedure: the resistor (R_e) and the instrument are connected to the output terminals of the blasting machine. The apparatus is being charged until the indicator shows that it is fully charged at the first of the blasting voltages. The blasting machine is initiated and the output voltage shown by the voltmeter. The testing is repeated for the rest of the blasting voltages.

8. METHOD FOR THE SPECIFIC TESTING OF BLASTING MACHINES

The apparatus consists of a resistor for each sequence output circuit with the value of the resistance equal to the maximum resistance of the initiating circuit (R_e) of the sequence circuit in question and a resistor with an ohmic rated value higher than the maximum resistance of the sequence initiation circuit of the exploder.

Procedure: the resistor (R_e) is connected to each of the separate output circuits of the sequence blasting machine. The blasting machine is initiated and checks are made to see whether the initiation is correct. The process is repeated but one of the resistors (R_e) is replaced with a resistor with a higher resistance. Records are made whether the blasting machine shall initiate.

9. METHOD TO TEST THE OPERATION OF THE SAFETY DISCHARGE DEVICE ON BLASTING MACHINES WITH THE ACCUMULATION OF POWER IN THE CONDENSER

The apparatus consists of a volt meter which shows the output voltage of the blasting machine and a resistor with the value of its resistance equal to the maximum resistance of the blasting circuit (Re).

Procedure: for the case of blasting machines which initiate automatically when the condenser is charged, there shall be carried out the measurements said above.

For the case of blasting machines which don't initiate automatically, there shall be carried out the measurements said below.

10. MEASUREMENT OF THE RESIDUAL CHARGE BEFORE USE

The voltmeter is connected to the output terminals of the blasting machine and then checks are being made to see whether, there is any voltage recorded on the output terminals when the initiation device is triggered.

11. MEASUREMENT OF THE RESIDUAL CHARGE WHET HERE THERE ARE NO BLASTINGS AFTER CHARGING

The voltmeter is connected to the output terminals of the blasting machine and it is charged. When this one shows „ready to blast'', the charging is ceased and:

- for the case of blasting machines which need 2 hands to be handled: all the buttons, key switches or similar devices which have been actuated during charging are now released. After a while, the blasting device is triggered. The value of the voltage at the output terminals is recorded.
- blasting machines actuated with a key or similar device need to be switched from the charging state to the blasting state for being able to initiate. After a while, the blasting device is triggered. The value of the voltage at the output terminals is recorded.

12. MEASUREMENT OF THE RESIDUAL CHARGE AFTER BLASTING

The resistor is connected to the output terminals of the blasting machine, it is charged and then it is initiated. The resistor is disconnected from the output terminals of the blasting machine and then the voltmeter is connected to the terminals. The value of the voltage at the output terminals is recorded.

13. METHOD FOR THE SPECIFIC TESTING TO CHECK ELECTRODYNAMICS BLASTING MACHINES

The apparatus consists of an oscilloscope and a resistance which corresponds to the maximum resistance of the circuit Re.

Procedure: the oscilloscope and the resistance are connected to the output terminals of the blasting machine. The spring of the device is charged and the blasting machine is initiated in compliance with the instructions of use. We record as the voltage U_2 and the maximum voltage U_1 the points where the contacts close. U_2 is calculated as a percentage from the value of U_1.

14. PROTECTION TO EXPLOSION OF BLASTING MACHINES INTENDED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES

Blasting machines intended for use in potentially explosive atmospheres (for ex. in a coal mine or gallery crosses coal or oil beds) shall not be an ignition source for the explosive atmospheres.

The explosion-proof blasting machines shall have to meet the applicable essential health and safety requirements stated in the technical regulation on equipment and protective systems intended for use in potentially atmospheres and in the Government Decision no. 752/2004.

15. TESTING METHOD OF DEVICES FOR DISCONNECTING THE OUTPUT POWER OF BLASTING MACHINES INTENDED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES WITH GAS

The apparatus consists of an oscilloscope with a time basis suitable to record the output current/voltage of the blasting machine all through a period of time suitable to this purpose and a resistor which corresponds to the maximum resistance of the initiation circuit (Re).

The testing procedure shall have to be the same with the one described in the procedure used establish the output power, but the pulse time shall be measured to establish whether it doesn't exceed the disconnecting period. The output terminals are connected to the oscilloscope (see Fig. 1) so that we get a simulation of the maximum resistance of the blasting circuit (Re).

The blasting machine is actuated in compliance with the instructions of use. The following parameters shall be calculated and recorded:

- the output power of the blasting machine all through the maximum admitted period, and
- the period of time.

INSEMEX Petroşani has developed testing procedures for each of the above said methods at the accredited laboratory LIEx.

REFERENCES

[1]. * * * *SR EN 50014 „Aparatură electrică destinată atmosferelor potenţial explozive.* Prescripţii generale" , 2003

[2]. * * * *Prescripţii tehnice anexă la „Norme Specifice de Protecţie a Muncii pentru Depozitarea, Transportul şi Folosirea Materiilor Explozive",* ediţia 1997

[3]. * * * *Hotărârea de Guvern nr. 752/14.05.2004 publicată în Monitorul Oficial,* Partea I nr. 499 din 03.06.2004

[4]. Ghicioi, E. - *Teza de doctorat ,2005*

[5]. * * * - *Seria SR EN 13763Explozivi pentru uz civil. Capse detonante şi relee întârzietoare*

[6]. Ghicioi, E. - *Contract nr. 45/07.09.2005 INSEMEX-RENAR-UMM modul CEEX 4 "Implementarea noilor metode de testare conform primului standard armonizat pentru explozoarele utilizate la iniţierea capselor electrice detonante şi destinate atmosferelor potenţial explozive - acronim INIEx"*

L′ELABORATION DES SCHEMAS DE TIR EN CORRÉLATION AVEC LES PARTICULARITES DES ROCHES TRAVERSĖES PAR LES TRAVAUX SOUTERRAINS DU SECTEUR LIVEZENI – DUMITRA DU COMPLEX HYDRAUENÉRGÉTIQUE LIVEZENI – BUMBESTI

SEMEN CONSTANTIN *

Abstract: The hydropower development of the river Jiu on the sector Livezeni – Bumbesti includes 2 HPP located in the googes area, connected bz a headrace tunnel length of 20 Km, gross total water head 252 m, installed flow 36 m^3/s installed power 65 MW. The dominant rocks types, undercrossed by the gallery, are the schysts of all kinds, quartz gneiss, the amphybolite, diorite, rocks classified in to 5 tupes considering the quality coefficient (Q).The performing of shattering operation requires to elaborate blasting patten considering rocks characteristics such as the type of used explosives for achieving an efficient shattering and a good shaping of the works profile. For that purpose varians technical shattering solutions have been established, based an performed experiments, solutions whics focus an improving the shattering process translated on to varians technical and economical indicators.

Keywords: Characteristics of rocks, blasting patten, type of explosires, shattering, shaping of the works profile, technical and economincal indicatory.

INTRODUCTION

Le complexe hydroénergétique du rivier Jiu comprend 2 centrales hydrauliques situées dans le défilé du Jiu, jointées par un tunnel de 20 km, tunnel qui assure un débit d′eau de 36 m^3/s. Les 2 centrales divisent le travail souterrain en 2 secteurs : Livezeni – Dumitra avec une longueur de 6,9 km et Dumitra Bumbesti avec une longueur de 13,2 km.

Le secteur Livezeni – Dumitra, traverse des différent types de roches représentées par des granites, des diorites, des gnaisses, des amphibolites, des

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schistes de différent types, des roches classifiées en 5 catégories après le résistance à compression.

La technologie de creusement du travail est par le tir avec l'utilisation de l'installation de forage Tamrock Axera D05 – une installation electro- hydraulique, du chargeur PNB-1 et le transport avec des camions Roman.

Le travail souterrain a une section circulaire avec un diamètre intérieur du soutènement de béton de 3,8 m.

1. LA NECESSITÉ DE L' ELABORATION DES NOUVELLES SCHEMAS DE TIR EN CORRELATION AVEC LES PARTICULARITÉS DES ROCHES

Le caractère néhomogène de la structure géologique, les propriétés différentes des roches a impose le groupement des roches en 5 catégories après le coefficient de résistance (f) et de coefficient de qualité (Q) (tab. 1).

La analyse de la structure géologique conduit à la conclusion que, de longueur de 6,9 km, 34% (2340 m) traverse des roches de grande résistance (FT), 28,3% (1953 m) des roches résistantes (T), 18% (1300 m) des roches de moyenne résistance (ST), 14% (966 m) des roches de résistance réduite et 5% des roches de résistance très réduite.

Tab.1 : ***Les catégories des roches traverses par le tunnel***

catégorie de roche	RMR	Q	$f=\frac{c}{100}$	Des types de roches représentatives
I FT	> 60	> 20	> 8	granites; diorites
II T	40 – 60	10 – 20	6 – 8	graisses
III ST	20 – 40	1 – 10	4 – 6	amphibolites
IV M	10 – 20	0,05 – 1	2 – 4	schysts compacts
V FM	< 10	< 0,05	1 - 2	schysts très tectonisés

Le soutènement du travail est réalise en fonction de catégorie des roches ainsi : dans les roches FT, T et ST des boulonnes – filet métalliques – béton projeté, dans les roches M et FM un soutènement métallique U 120 avec une distance entre cadres de 0,5 – 1 m.

En conformité avec le projet ISPH le tunnel a une section demi-circulaire avec des parois pendes, avec une largeur de la base de 3,86 m, le rayon de la voûte de 2,2 m, la hauteur de 4,4 m, une section de creusement de 16,6 m^2, et pour une sur largeur de 10 cm, la section est de 18,4 m^2.

Les schémas de tir élaborées prévoient l' utilisation d' explosif dynamite G encartouchée à un diamètre de 25 mm ou 40 mm, un poids du cartouche de 100 g ou 400 g. Les paramètres des schémas de tir actuellement utilise dans le taille sont présentés dans le tableau 2.

L’analyse des paramètres des schémas de tir met en évidence que, bien que le tunnel traverse des roches avec un coefficient de résistance variable entre 2-8, la projection des schémas de tir s'a fait seulement pour 2 catégories des roches respectivement pour des roches FT avec f > 6 et le reste des roches, f < 6.

*Tab. 2:**Les paramètres de l'actuelle schéma de tir pour une longueur du trou lg = 2,2 m***

Le paramètre	Valeur pour		Observation
	f < 6	f > 6	
Nr. des trous de bouchon	8	8	
Quantité d'explosif par trou, Kg	1	1,2	Dynamite avec Ø 40 mm
Nr. des trous auxiliaires 1.	8	8	
Quantité d'explosif par trou, Kg	0,8	1	Dynamite avec Ø 40 mm
Nr. des trous auxiliaires 2.	18	18	
Quantité d'explosif par trou, Kg	0,8	1	Dynamite avec Ø 40 mm
Nr. des trous à la sur base	5	5	
Quantité d'explosif par trou, Kg	0,8	1	Dynamite avec Ø 40 mm
Nr. des trous à la base de la galerie	9	9	
Quantité d'explosif par trou, Kg	1	1,2	Dynamite avec Ø 40 mm
Nr. des trous de contouration	30	30	
Quantité d'explosif par trou, Kg	0,6	0,8	Dynamite avec Ø 25 mm
Nr. totale des trous	78	78	
Quantité totale d'explosif Kg	75,4	59,8	
Quantité spécifique d'explosif Kg/m^3	2,27	1,8	
Détonateurs utilisés	CEP 0,5 Cu	CEP 0,5 Cu	

Une autre constatation est celle que le numéro des trous est constant (78) sans tenir compte de type et de caractéristiques des roches diminuant seulement la quantité d'explosif par trou et la quantité totale avec 21 %.

L'analyse d'effet de tir a mis en évidence les suivantes :

- une grande distance de projection des roches déterminée par une quantité trop grande d'explosif;
- l'existence des sur largeurs > 10 cm ;
- une grande quantité spécifique d'explosif et de détonateurs;
- un puissant effet séismique qui détermine la fissuration des roches sur le contour du travail et l'apparition des sur largeurs.

2. L' ELABORATION DES SCHEMAS DE TIR EN CORRELATION AVEC LES PARTICULARITÉS DES ROCHES

L'évaluation de l'efficacité de l'effet du tir a été effectuée par 3 facteurs, respectivement par la distance de projection des roches, par la granulométrie des roches et par la contouration des travaux.

La distance de projection des roches – paramètre qui met en évidence la justesse de la distribution des trous, la justesse de la détermination de la quantité d'explosif totale et par trou, aussi bien que la succession des tirs – est située dans les limites très larges, de 15 à 40 m. Pour les schémas de tir correctement projetées et correctement utilisées on estime que 65 – 79% de volume des roches disloquées doit être jeté a 3 – 3,5 m. Ce paramètre a une influence décisive sur la stabilité du soutènement, aussi bien que sur l' utilisation efficiente des chargeurs.

L'application des solutions de soutènement combine qui ont à la base, boulonnage et béton projeté, est conditionnée par l'obtention d'un contour des travaux approché de plus en plus de contour projeté avec la réduction à minimum des sur largeurs, max 10 cm. La poursuite d'effet du tir, ayant en vue la contouration des travaux met en évidence que les plus fréquentes sur largeurs sont à toit – dans la situation des roches stratifies à une pendage réduite, respectivement dans la direction des roches avec des résistances réduites, des sur largeurs qui augmente la quantité de béton utilisée.

Ayant à la base l'analyse des schémas actuelles de tir, des paramètres spécifiques et l'effet du tir ont été projetées et expérimentées des différentes schémas en dépendance des conditions géominières exprimées par le type et les caractéristiques des roches, par leur compactité et leur homogénéité, par l'orientation des plans de stratification et leurs pendage, avec l'utilisation des différent types d'explosif et de détonateurs.

La projection des schémas de tir s'a fait pour 3 catégories de roches, respectivement pour des roches très résistantes (f = 8), pour des roches résistantes (f = 6), pour des roches de moyenne résistance (f = 4), des roches qui ont la plus grande participation (81 %) dans la structure géologique traversée par le travail.

Les paramètres des schémas de tir projeté sont présentés dans le tab.3, pour la variante actuelle d'explosif (Dinamitã G) et détonateurs (CEP-0,5 cm).

Tab. 3: ***Les paramètres des schémas de tir projetées (lg = 2,4 m)***

Paramètre	Valeurs pour des roches :		
	FT (f = 8)	T (f = 6)	ST (f = 4)
Nr. de trous de bouchon	6	6	6
Quantité d'explosif par trou	1,4 25% Ø 25 75% Ø 40	1,2	1
Nr. de trous auxiliaires 1	8	7	6
Quantité d'explosif par trou, kg	1,2 50% Ø 25 50% Ø 40	1	0,8
Nr. de trous auxiliaires II	11	7	6
Quantité d'explosif par trou, kg	1,2	1	0,8
Nr de trous à la sur base de la galerie	3	3	2
Nr de trous à la base de la galerie	7	6	6
Quantité d'explosif par trou, kg	1,4 25% Ø 25 75% Ø 40	1,2	1
Nr. de trous pour contouration	25	19	17
Quantité d'explosif par trou, kg	0,6 Ø 25	0,5	0,5
Nr. total de trous	60	50	44
Quantité totale d'explosif, kg	57	40	30
Quantité spécifique d'explosive,kg/m^3	1,63	1,36	0,85
Détonateurs utilisés	CEP 0,5 CU Rockstar Riodet	CEP 0,5 CU Rockstar Riodet	CEP 0,5 CU Rockstar Riodet

L'analyse des valeurs présentées met eu évidence l'efficience technique et économique, des schémas de tir projetées et expérimentées, l'efficience exprimée par :

- la diminution du numéro total de trous avec 24 – 36 %;
- la diminution de la quantité spécifique d'explosif avec 25 – 38 %;
- la diminution de la quantité totale d'explosif avec 20 – 36 %;
- une bonne contouration du travail;
- la diminution de la distance de projection et du degré de fissuration des roches facteur d'augmentation de la stabilité du travail.

Pendant de l'expérimentation des schémas de tir ont été utilises des differents types d'explosif et de détonateurs.

La comparaison des résultats du tir a eu à la base le coefficient de dislocation (η), la distance de projection et la granulométrie des roches, les valeurs de la sur largeurs, (tab.4).

Tab. 4: ***La comparaison des résultats du tir pour des différent types d'explosifs et des détonateurs.***

Des types d'explosif et des détonateurs	Schémas de tir actuel (ISPH)	Schémas proposées
Dynamite G, CEP 0,5 Cu	η = 0,8 L = 40 – 50 m non uniforme sur largeurs 0,3 – 0,5 m	η = 0,85 L = 10 – 15 m uniforme sur largeurs réduites < 0,15m
Austrogel Rockstar 25		η = 0,85 L = 10 – 15 m uniforme sur largeurs < 0,15m
Austrogel – pour les trous de bouchon Lambrex 1 – trous auxiliaires Lambrex contour – pour des trous de contouration		η = 0,85 L = 10 – 15 m uniforme une bonne contouration < 10 m
Goma ECO 2 Riodet 23		η = 0,85 L = 12 – 16 m uniforme sur largeurs < 15 cm
Goma ECO 2 Riocord de 100 g/m pour les trous de contouration		η = 0,9 L = 10 – 12 m uniforme une très bonne contouration

En déterminant les frais de tir ayant a la base les schémas de tir projetées et expérimentées, les types d'explosif et de détonateurs, résulte les valeurs de tab.5.

Tab. 5:***Les frais de tir pour de roches FT***

Variante technologique	N_g	l_g	Q	C_1	C_2	C_3	C_4	Total lei
Actuelle (Dynamite G, CEP-0,5 CU	78	2,2	74	643,8	288,6	-	1213,2	2145,6
Proposée (Dynamite G, CEP-0,5 CU	60	2,2	57	496	222	-	933	1651
Austrogel, Rockstar	59	2,2	55	296,8	192,75	-	868	1358
Austrogel, Lambrex 1, Lambrex contour, Rockstar	55	2,2	53	306	189,5	-	868	1363
Goma ECO 2, Riodet 23	61	2,2	58	318,7	119,4	-	897	1336
Goma ECO 2, Riocord 100, Rodet 23	55	2,2	38+ 41,25 m	208,8	117,4	144,4	868	1339

ou :

C_1 – les frais avec l'explosif ;
C_2 – les frais avec les détonateurs ;
C_3 – les frais avec cordeau détonant ;
C_4 – les frais de foration des trous.

4. CONCLUSIONS

La corrélation des paramètres spécifiques des schémas de tir avec le type et la résistance des roches, avec leurs compactité et leurs homogénéité, avec le type d'explosif et de détonateurs présente une importante source de diminution des frais de tir, par la diminution du numéro des trous, du numéro des détonateurs, de la quantité d'explosif. Aussi cette corrélation a des avantages techniques par la diminution de la distance de projection des roches, par une granulométrie uniforme et une bonne contouration du travail.

BIBLIOGRAPHIE

[1]. Letu N., Semen C., *Explosifs miniers,* Universitate de Petrosani, 1995,

[2]. Letu N., Semen C., *Solutions techniques d'augmentation de l'efficience du processus de dislocation des roches à la réalisation des travaux miniers,*

[3]. Semen C., *Considérations théoriques et pratiques sur la projection des schémas de tir dans les constructions souterraines,* vol.II, Universitaria ROPET 2000.

HOW TO EVALUATE WATERPROOFNESS OF CIVIL USE EXPLOSIVES IN COMPLIANCE WITH THE HARMONIZED EUROPEAN STANDARDS APPROVED AS ROMANIAN STANDARDS SR EN 13631-5: 2003 AND SR EN 13630-8:2003

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Abstract: The paper shows the results of the researches carried out by INSEMEX Petroşani on testing civil use explosives (high explosives, detonating cords and safety fuses) to evaluate water- proofness of these products viewing their compliance with the requirements from I.1, I.2;II 1(b) (f) (j), II 2B (a) (b) (c) in the Directive 93/15/EEC and with the Government Decision no.207/205 on essential safety requirements of civil use explosives and on the conditions for their marketing.

1. GENERAL ASPECTS

Explosives are a source of chemically obtained energy and are being used by several industries all throughout the world.

In Europe, the Directive 93/15/EEC (the Directive of explosives) states the general essential safety requirements for the civil use explosives and the conditions for their marketing. This directive has been transposed into the Romanian legislation by the Government Decision no. 207/17 March 2005 and published in the MONITORUL OFICIAL no. 286/06 April 2005.

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A large part of the civil use explosives are intended to be used in humid environments with water ingress so that both their safety and their reliability can be adverssely affected by water. Consequently, one of the essential safety requirements of the civil use explosives is their resistance to water ingress (requirement II 1.from the Government Decison no. 207/2005).

To evaluate waterproofness of high explosives (blasting explosives) the provisions stated in the harmonized European Standard no. 13631-5: 2002, are valid and for the case of detonating cords and safety fuses EN 13630-8: 2002, these standards have been approved as Romanian standards, SR EN 13631-5:2003 and SR EN 13630-8:2003.

2. EVALUATING THE REQUIREMENT ON WATERPROOFNESS

A) High explosives (blasting explosives)

In compliance with the provisions stated by SR EN 13631-5: 2003, we have two situations for the case of high explosives:

1) the producer doen't state whether the explosive is intrinsec waterproof;

2) the producer states that the explosive is waterproof by its physical state when marketed.

First situation: The producer doesn't state whether the explosive is intrinsec waterproof

The material used for packing or encasement shall be submitted, to a preliminary testing on the stand. This stand is made of a V – shaped metallic guidance of 1000 mm in length. One of the side walls of the guidance has several holes drilled which allow the screwing in of a screw with cone shaped tip at 45^0 and the radius at the tip < 0.1, with the axis of the screw perpendicular on the longitudinal axis of the guidance.

The position of the screw is adjusted by screwing in one hole of the guidance so that,depending on the diameter of the cartriges of explosive, the sharp tip of the screw in working position leave traces over the cover of the cartridges of explosive following the two perpendicular axes.

Each cartridge submitted to this preliminary testing shall be rotated with 90^0 so that 4 traces of the sharp tip shall be recorded over the cover of the explosive cartridges.

The preliminary testing shall give one of the folowing result (1.1 or 1.2):

1.1 Once the preliminary testing is over, we get visible traces, but no penetration of the cover. In this situation, the cover of the explosive cartridges forms an integrant part of the product waterproofness. Waterproofness of the explosive shall be determined on the cartridges of explosive the manner they have been delivered by the producer.

1.2 During the preliminary testing the cover of the cartridges records a visible cutting (penetration). It results that the cover doesn't form an integrant part of the product waterproofness. So in this situation the waterproofness of the explosive shall be determined on test items made of cartridges of explosives previously cut, in accordance with SR EN 13631-5: 2003 subclause 5.2.

Second situation: The producer states that the explosive displays an intrinsic waterproofness

Explosives are a source of chemically obtained energy and are being used by several The test items (i .e the cartridges of explosive) shall be cut in compliance with the provisious stated in SR EN 13631-5:2003, subclause 5.2. Then, they shall be immersed entirely into water for 5 hours. Once this period elapsed, the cartridges are tested for their full detonation and are being initiated by an electric detonator. Its equivalent power of initiation shall be indicated by the producer of the explosive and the conditioned cartridges shall be submitted to 3 consecutive testing. Table no 1 shows the testing diagram regarding waterproofness of the high explosives.

B) Detonating cords

In compliance with the provisions stated by SR EN 13630-8: 2003, the test item was made of 5 pieces of detonating cords of (2000±50) mm,in length minimum. These pieces shall be immersed in water for $24_{0}^{+0,5}$ h under a traction force of 400_{0}^{+5} N; afterwards, a length of 1000 mm shall be cut from each piece of detonating cord which has been immersed into the water. The 5 pieces of detonating cord immersed and subjected to the traction force of 400_{0}^{+5} N shall be tested in compliance with SR EN 13630-7: 2003, for their sensitivity to initiation and the operating state is verified (there are recorded the indentations produced on the aluminium witness plates).

C) Safety fuses

The item for testing waterproofness consits in 5 pieces of safety fuses of (1500 ± 50) mm each. They are introduced in a tank with water where the height of the water column is $500_{0}^{+2,5}$ mm. The ends of the safety fuses are left outside the water level. After conditioning for $24_{0}^{+0,5}$ h, a part of (1000 ±5)mm, shall be cut from each safety fuse immersed and tested for the burning period in open air in compliance with SR EN 13630-12:2003. The burning rate shall be within the limits stated by the producer.

The photo no.1a, 1b and 2 shows the test stands used to evaluate the requirement on waterproofness of high explosives and of detonating cords. The same test stand is being used for safety fuses with the observation that the safety fuses shall not be subjected to a traction force but they shall be immersed into water for a period of 24 hours, after that there is measured the burning rate in open air, in compliance with SR EN 13630-12: 2003.

The detonating cord RIOCORD 6g/m ANTIGRISU batch no. 704 L 007 made by UEB –SPAIN in July 2004 (Test Report INSEMEX-LETI no. 437 / 15.12.2005, and the following high explosives were tested on the above –mentioned stands:

- **Emulite –TG/Romulite TG explosive emulsion, ϕ 27 mm/155g, encased in polythylene foil, batch no. 070526088/July 2005, producer: Nitro-Mak (TURKEY) (Test Report INSEMEX-LETI no.1 / 09.01.2006).**

• **Danubit 3 gelly type common explosive- ϕ 28mm/200g encased in waxed paper, batch made by Isrochem Bratislava (SLOVAKIA) between 15-23.08.2005 (Test Report INSEMEX-LETI no.2/10.01.2006.**

For all the above situations, the products met the requirement for waterproofness in compliance with the testing method PI-LETI 02.1 and with the provisions stated by SR EN 13631-5: 2003 and SR EN 13630-8:2003.

Figs no.3 şi 4 shows the operating state of the detonating cord RIOCORD 6g/m ANTIGRISU after an immersion into water for a perriod of $24_{0}^{+0,5}\ h$ hours under a traction force of 400_{0}^{+5} N and the indentations produced by the detonating cords on the aluminium witness plates.

Table no. 1
Test diagram for waterproofness of high explosives

No	**Type of high explosives**	**Preliminary**		**Waterproofness testing**	
		Testing conditions	**Result of the preliminary testing**	**Testing conditions**	**Requirement**
0	1	2	3	4	5
1	High explosives encartridged: 1.1- the producer doesn't state whether the explosive is intrinsec waterproof	-Checking the traces left by a sharp metallic tip over the cover of 3 cartridges of explosives	- visible traces, with no penetration of the cover	3 columns of cartridges of explosive the manner they have been delivered by the producer (the length of each column –minimum 0,5 m) shall be immersed in water at a depth of 200 mm minimum for a period of 5 hours	Full detonation of each column of explosive produced by the electric detonator with the equivalent power of initiation stated by the producer of the explosive after a conditioning in water at a depth of 200 mm a period of 5 hours.
			Penetration of the cover	3 columns of cartridges of explosive cut according to SR EN 13631-5: 2003 subclause 5.2	Full detonation of each column of explosive produced by the electric detonator with the equivalent power of initiation stated by the producer of the explosive after a conditioning in water at a depth of 200 mm a period of 5 hours.
0	1	2	3	4	5
1	1.2 – High explosives	Not applicable	Not applicable	3 columns of cartridges of explosive cut	Full detonation of each column of explo-

	encartridged: the producer states that the explosive bis waterproof by its physical state when marketed			according to SR EN 13631-5: 2003 sub-clause 5.2 (the length of each column minimum 0,5 m) shall be immersed in water at a depth ≥200mm for a period of 5 hours.	sive produced by the electric detonator with the equivalent power of initiation stated by the producer of the explosive after a conditioning in water at a depth of 200 mm a period of 5 hours.
2	Bulk high explosives	Not applicable	Not applicable	The test item shall be introduced into a plastic cover with the diameter equal to the smallest diameter stated by the producer for the use of the explosive and the length of cover of at least 10 times its diameter. The cover loaded with explosives is cut in complisance with the provisions stated in din SR EN 13631-5 : 2003 subclause 5.2 . Then, the means of initiation recommended by the prtoducer of the explosive is attached to one end and the whole is introduced into a plastic pipe with the inside diameter twice the diameter of the cover loaded with explosive. The pipe is filled in with water and after 5 hours the test item is detonated and an evaluation is being performed to see whether detonation is complete.	Full detonation of the test item conditioned in water for a period of 5 hours.

Photo 1a. Trough for a preliminary testing of high explosives (outside view)

Photo 1b. Tank for immersion in water of encartridged high explosives

Photo 1a. Trough for a preliminary testing of high explosives (inside view)

Photo 2. Stand for testing waterproofness detonating cords

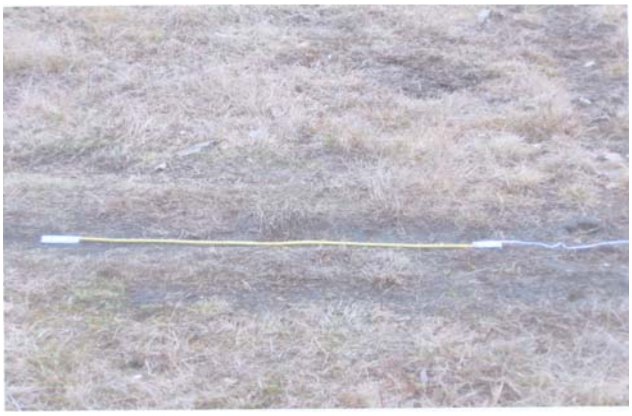

Photo 3 Assembly made of an electric detonators and a detonating cord of RIOCORD 6g/m ANTIGRISU, after immersion in water for a period of $24\,^{+0,5}_{0}$ *hours under a traction force of* $400^{5}_{0}N$ *–witness plate*

Photo 4 Witness plates with the indentations produced by the detonating cord RIOCORD 6g/m ANTIGRISU after immersion in water for 24 hours under a traction force of 402N.

5. CONCLUSIONS

Both the procedure and the test stands designed by INSEMEX Petroşani, for checking up waterproofness of civil use explosives (high explosives, detonating cords and safety fuses) have allowed a good evaluation of waterprofness of these products in compliance with the provisions of the harmonized European Standards.

The results of tests have been recorded in test reports and have supported the process for the evaluation of conformity of products in accordance with the provisions stated by the Government Decision no. 207/2005; process accomplished by the body for the certification of civil use explosives INSEMEX-SECEMTI

REFERENCES

[1]. Fodor D. - *Explozivi industriali*, Editura Infomin Deva, 2000.

[2]. Tat S., Zaporojan M., Fissgus K. - *Explozivi şi tehnica împuşcării în industrie*, Editura Tehnică, 1985

[3]. *** - *Directiva 93/15/CEE*

[4]. *** - *HG 207/17.03.2005*

[5]. *** - *SR EN 13857-1:2004 - Explozivi pentru uz civil. Partea I: Terminologie*

[6]. *** - *SR EN 13631-5:2003 Explozivi pentru uz civil. Explozivi brizanți. Partea 5. Determinarea rezistenței la apă*

[7]. *** - *SR EN 13630-8:2003 Explozivi de uz civil. Fitile detonante şi fitile de amorsare. Partea 8- Determinarea rezistenței la apă*

[8]. *** - *SR EN 13631-1:2005 Explozivi pentru uz civil. Explozivi brizanți. Partea 1: Cerințe*

[9]. *** - *SR EN 13630-1:2004 - Explozivi pentru uz civil. Fitile detonante şi fitile de amorsare. Partea 1- Cerințe*

[10]. *** - SR EN ISO/CEI 17025:2005 Cerințe generale pentru competența laboratoarelor de încercări şi etalonări

USE OF TOPOGRAPGIC COORDINATES FOR MODELLING 2D AND 3D VENTILATION NETWORKS

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Abstract: Providing the best safety at the working places in underground means, among other things, to provide a minimum concentration in oxygen and a dilution of the gases discharged during engineering operations or emitted by the deposit. All these conditions shall be fulfilled when the ventilation system has been suitably designed and managed. A suitable management of the ventilation involves a series of laborious calculations which can be easily solved with the available IT. This paper shows a step when the IT is being used for a good management of the ventilation, i.e. for a 3D and 2D modeling of the ventilation network.

Key-words: topographic coordinates ventilation network, 2D and 3D modeling

1. INTRODUCTION

Providing good working conditions in underground is one of the top priorities for all the managing persons as well for the institutions with responsibilities in this field of activity.

Providing suitable ventilation in underground, as the first safety measure is one of the stages in providing a suitable working environment in underground. A good

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operation of the ventilation system shall provide a minimum concentration of oxygen and an adequate dilution of gases emitted by deposits or produced during engineering operations.

The management of the ventilation means to determine and to maintain the optimum operating parameters of the ventilation installations, together with a good repartition of air flows along each branch of the ventilation network.

To this purpose and due to the laborious calculations that have to be performed and due to the huge volume of information, IT should be used.

2. USE OF TOPOGRAPHIC COORDINATES TO DEVELOP VENTILATION NETWORK

Developing a mine ventilation network involves, on one hand, a huge amount of measurements, determinations and observations and, on the other hand, a complex calculation system for allowing a good identification of actual repartition of air flows along each branch of the ventilation network, as well to spot pressure leakages along the mine workings related to each branch. Also, this issue involves a unitary approach of the system ventilation network - ventilation installations which change continuously depending on the change of the ventilation network (some ventilation circuits close, some new circuits open).

So, all these measurements, data, calculations, observations necessary to develop a ventilation network need time and cannot provide an adjustment of results in real time with the changes occurred in the ventilation network.

Another choice in settling this aspect is the use of the IT and of expert software designed to this purpose.

So, INSEMEX Petroşani bought Canadian expert software called 3D CANVENT which allows both modeling and developing of ventilation networks. The first stage covers the modeling of the ventilation network with the support of topo coordinates which define a point A (X, Y, Z) in space.

The maps and the topo coordinates currently existing at mines help in modeling horizontal, vertical and inclined mine workings inside a spatial system of coordinates.

One of the basic elements to start from is the distance between two points in space A (X_1, Y_1, Z_1) and B (X_2, Y_2, Z_2).

The distance between A and B shall be determined with the following equation:

$$\overline{AB} = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2 + (Z_2 - Z_1)^2} \quad (1)$$

After determining the distance between points, depending on their position in space, one can draw up projections both in plane system of coordinates (X, Y); (Y, Z); (Z, Y) and in spatial system of coordinates (X, Y, Z).

3. MODELING THE VENTILATION NETWORK

Based on the topo coordinated from the expert department at Vulcan mine, we have modeled the ventilation network of the mine by using 3D CANVENT expert software.

To this end, there has been considered the structure of the mine network which includes:

− Shaft no. 7;
− Chorin shaft;
− The shaft with the skip;
− Shaft no. 10 - Valea Arsului;
− B'Allomas raise;
− Karolus raise;
− Ionaşcu raise;
− Terezia raise.

The mine networking spreads on 4 levels:

− level 315;
− level 360;
− level 420;
− level 480.

Also, the ventilation network includes other mine workings (raises and stopes), of which the following ones can be mentioned:

− stope no. 2 bed 3 bl. VI;
− stope no. 4 bed 3 bl. VI;
− stope no. 0 bed 3 bl. VIII depth 374;
− stope no. 0 bed 3 bl. VIII depth 384.

The measurements in situ determined the airflow directions and other aerodynamic parameters specific to the mining network of Vulcan mine.

With the help of technical data got from the topo department of Vulcan mine and with the help of spatial maps, got from the department in charge with the ventilation of the mine, there have been identified the junctions and the branches specific to Vulcan mine:

− 240 de junctions;
− 300 de branches.

These characteristics have highlighted the complex structure of the ventilation network.

Consequently, we have got:

– the spatial ventilation diagram in an (X, Y, Z) - 3D system of coordinates - Fig. no. 1,
– the ventilation diagram in a plane system of coordinates (X, Y) - Fig. no. 2;
– the ventilation diagram in a plane system of coordinates (X, Z) - Fig. no. 3;
– the ventilation diagram in a plane system of coordinates (Y, Z) - Fig. no. 4.

4. CONCLUSIONS

Among other aspects, an efficient ventilation system is necessary for providing the best possible working conditions in underground.

But the management of an efficient ventilation system involves the adjustment of the ventilation installation to work at their optimum parameters and a correct repartition of air flows on each branch of the mine.

For modeling the ventilation networks, the high class IT is being used together with expert software specially designed to this purpose.

Modeling the ventilation networks makes use of the topographic coordinates for spatial and plane plottings.

Based on the topographic coordinates got from the department in charge at Vulcan mine, we have succeeded a 2D and 3D modeling of the ventilation network of this mine.

REFERENCES

[1] Băltărețu, R., Teodorescu, C., *Aeraj şi protecţia muncii în mină,* Editura Didactică şi Pedagogică, Bucureşti, 1971

[2] Cioclea, D., ş.a., *Rezolvarea reţelei de aeraj pe baza măsurătorilor de aeraj în scopul punerii în funcţiune a noii staţii de ventilatoare VOD 2,1 de la Puţul nr. 10 - Valea Arsului,* studiu INSEMEX Petroşani, 2006

[3] Gherghe, I., *Raţionalizarea reţelelor de aeraj ale minelor din Valea Jiului în condiţiile restructurării acestora ca urmare a închiderii unor zone inactive,* Studiu INSEMEX 2004

[4] Gherghe, I., *Servicii de modelare şi simulare a reţelei de aeraj pentru E. M. Petrila,* Studiu INSEMEX 2006

[5] Le Roux, *Notes on Mine environmental control,* The MVS of South Africa 1990

[6] Matei, I., Moraru, R., ş.a., *Ingineria mediului şi ventilaţia în subteran,* Editura Tehnică, Bucureşti, 2000

[7] Patterson, A. M. Dr.Eng., *The Mine Ventilation Practitioner's DATA BOOC,* M.V.S. of South Africa 1992

[8] CANMET, *Mining and Minerals Sciences Laboratories Underground Mine Environment and Ventilation,* - Manual de utilizare a programului 3D - CANVENT 2K

[9] x ^{x} x, *Proiectul de aeraj general al minei Vulcan pentru anul 2006.*

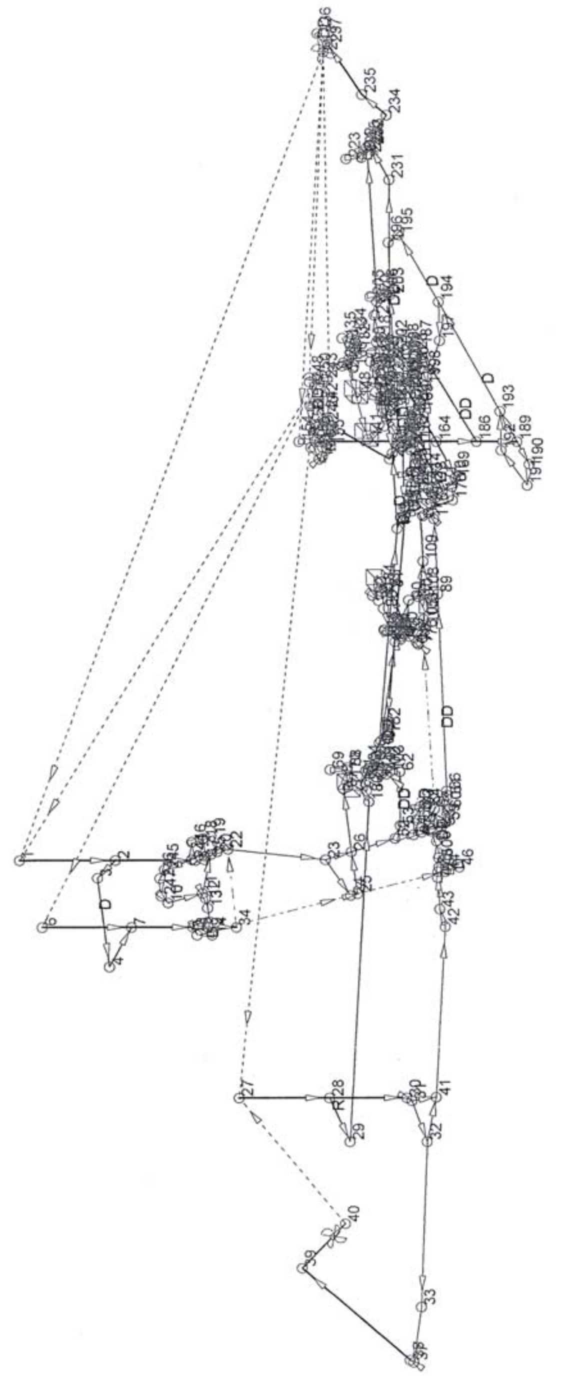

Fig. 1

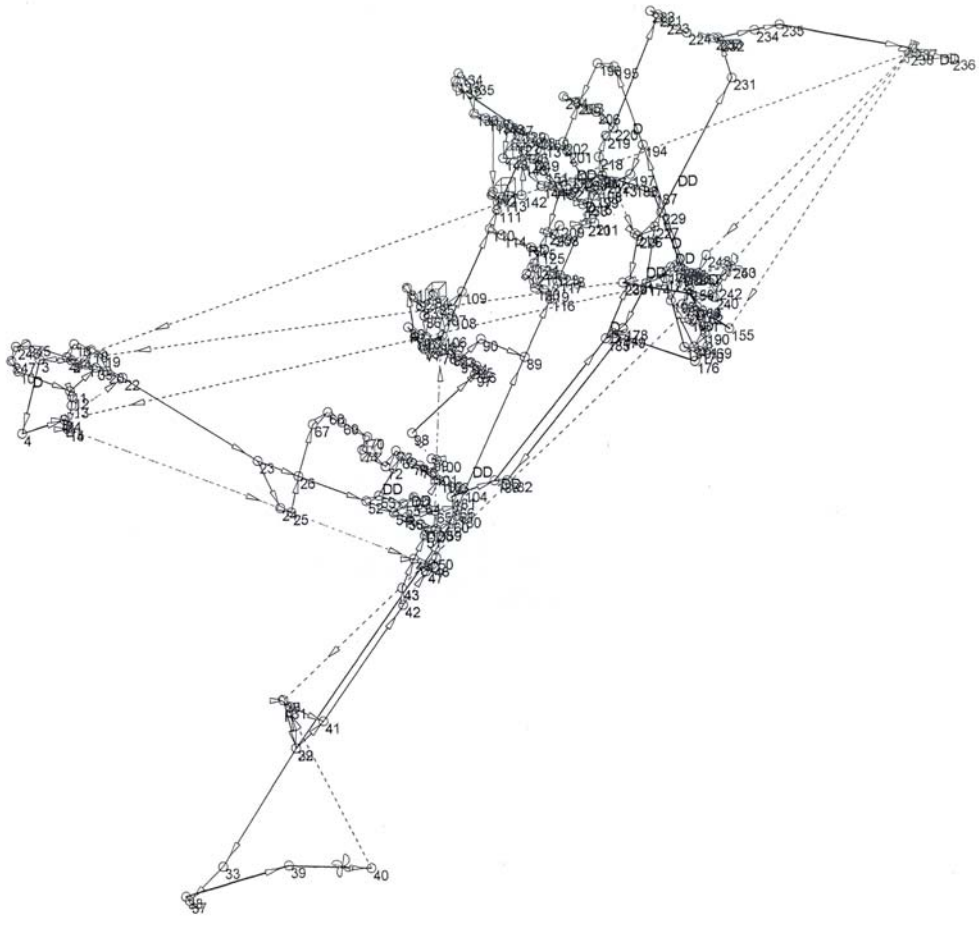

Fig. 2

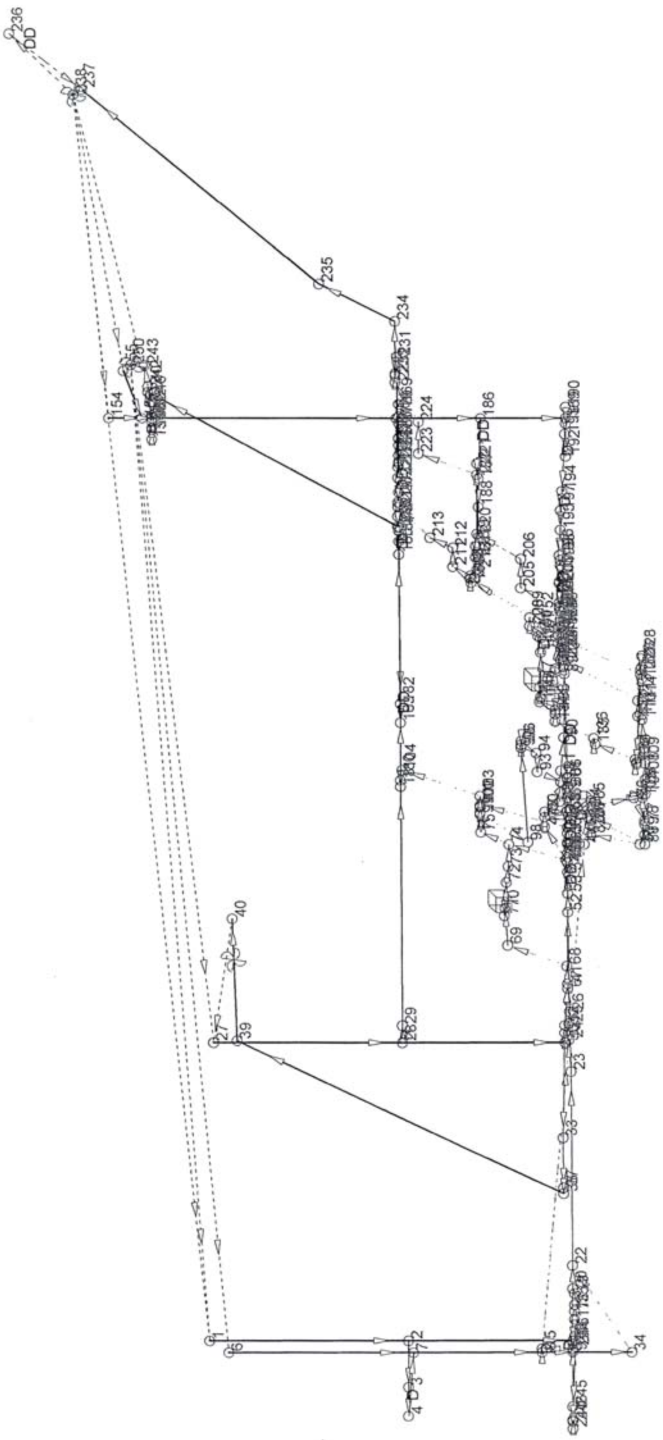

Fig. 3

Fig. 4

APPROACHES AND CONTRIBUTIONS RELATED TO THE ELEMENTS OF THE OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT

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CRISTINA KNEBEL [**]

Abstract: More and more, the economic type organization is seen as a producer of ethic standards which stimulates both production and the revenues. Redefining the identity of a company according to the present concourse of events makes necessary to improve the general managing system and the operation of a highly performant and sustainable occupational health and safety management able to provide a healthy and safe working environment in compliance with the applicable European and international regulations. Until now, INSEMEX Petrosani hasn't developed a specific model of the OHSM, but the experts from INSEMEX have analyzed a lot of systems of this kind for being able to produce products and services. These items include component elements of the OHSM and sometimes these elements have grounded vital decisions. This paper shows several aspects related to the management in general and to the OHSM in particular, as well how the staff from INSEMEX Petrosani is being involved in different activities that support the design of OHSM for beneficiaries and co-workers

1. ABOUT THE MANAGEMENT OF THE ORGANIZATION AND ABOUT OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT

The managing process and the managing skills together with the strategic trends and specific policies underlying the technical and financial balance sheets of the organization, the responsibility and the commitment displayed shall trace the ruling spirit and the general trend of the organization.

The present development and demands have required a re-definition with an opening towards multiple targets and activities which extend beyond the financial

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domain (technical and engineering issues, legislation, industrial engineering, informatics, psychology, sociology, etc.).

Consequently, the management of an organization is quite complex; it covers specific activities and expert personnel.

Both the definition and the domain of the management differ from one author to another. for example, J. Burhidge in the ”Industrial engineering handbook” defines the management as ”the knowledge on planning manage and control the human effort with the view to reaching the pre-determined targets in compliance with the approved politics”.

The characteristic feature of the management of the organization is that man situates in the center of its investigations, both as a subject and object of the management from the viewpoint of tasks assigned to him, in tight relation to the general targets, resources and means displayed by the systems - he is part of. The occupational health and safety management is a component part of the general management of the organization and covers the organization structure, planning, responsibilities, practices, procedures, processes and resources for developing, implementing, fulfilling, analyzing and preserving occupational safety policy.

Both at European and at international level, economy sees a new trend related to the increasing of occupational safety weight; that means developing concrete and essential targets for each organization apart. These targets are as important as the ones related to productivity quality of products or the environment protection.

If we speak strictly about the situation here in Romania, we may say that it is necessary to consolidate the culture on safety aspects, considering the dynamics of European targets, the technical progress in the design and development of new production means, of new engineering solutions for preventing occupational risks and the harmonization of the legislation on occupational health and safety as well the specific features of our organizations so that this culture becomes a factor of competitivity.

The main purpose of the occupational health and safety management (OHSM) is to interfere within the causes that might trigger a certain hazardous incident, occupational disease or accident and to cut the process in progress of these risks.

OHSM shall use the following general principles:

– risk avoidance;

– evaluation of the risks which cannot be avoided;

– fighting against risks coming from the source;

– all the working places shall be designed in relation to the particular aspects of the worker;

– all the employees shall be kept informed on the technical progress;

– the hazardous factors which may come up during the production flow shall be replaced with non-hazardous ones;

– developing an integrated prevention type policy on labor organization, production flow, working conditions, the dialogue between employers and employees;

– the measures for a collective protection shall have priority; additionally, these measures shall be supplemented with measures for personal protection.

The National Institute for Mine Safety and Protection to Explosion - INSEMEX Petroşani carries on basic and applied researches, for technologic development, develops technical regulations for public and national interest viewing occupational health and safety protection, the environment protection, the evaluation of the industrial risk and protection to explosion for all the industries, carries out technological and scientific researches which support the development and the grounding of certain elements and of component parts of the OHSM for several Romanian beneficiaries.

2. FLEXIBILITY TO TRANSFORMATION OF OHSM

During the everyday life, transformation is an analytical process. It includes a selection of present knowledge, gathering new information and the management of all these data for being able to get optimum results.

Both in economic type organizations and in the research and development organizations, flexibility to transformation is essential due to the currently unbalances / internal non-compliances which tend to come up at the same time with the impact between progress and real facts. The managers are the most involved persons in this process of transformation, which sometimes proves to be quite difficult due to all the problems raised and to the fast developing tempo.

The manager is the only person able to recognize the need for a transformation and to determine the optimum moment for implementing this transformation; the manager shall have a good communication skills so that everybody around him feel as partners and not as being forced to perform this transformation.

This transformation is being related mainly to the management of human resources, i.e. a simultaneous gratification of all persons working inside an organization and the organization which is seen as an opened system.

This approach shall influence the working motivation of employees, the structure of the organization and the decision taking.

The number of variables which conditions the system is increasing and their keeping under control depends on how flexible is the system. In this spirit, the management and the OHSM represent an assembly in a continuous transformation, enclosing distinct interacting moments, in relations of determination and influence.

Occupational health and safety has seen fundamental changes by changing both the content and the structure of legislation adapted to the markets requirements so as to be operational in the new social and economic relations and applicable to all categories of economic agents.

INSEMEX Petroşani has brought important contributions to the harmonization of the Romanian occupational health and safety standards with the European standards. This new harmonization shall provide a free move of goods, with a direct influence over the whole national economy; consequently, we shall have an improved social protection, a wider opening towards Europe, gaining the experience of the strongly developed countries.

In compliance with the regulations in force, it is compulsory to certify the products and services regulated by the Romanian standards, with reference to life protection, to occupational health and safety protection and to the environment protection; otherwise their marketing is strictly forbidden.

The safety of equipment shall be certified so as to stop the dissemination of those products which may adversely affect health and safety of workers.

In this respect, INSEMEX Petroşani tests and approves the documentation and certifies the technical equipment, electric installations, materials and outfits made in Romania or abroad for their use in potentially explosive atmospheres; here, at INSEMEX we also test and deliver approval for use for explosive materials and for means of initiation used by economic agents.

3. HOW OCCUPATIONAL HEALTH AND SAFETY IS SEEN

Perception is a process specific to human behavior through which a person shall select, reject, ignore and analyze the outside stimuli with the view to finding new meanings for the outside world.

Feeling a certain hazard, some unusual situations or some real aspects in a working system is not a simple deed, a passive stand but involves an active stand because of the unpredictable changes they can trigger at one moment, this giving birth to different behaviors or points of view.

From the point of view of occupational safety, we have:

– a normal behavior which doesn't jeopardize either health, the body integrity or the biological functions of the body;

– an abnormal behavior which can favor or can trigger an accident or an occupational disease.

An abnormal behavior related to occupational health and safety involves an unsafe or unsuitable behavior compared to a normal working behavior.

If a person displays an outlook different from another person, it shall be considered as a possibility to develop the thinking process to enlarge knowledge, some additional information.

The manner of perception, of confrontation with the bunch of relations settled inside a group can generate individual values and sometimes outstanding collective values, ”a num-culture” which, depending on the circumstances, can turn into an obstacle or into a valuable resource for the development of the company with the view to reaching the targets. All these aspects are quite important from the point of occupational health and safety because they are important in getting a safe and health working environment.

4. ELEMENTS OF THE OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT (OHSM)

Each economic organization shall have an occupational health and safety policy approved by the top managing board. This policy shall have to state the aims of the managing board with respect to the future development, the general targets and a commitment for increasing performance; this policy shall also state the means necessary to reach the said aims and the means for meeting the applicable regulations.

The occupational health san safety policy shall be made available to the whole working staff so that they become aware of each and everyone's duties. Also, it shall be analyzed at specific intervals for further improvements. A series of applicable standards and guidelines include specifications on occupational health and safety.

The development of the organization, including in the field of occupational health and safety involves a planned effort for carrying out the necessary changes.

Planning involves an objective evaluation of present and future conditions, an evaluation of possibilities and of needs, motivating the working staff to determine and ground both the targets and the means. We also need flexibility in operating the plans when the evaluation of the circumstances and of the whole assembly require the carrying out of changes.

The sequence of these operations covers the following stages:

− establishing the potential evolution trend;

− stating the targets;

− a qualification of the possible results;

− planning the actions and the details on their sequence in relation to their importance and mutual determination, stating the period necessary for each operation;

− establishing the necessary material and human resources and the manner they are going to be used;

− presentation of tactics.

When establishing health and safety targets, the organization shall have to consider the applicable legal requirements, the related risks, the engineering options, the financial part, and the operational and business requirements as well the views of the parties involved.

When developing a strategy, one can start from the idea that occupational accidents and diseases can be avoided. Other aspects that have to be covered by this strategy are:

− improvement of unsafe situations, supervision and control of the protective measures, analyzing the occupational accidents with the view to establishing their causes. The documents that include the planning of occupational health and safety shall have to include procedures used for identifying risk evaluation and control, together with the duties of the workers. All the results shall have to be recorded.

The implementation of plans and of programs covering the occupational health and safety aspects shall be fulfilled with the help of the managing board; also, it is necessary to lay the foundations of a safety structure, to train both the workers and their representatives in this spirit, together with a solid motivation.

The organization of the occupational health and safety management involves a sizing and grouping together of duties in relation to the operations performed the relations among them and the set of rules which governs them. An efficient occupational health and safety means a good trace of the framework and structure of the organization, to establish the competent bodies and the relations inside them, as well the configuration of the informational system.

Involving the workers with the view to reaching the aims stated for occupational health and safety and an optimum synchronizing of these operations with the view to getting a maximum efficiency it means a good coordination / management. The manager states the duties of each worker (the duties shall depend on the working skills of each worker) and the whole team shall joint their efforts.

The training of the workers on occupational health and safety shall be performed based on non-voluntary orders. A good participation of workers needs a good system of communication and a suitable motivation.

One can get a diminution of perturbation if the decision is taken the nearest possible to the target and as quickly as possible by combining a good reasoning (formalization, modeling or simulation) with information (a good knowledge of reality as a prerequisite of the target) and the target.

A decision shall offer the possibility for re-design the occupational health and safety management.

Correct decisions need competent people. Both competence as well as responsibility represents notions derived from assignments and they express the ability of a worker to fulfill the duties at work the manner they are stated in the job description sheet. Competence is being defined from the point of view of studies, training and/or experience.

The OHS training shall be performed according to certain procedures; it shall be different depending on responsibilities, capabilities and knowledge and depending on the specific risks and the applicable regulations in force.

Control shall provide a permanent and full checking of the manner in which the activity is being carried out compared to the pre-determined programs. This control gives the possibility to see and measure the deviations from this program, with the specification of the corrective measures.

In this spirit, inspections and direct controls in the field play an important part. The control shall be well documented by stating the target, the competences, the procedures, the necessary specific data, the check points.

For being able to determine the efficiency of occupational health and safety measures according to the personal procedures, the organization shall monitor and measure the performances. Consequently there are being made quantitative and qualitative measurements, there is being monitored the fulfillment of OHS targets, the level of the return performances (rate of accidents) and the proactive performance (compliance with the targets) are being measured; we shall also have a monitoring of the behavior and of the feedback.

5. PART PLAYED BY INSEMEX PETROŞANIFOR DEVELOPING THE COMPONENT ELEMENTS OF THE OHSM

a. Activities that support the OHS policy:

− Classification of mines from the point of view of toxic and/or explosive gas emissions;

− Classification of useful minerals from the point of view of their tendency to self-ignition;

− Compliance with the requirements stated in standards for materials and equipment, as well their certification;

− Evaluation of safety in the working areas with potentially explosive atmospheres;

− Expert examinations of certain events (occupational accidents occurred in different industries);

− Expert examinations on the current working conditions (special or distinct working conditions);

− Analyses of occupational diseases and classification into different levels of risks and hazards of the working places;

− Advisory for the fields of activity.

b. In relation to the planning of OHS, INSEMEX carries out evaluations of occupational risks (starting from identification of hazards and going up to establishing the preventive and protective measures with the view to controlling the risk), harmonize the specific standards and technical provisions with the E.U. ones, assesses the impact of industry over the surrounding environment, develops idea for the environment protection and rehabilitation, for preventing the adverse impact of the risk factors due to the poisonous substances specific to mining operations and industry engineering processes.

c. For a suitable implementation and operation of the occupational health and safety, INSEMEX provides technical assistance for technologic transfer in the fields of activity, for monitoring the safety parameters, blasting methods for increasing the safety parameters in mines and open casts, develops systems for the labor safety and protection when using equipment and mechanical installations.

d. With respect to the awareness and evaluation of workers on OHS, INSEMEX carries out training programs: the certification of the personnel expert in the design, mounting, installation, maintenance and repairings performed in industrial areas classified as hazardous areas regarding the formation of explosive atmospheres, training and recertification of rescuers operating in explosive and/or toxic atmospheres, training of trainers, psychologic certification of the workers with collective responsibility concerning labor safety, etc.

e. For checking up purposes and corrective measures, INSEMEX Petroşani measures the level of poisonous substances (dust, gases, noise) and the parameters of microclimate (temperature, relative humidity); these operations are necessary for avoiding occupational diseases and developing the best possible working conditions; here, we also train and certify the workers with responsibilities on sampling and measuring the level of poisonous substances as well the dust laboratories.

6. CONCLUSIONS

Considering the bunch of variables which influence OHSM, it is quite difficult to develop a unique, universally valid system.

This is the reason why the applicable regulations in force settle only requirements, basic guidelines or they approach only punctual aspects of the OHS. But each organization displays certain specific features which need to be handled. Here we may consider the skills of the manager and his managing knowledge, the method applied (science) which is going to show their efficiency through the gained results

REFERENCES

[1]. Darabont, A., Pece, Şt., Dăscălescu, A. - *Managementul securităţii şi sănătăţii în muncă*, Editura AGIR, Bucureşti, 2001

[2]. Mihuleac, E. - *Ştiinţa conducerii. Metodologie şi metode de conducere*, Editura Didactică şi Pedagogică, Bucureşti, 1982

[3]. Popescu, J.A. - *Teorie şi practică în analiza sistemelor de conducere*, Editura Scrisul Românesc, Craiova, 1977

[4]. x ^{x} x - *OHSAS 18001:2004 - Occupational health and safety management systems. Specification*

[5]. x ^{x} x - *OHSAS 18002:2004 - Sisteme de management al securităţii şi sănătăţii în muncă. Linii directoare pentru implementarea OHSAS 18001*.

THE EFFECT OF DIFFERENT REAGENTS IN FINE COAL FLOTATION

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Abstract: The flotation collector action on coal particle surface has as result the surface energy decrease. Using film flotation method can be established the mean critical surface energies and their variation in the case of coal particles before and after reagent action. The dependence between surface energy of coal and flotation response is discussed. The presence of a strong link between surface energy and flotation response is suggested. Also, some action mechanisms for the attachment of different reagents to coal surface are presented.

Keywords: coal, froth flotation, film flotation, means critical surface energy, apolar oil, and surfactant.

1. INTRODUCTION

Coal is a combustible material that results from geologic alteration of vegetable matter, largely in the absence of air. Depending on the oxygen content of coal, there is a progression in carbon content and hydrophobicity, and hence, floatability of various coals. Coal flotation makes use of the natural hydrophobicity of the carbonaceous matter in coal. To enhance the hydrophobicity of the coal particles and to increase flotation process efficiency, different kinds of flotation reagents are used. Of the collectors, the most frequently used are the petroleum derivatives fuel oil and kerosene. These collectors are recommended for use in larger quantities with low rank coals and oxidized coals. In the case of coking coals they are normally used only in small portions. However, for low-rank coals containing greater amounts of oxygen, oily collectors will not spread on the surface of the coal particles, which leads to poor flotation performance and large reagent dosages requirements even to obtain moderate

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recovery of coal. The most commonly oxygen functional groups on coal surface are carboxyl, phenolic and carbonyl functionalities which reduce the hydrophobicity of the coal surface by increasing the number of sites that hydrogen bond with water molecules. It is this that makes the coal more difficult to float with oily collectors. For this situation, were proposed different solutions, using polar or polar-apolar reagent mixtures that determine coal floatability increasing.

Unequivocal quantitative description of the hydrophobicing action of reagent meets with serious methological obstacles because none of the different methods of testing floatabilty and characterizing flotation performance are accepted as standards.

The purpose of this paper is the determination of the natural floatability characteristic of coals with different grades of metamorphism and correlating it with surface energy defined by the film flotation method. Also, the activated flotation response of coal under standard conditions or close to them was determined. In order to increase coal floatability, different reagents were used and it should be noted some details of the action of the different collectors.

2. EXPERIMENTAL MATERIALS AND METHODS

2.1. Coal samples

In this investigation, two indigene coals with different grades of metamorphism were used. General chemical and technological characteristics of coal are illustrated in table 1.

Table 1 **Chemical and technological characteristics of coal samples**

Coal sample	A [%]	MV [%]	C [%]	O [%]
E.M.Lonea	7.77	39.62	76.54	14.29
E.M.Lupeni	9.75	33.66	81.66	9.8

The coal samples, received in large lumps were crushed and then milled till the operation product has particle size below 0,5mm in diameter.

The coal samples differ between themselves by grade of metamorphism which is reflected in their chemical composition and physical and technological properties. Carbon contents in samples were in the range from 76,54% in the case of coal from E.M.Lonea, to 81,66% in the case of coal from E.M.Lupeni. Proportionally to the increase of carbon content, the oxygen content decreases from 14,29% in the case of coal from E.M.Lonea to 9,8% in the case of coal from E.M.Lupeni. Along with the increase of the grade of coal metamorphism, the volatile matter content diminishes.

2.2. Reagents

In film flotation test, methanol and distilled water solutions of different surface tensions were prepared.

In flotation tests were used two apolar collectors, dodecane and nonylbenzene. The nonylbenzene molecular structure contains about the aliphatic chain, a benzene ring. Also, two heteropolar reagents were used, nonylphenol and polyethoxilated nonylphenol. The first reagent contains a hydroxyl functional group and the second contain more oxygenated groups. All these reagents and their molecular formula are presented in table 2.

Table 2 ***Chemical reagents used in flotation tests***

Reagent	Molecular formula	MW	Character flotation reagent
Dodecane	$C_{12}H_{26}$	170	Apolar collector
Nonyl benzene	C_6H_5-C_9H_{19}	204	Apolar collector
Nonyl phenol	HO-C_6H_4-C_9H_{19}	220	Heteropolar collector
Polyethoxilated nonyl phenol	$H(CH_2O)_4$-O-C_6H_4-C_9H_{19}	341	Heteropolar collector
4-methyl 2-pentanol	$(CH_3)_2CH$-CH_2-CHOH-CH_3	102	MIBC-Frother

2.3. Procedures

Film flotation is a characterization test for determining the floatability of a coal sample. In this procedure, particles of narrow size fractions are gently dropped onto the liquid – air interface of aqueous methanol solutions of varying surface tension. In general, the solids either remain on the liquid surface or are immediately imbibed. Thus, for closely graded monosized coal powder fractions, the times of immersion need not be measured. The film flotation result is a separation of particle population to a series of lyophilic and lyophobic fractions.

Zisman's concept of critical surface tension states that a particle will float if the surface tension of the medium is above some critical value and skin if the surface tension is below this value.

The results yield a surface tension versus % floating material curve.

Three parameters are used to describe their results:

- the surface tension of the solution that wets all the particles, γ_c^{min};
- the surface tension of the solution where no particles are wetted, γ_c^{max};
- the surface tension of solution where half of the particles are wetted, $\overline{\gamma_c}$.

Every measurement was repeated 3 times and average was taken as the final result.

Sample weight was of 0,2g in the size range of 0,09 – 0,125mm.

In order to obtain a result of the collectors action on coal particle surface, was achieved a wetting technique with collectors outside the flotation environment. Films of flotation reagents were spread on coal particle surface, using reagent solutions according flotation consumption and solid concentration. Coal sample was conditioned 1 hour in water and 48 hour in reagent solution, then was filtered and dried at ambiental temperature.

Flotation tests were carried out in a Denver laboratory machine with cell capacity of 1,2l. Concentration of solids in the feed was 100g/dm^3. The suspension was conditioned before every experiment for 30s, mixing it in the flotation cell with reagents without air inflow. Reagents were batched totally at the beginning of experiment, and their unitary dose univocally was 1g/kg of coal being floated. Every experiment was conducted till the appearance of empty froth.

The obtained samples of concentrates and wastes were analyzed in order to determine yield and ash content in flotation products.

3. RESULTS AND DISCUSSION

In figure 1, the film flotation partition curves for the two coal samples are presented. It can see that, partition curve shifts to the higher surface tension range when the metamorphism grade decreases. The mean critical wetting surface tension of the coal particles increases from 47,11 mN/m for the Lupeni sample, to 56,61 mN/m for the Lonea sample.

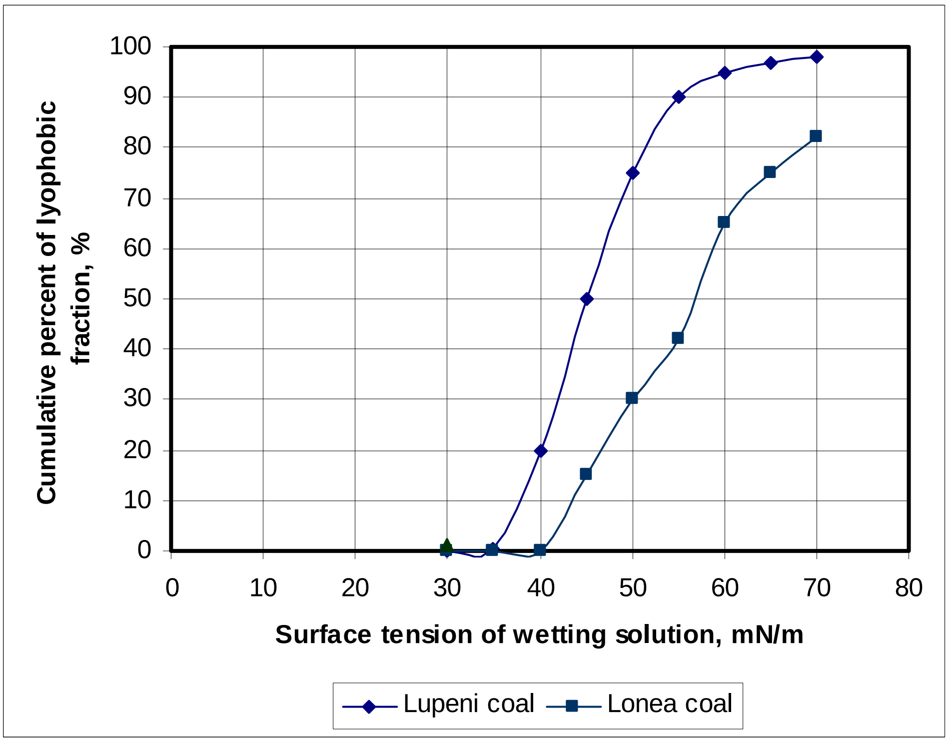

Figure 1 – Film flotation partition curves of natural coal samples

In figure 2, the same curves are presented, but for coal samples conditioned with dodecane. It can see from figure 2 that the mean critical wetting surface tension of coal particles decreases in different manner. For Lupeni sample, it can see that the mean critical wetting surface tension decreases to a value of 44.56 mN/m, and for Lonea sample to 55.21 mN/m. The presence of dodecane films on coal particle surface determines a more pronounced decrease of the mean critical wetting surface tension for coal with higher carbon content.

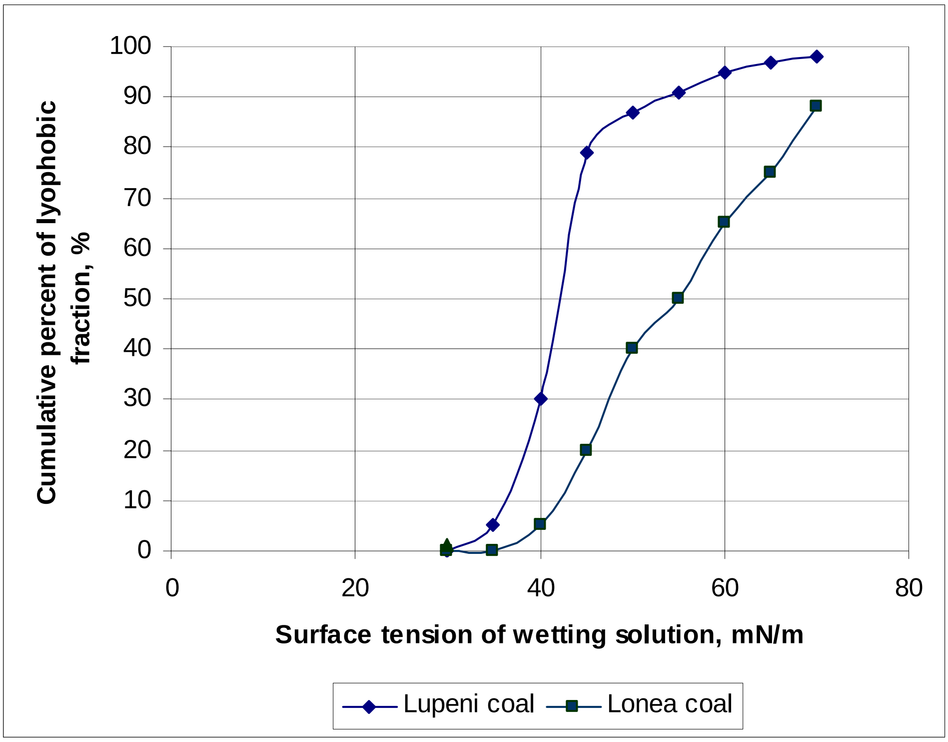

Figure 2 – Film flotation partition curves for coal samples conditioned with dodecane

The results of flotation experiments show that the performance data vary for each sample and from reagent to reagent. It is interesting to compare the runs individually performed in presence of dodecane, nonylbenzene, nonylphenol and polyethoxylated nonylphenol; these four runs carried out using for each coal the same initial doses of collector of 1g/kg coal and of 0,5g/kg for MIBC. Noticeable changes in the performance were observed in the use of the four different reagents. As can see in figures 3 and 4 the combustible matter recovery and the ash rejection are different for each coal.

The results indicate that the polyethoxilated nonylphenol is more effective than the other collectors for both coals. Also, nonylbenzen is more effective then dodecane. Compared with dodecane, reagents containing a benzene ring have much better collecting ability.

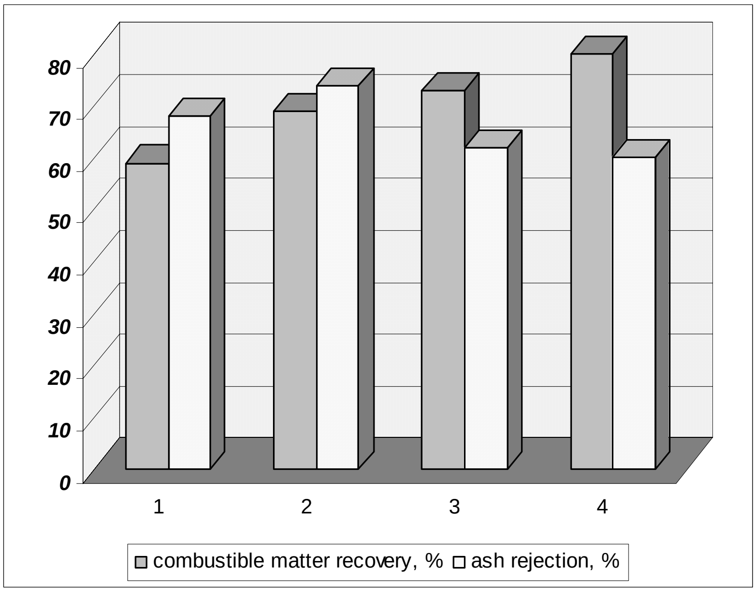

Figure 3 – Reagents versus combustible matter recovery and ash rejection (initial reagent loading: collector 1g/kg; MIBC 0,5g/kg) for Lupeni sample
1 – dodecane; 2 – nonyl benzene; 3 – nonylphenol; 4 – polyethoxilated nonylphenol

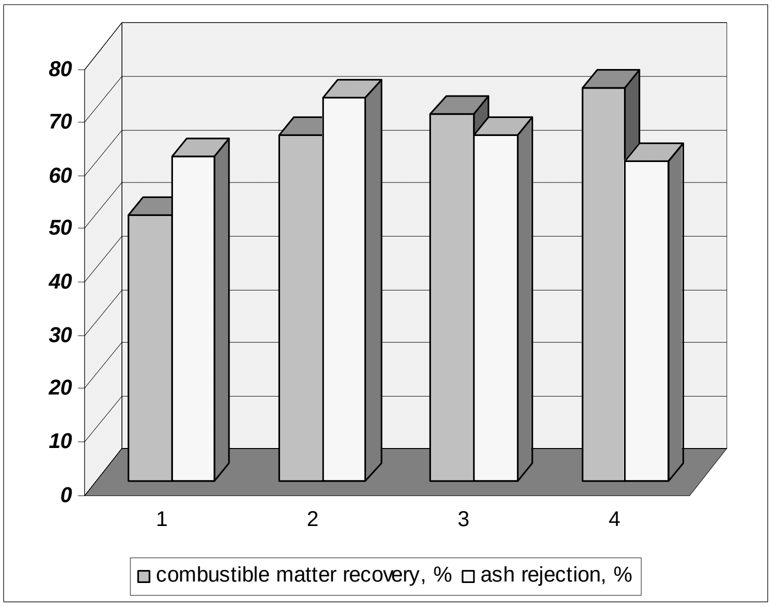

Figure 4 – Reagents versus combustible matter recovery and ash rejection (initial reagent loading: collector 1g/kg; MIBC 0,5g/kg) for Lonea sample
1 – dodecane; 2 – nonyl benzene; 3 – nonylphenol; 4 – polyethoxilated nonylphenol

In considering details of action of apolar oil and non-ionic surfactants studied here, it should be noticed that they have different action mechanisms at water – coal particle interface.

In order to be effective, the insoluble oil used as collector for coal flotation must spread over the coal surface. If coal surface contains polar sites, there is a stronger affinity of these one with water molecules, reducing the oil/water contact angle, thereby reducing the tendency of dodecane to spread over the coal surface. Thus, the most hydrophobic coal from Lupeni mine, can be floated with good results using dodecane as collector reagent. This means that dodecane is able to spread over the coal surface, forming an oily film that increases coal hydrophobicity and consequently its floatability. On the other hand, in Lonea coal flotation the combustible recovery is very low when dodecane is used as the collector. Lonea coal is more hydrophilic and dodecane can't form on coal surface, at this concentration, the hydrophobization film. Most likely, such films can be achieved when the dodecane dose is increased. When surfactants are used as collectors, is possible to achieve better results. These results indicate that the surfactants used have the ability to enhance in this case the hydrophobicity of coal particle surface.

Nonyl benzene is more effective collector than dodecan, for both of the two coals. In this case, appear two possible mechanisms for the interaction between reagent molecules and coal surface. About the interaction between an aliphatic chain and the coal surface, there is a second possibitily of interaction between a benzene ring with the aromatic sites on the coal surface. This is due to strong π bonding interaction between the aromatic component of the coal matrix and the benzene ring of the reagent. Both of the two samples achieved better flotation results with nonyl benzene, the more hydrophilic coal flotation results being more positive affected.

Nonylphenol and polyethoxilated nonylphenol are surfactants possessing oxygenated groups and when are used like collectors in coal flotation they are more effective than the other collectors. These two reagents differ because of the possession in their molecular structure of some oxygenated functional groups: hydroxyl in nonylphenol and besides ethoxy in the second. As we know, the surface of coal consists of inherently hydrophobic areas and also sites containing oxygenated functional groups (carboxyl, carbonyl, phenolic and ester groups). These reagents can interact with coal surface following three possible mechanisms. The first mechanism of interaction between the surfactants and the coal surface appears to be through the polar groups of reagent interacting with the oxygenated functional groups on the coal surface by hydrogen bonding. The second mechanism involves the interaction of nonpolar chain with the carbonaceous sites on the coal surface by dispersing water molecules from the coal surfaces. The third mechanism involves the interaction between a benzene ring with the aromatic sites on the coal surface, due to strong π bonding interaction.

The coal flotation results assert the previous appreciations. It can see that the combustible matter recoveries are substantially enhanced when non-ionic heteropolar reagents are used in coal flotation.

All these facts are in concordance with the bond nature between reagent molecules and coal surface. It is well known that polar interaction is stronger than hydrogen bonding and this second type is stronger than van der Waals interaction.

4. CONCLUSIONS

Film flotation technique allows us to obtain information on coal natural and activated floatability. The mean critical surface energy of coal can be correlated with coal natural floatability and also can be observed a good correlation between the same parameters in the case of coal flotation using different reagents.

For the flotation of the Lonea and Lupeni coals, non-ionic surfactants are more effective collectors than dodecane (an oily collector).

The attachment of the collector reagents to the coal surface can take place by three possible mechanisms. In the case of surfactants, are possible all these three mechanisms and their effectiveness as coal flotation collectors are better. Depending on the rank of the coal and its hydrophobicity, one or the other of these interaction mechanisms may be more dominant. Experiments of coal flotation showed that while is difficult to float most hydrophilic coal with dodecane, the surfactants, clearly enhance the hydrophobicity of such coal surface.

Nonylbenzene was found to be better flotation collectors than dodecane for these two coals, indicating strong interaction of the benzene ring with aromatic sites on the coal surface. The same interactions can appear in the case of surfactants.

5. REFERENCES

[1]. Fuerstenau D.W., Diao J., Williams M.C., *Characterization of coal Wettability of Solid Particles by Film Flotation*, 1991;

[**2]. Cristea G., Cristea N.,** *Application of a new concept for coal wettability evaluation*, 2006.

THE DEGRADATION ON THE LIGNITE'S QUALITY DURING STORAGE

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Abstract: The quality depreciation is caused by the oxidation phenomenon of the stored coal, phenomenon depending part on the storage conditions but also on the physico-chemical features of the lignite. Knowing the main factors that promote the oxidation of lignite during storage requires a strict analysis over the variation of the coal's physico-chemical features in relation to the measurable environment elements to which it has been exposed. Working on the base of field observations, of laboratory analysis executed on a number of storehouses built for study, allows the identification of the main elements of the oxidation process and the correlation between these elements and the depreciation level of the lignite's quality.

Keywords: degradation, lignite, storage, oxidation, coal, quality

Introduction

Lignite exploitation in careers is dependent on the weather turbulences and also on the exploitation conditions and the equipment maintenance.

To assure a rhythmic delivery of production in conformity to the active contracts and also to be able to handle the varied necessities of the market, between exploitation and delivery appear certain delays that force coal storage for different periods of time.

Lignite storage determines a depreciation of the quality characteristics under the influence of external factors to which it is exposed thus determining economical losses.

To reduce the proportion of losses this paper wants to identify the factors

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that have greater influence in the quality depreciation of the lignite as well as the values at which these factors have minimal effect on the process.

In other words through this research we'll try to find the minimum cost storage conditions that would reduce losses in the storage period.

Laboratory experiments

Evaluating the behaviour of the lignite on oxidation

It is well known that the auto oxidation process stands at the base of the quality loss of the lignite. Knowing the phenomenon that favourites the lignite oxidation imposes a careful analyze of the physico-chemical properties variation depending on the storage period.

To identify the behaviour of the lignite from Bazinul Oltenia on auto oxidation we applied a series of laboratory experiments to treat the coal prepared at a granulation of under 0,2 mm with a solution of perhydrol 20%. The mixture temperature is recorded every minute until it reaches the temperature of 50^0C. After this temperature is reached the reading takes place every 10^0C until the maximum temperature is reached. This phenomenon is manifested through increasing turbulence of the mixture, through the formation of effervescent bubbles expanding toward the superior part of the coated balloon in a very short time period. At a short time after the maximum temperature is reached the reaction starts to decrease in intensity and the mixture stars to cool down.

In the cooling process the temperature is recorded from the maximum temperature to the minimum temperature every 10^0C, until the temperature of 50^0C is reached. Under the level of 50^0C the auto oxidation process is no longer representative thus the temperature decrease is no longer recorded.

The experiment was made on several coal samples from different careers.

The obtained results are presented in table 1 and in figures 1 and 2.

On the basis of preliminary results that the temperature's growth gradients have been determined during the two periods and are displayed in Table 1.

Tabel nr 1

Open pit	Career	Start temperature [^{0}C]	Maximum temperature [^{0}C]	Heating time [min]	Heating speed [^{0}C]/ [min]	Cooling time [min]	Cooling speed [^{0}C]/ [min]
Berbeşti	Berbeşti Vest	23	94	10	7,1	9	4,9
	Alunu	25	92	15	4,5	13	3,2
	Panga	26	94	18	3,8	10	4,4
	Seciuri	22	90	22,5	3	6,5	6,2
Jilț	Jilț Nord	22	90	21,9	3,1	6,9	5,8
	Jilț Sud	23	85	21,9	2,8	8,1	4,3
Motru	Lupoaia	29	95	10,9	6	10,9	4,1
	Roşiuța	29	95	10,9	6	11,9	3,8
Mehedinți	Husnicioara	22	88	25,5	2,6	10,5	3,6
Roşia	Roşia Jiu	28	92	10,5	6,1	7,5	5,6
Pinoasa	Pinoasa Sud	28	97	11,3	6,1	5,7	8,2

FIGURE 1 Temperature variations during self- oxidation process

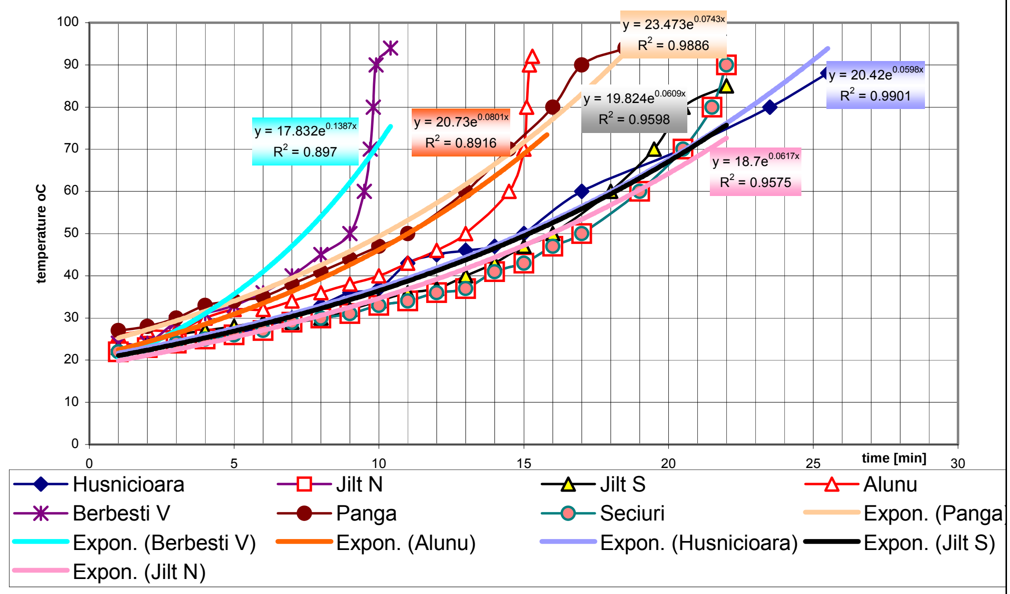
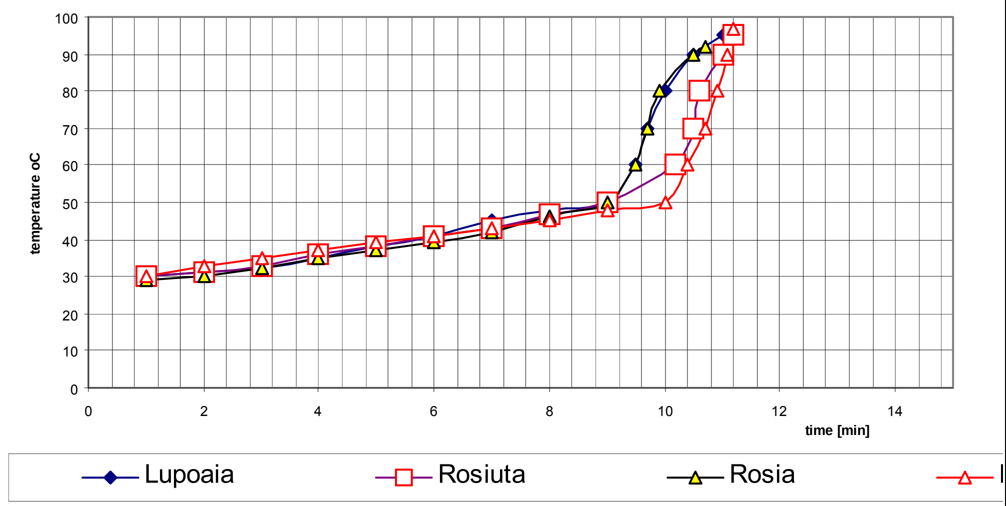


FIGURE 2 Temperature variations during self- oxidation process



The speed with which the process takes place imagined through the temperature that is reached in the time unit is very high in the second period for coal from Berbesti V and Alunu, the decrease taking place in this order: Panga, Seciu, Jilt N, Jilt S and Husnicioara Coal from Rovinari and Motru also present a high reaction speed that means that these coals have a high auto-oxidation potential when reaching the ignition parameters.

In conclusion after making the laboratory study results:

- Coals from E.M. Motru, E.M. Rovinari and partially coals from Berbesti are predisposed to the auto-oxidation process so their storage should be avoided;
- Coals from Panga, Seciu, Jilt N, Jilt S have a not so pronounced reactivity and so the auto-oxidation process takes place with a reduced speed, the delay being more pronounced;
- The less reactive coal in the process of auto-oxidation seams to be the one from Husnicioara.

The evaluation of the coal's structural changes

To verify the above hypothesis we considered necessary to extend research so we would be able to establish the changes that take place in the coal's structure during storage, through elementary analysis of the coal samples during a 30-day period. In this paper we compared samples from the following careers: Lupoaia, Rosiuta, Jilt Nord, Jilt Sud.

For these coal samples to reflect the initial characteristics it has been imposed that the sampling be done from fresh excavated and deposited coal from the up-mentioned careers.

The sample preparation methodology is:

a. The sample preparation consists of the coal screening at 5mm granulation. Refused granulation was milled and passed again through the sieve. The quantity of coal obtained having 5 mm granulation passed a new screening at 2,5 mm;

b. The coal that passed through 2,5 granulation was dumped, only the refused granulation being kept. The obtained quantity of coal after these operations was 10Kg for each sample.

c. The coal obtained between 2,5 and 5mm granulation dried for 8 hours in the cabinet dryer at a temperature of 70^0C, thus totally eliminating humidity;

d. Through homogenisation and quantity reduction we obtained 4 samples of 5Kg each from the careers: Lupoaia, Rosiuta, Jilt Nord and Jilt Sud;

e. Four cardboard cylinders were manufactured with a size of 10cm, foreseen with 1cm orifices on the cylinders whole surface at a symmetric distance of 5cm each.

f. The cylinders were placed on a disk of the filter sieve, that confers the natural transport possibility of air, to establish an environment that is very close to the one in the warehouse.

g. After humidity removal the first series of elementary and technical analyses took place.

h. Over the dry studied coal, water was pulverized in two progressive stages, to take its humidity to the experimental one, after which it has been introduced again in the cylinders.

i. After a period of: 5, 10, 20 and 30-day we collected a sample of 5g from each cylinder, the same set of experiments being accomplished as on the dry coal. The sampling was made through integral coal depletion from the cylinders.

j. After the first sampling when the initial parameters were determined, the coal was again pulverized with water and reintroduced in the cylinders for the next determinations.

k. The elementary analyses accomplished in calorimeter bomb for nitrogen, hydrogen and superior calorific value, in a furnace for volatile and ash content, also chemical for coal content.

Following the established methodology, in the table 2 we present the analyses results for coals from the career Lupoaia, in the table 3 output the analyses for coals from the career Rosiuta, in the table 4 output the analyses for coals from the career Jilt Nord and in the table 5 output the analyses for coals from the career Jilt Sud.

Tabel nr. 2

Crt. No	Deposit period [days]	Parameters							
		N_{mc} [%]	H_{mc} [%]	V_{mc} [%]	C_{mc} [%]	Wi [%]	Wh [%]	Aanh [%]	Qi [Kcal/Kg]
1	0	0,70	3,52	41,6	58,58		4,91	29,7	3814
2	5	0,72	3,36	41,45	58,45				3801
3	10	0,76	3,38	41,4	58,33				3785
4	20	0,77	3,36	41,00	58,00				3751
5	**30**	**0,8**	**3,40**	**41**	**57,83**				**3740**
6	0	0,70	3,52	41,60	58,58	17,5	4,91	29,7	3814
7	5	0,67	3,63	41,38	58,33				3768
8	10	0,66	3,77	41,27	58,21				3744
9	20	0,61	3,89	40,75	57,93				3742
10	**30**	**0,65**	**3,92**	**40,15**	**57,6**				**3739**
11	0	0,7	3,52	41,6	58,58	28,1	4,91	29,7	3814
12	5	0,65	3,71	41,45	57,90				3765
13	10	0,68	3,79	41,4	57,88				3744
14	20	0,7	3,93	41,00	57,69				3739
15	**30**	**0,71**	**3,99**	**39,50**	**57,45**				**3698**

Tabel nr. 3

Crt. No	Deposit period [days]	Parameters							
		N_{mc} [%]	H_{mc} [%]	V_{mc} [%]	C_{mc} [%]	Wi [%]	Wh [%]	Aanh [%]	Qi [Kcal/Kg]
1	0	0,59	3,25	38,62	57,15	0	3,81	36,4	3371
2	5	0,63	3,12	38,48	57,21				3364
3	10	0,64	3,15	38,52	57,18				3342
4	20	0,62	3,1	38,45	57,11				3328
5	**30**	**0,64**	**3,15**	**38,45**	**57,1**				**3328**
6	0	0,59	3,25	38,62	57,15	16,3	3,81	36,4	3371
7	5	0,58	3,41	38,59	56,83				3345
8	10	0,61	3,28	38,75	56,91				3321
9	20	0,57	3,35	38,81	56,78				3337
10	**30**	**0,58**	**3,38**	**38,76**	**56,75**				**3324**
11	0	0,59	3,25	38,62	57,15	29,8	3,81	36,4	3371
12	5	0,61	3,61	39,43	56,73				3321
13	10	0,63	3,52	39,86	56,65				3308
14	20	0,58	3,59	40,09	56,68				3315
15	**30**	**0,62**	**3,51**	**39,21**	**56,71**				**3303**

Tabel nr. 4

Crt. No	Deposit period [days]	Parameters							
		N_{mc} [%]	H_{mc} [%]	V_{mc} [%]	C_{mc} [%]	Wi [%]	Wh [%]	Aanh [%]	Qi [Kcal/Kg]
1	0	0,62	3,18	41,21	50,26	0	4,63	34,6	3102
2	5	0,63	3,21	40,97	50,2				3090
3	10	0,62	3,2	40,82	50,15				3081
4	20	0,6	3,2	40,85	50,18				3067
5	**30**	**0,63**	**3,21**	**40,73**	**50,16**				**3052**
6	0	0,62	3,18	41,21	50,26	15,6	4,63	34,6	3102
7	5	0,63	3,25	41,35	50,28				3065
8	10	0,6	3,26	41,3	50,18				3070
9	20	0,58	3,25	41,32	50,15				3070
10	**30**	**0,59**	**3,27**	**41,24**	**50,18**				**3075**
11	0	0,62	3,18	41,21	50,26	30,4	4,63	34,6	3102
12	5	0,6	3,31	42,73	50,18				3027
13	10	0,59	3,35	43,15	50,2				3015
14	20	0,61	3,32	43,12	50,14				3021
15	**30**	**0,57**	**3,33**	**42,24**	**50,01**				**3032**

Tabel nr. 5

Crt. No	Deposit period [days]	Parameters							
		N_{mc} [%]	H_{mc} [%]	V_{mc} [%]	C_{mc} [%]	Wi [%]	Wh [%]	Aanh [%]	Qi [Kcal/Kg]
1	0	0,65	3,15	37,91	56,15	0	5,1	35,81	3325
2	5	0,61	3,12	37,83	56,18				3285
3	10	0,63	3,16	37,72	55,91				3270
4	20	0,65	3,14	37,69	55,95				3275
5	**30**	0,61	3,15	37,74	55,88				32,68
6	0	0,65	3,15	37,91	56,15	16,1	5,1	35,81	3325
7	5	0,62	3,25	38,15					3300
8	10	0,62	3,31	38,12	56,08				3297
9	20	0,6	3,28	38,21	59,97				3278
10	**30**	0,62	3,32	38,18	56,03				3285
11	0	0,65	3,15	37,91	56,15	31,3	5,1	35,81	3325
12	5	0,6	3,31	38,25	55,92				3257
13	10	0,64	3,47	38,41	55,87				3243
14	20	0,67	3,4	38,56	55,91				3255
15	**30**	0,63	3,45	38,52	55,67				3264

On the basis of laboratory tests on coals from the careers Lupoaia, Rosiuta, Jilt Nord and Jilt Sud, where in the first faze, through drying took place a loss of humidity, followed by a controlled humidification, we noted the following:

a) Nitrogen content remains about constant in all three test stages;
b) Hydrogen content increases about 1%;

c) Volatile matters content is variable; sometimes increases, sometimes diminishes, but in reduced limits;
d) Carbon content diminishes in all the cases with an average of over 0,5 %;
e) Superior calorific value, presents a diminution from the initial value as established in all test phases, as follows:
- In the dried phase, Qsup med= -1, 0%;
- The intermediate humidity, Qsup med= -1, 4%;
- The final humidity, Qsup med= -2, 0%.

These tests prove that the oxidation process takes place in all three experimental phases (dry, intermediate and final humidity), process that from which results the superior calorific value diminishing, bolder to erected humidity.

Knowing interdependency between qualitative coal features and the atmospheric factors acting on coals, in a certain period, accomplishes on a long-time investigation.

After calculus effectuation and correlated charts, of the calorific value and the duration of coal storage, it has been necessary to know in what scale and in what form the environmental factors influence the process of oxidation and qualitative coal depreciation.

From the analysis of the environmental factors, concluded that only a mere part of this has a continuous action on all studied period, and others have a shorter time action, so that we neglected them.

The first category includes:

- ♦ The temperature of the air;
- ♦ The temperature of the soil;
- ♦ The relative humidity of the air;
- ♦ The air pressure;
- ♦ The speed of the wind.

The environmental factors with a reduced action, on the process of coal oxidation are: wind direction, hurry, precipitations and the thickness of the snow layer.

Monthly average statistics are presented in the table nr. 6.

Table 6

Crt. No.	Period [month]	Temperature of the air [^{0}C]	Temperature to soil [^{0}C]	Relattive air humidity [%]	Air pression [mBar]	Wint speed [m/s]
0		1	2	3	4	6
1	January	-1,74	-2,07	94,35	992,23	0,14
2	February	-3,97	-3,65	83,43	995,58	0,41
3	Marth	4,26	4,97	71,35	997,04	0,56
4	April	10,01	11,19	70,30	1289,34	0,73
5	May	19,59	22,34	59,03	991,54	5,43
6	June	22,79	27,12	66,13	991,02	0,55
7	**Average six month**	**8,49**	**9,98**	**74,10**	**1042,79**	**1,30**

After the main factors settlement, influencing the process of oxidation and qualitative coal depreciation analysed the ratio among the calorific value obtained against the average parameters in the reported period.

On the basis of obtained data from the analyses of quality of the wagonable lots and time registration for waiting time in the own warehouses at the careers Lupoaia and Rosiuta, from January to June, was obtained exponential dependence of the calorific value monthly of the storage period. This is presented in the chart figures 3 and 4.

FIGURE 4. Delivered coal quality variation depending on the storage time on the career ROSIUTA

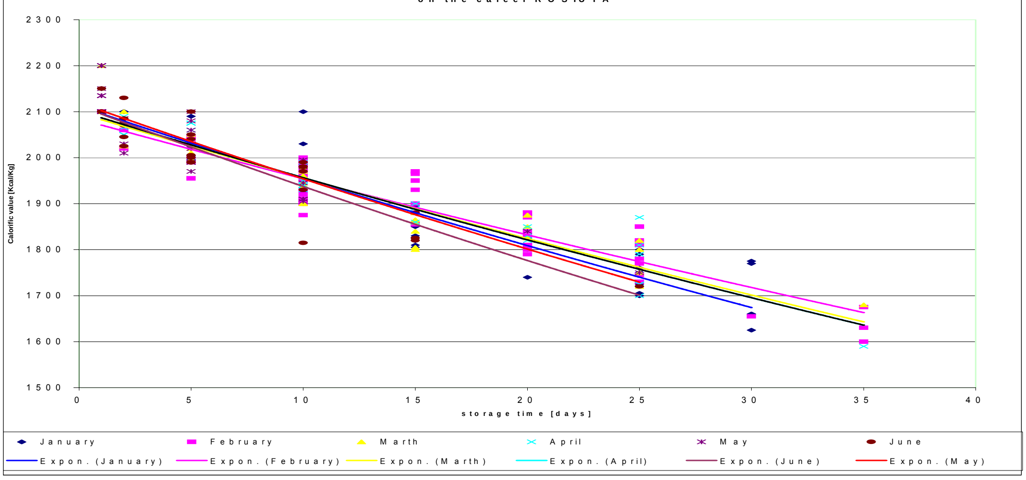
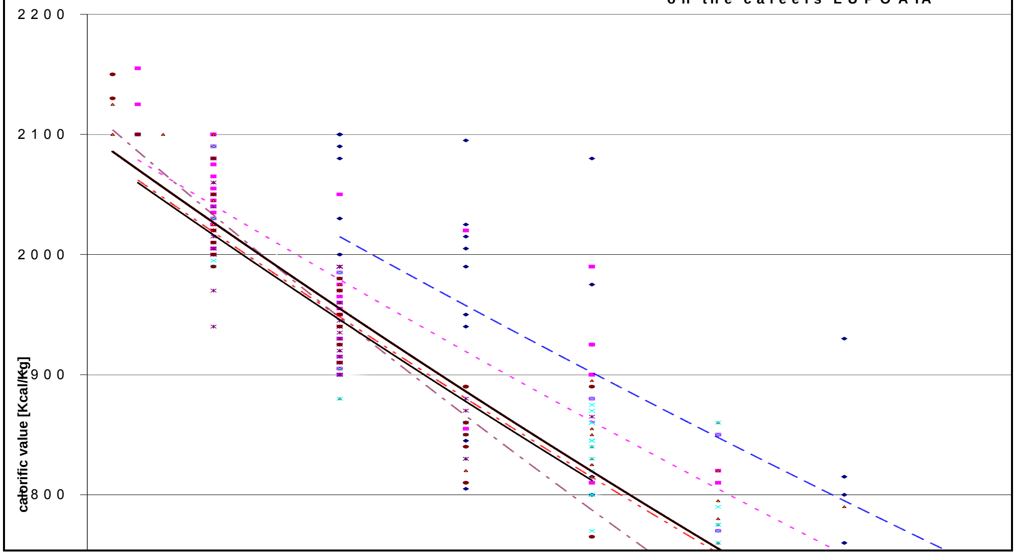


FIGURE 3. Delivered coal quality variation depending on on the careers LUPOAIA



As the chart shows, observed that coal depreciation in warehouses, begins in the moment of warehouse leaving, up to the moment of shipping and reporting parameters. Waiting period for the coal in warehouse is variable and measures limits from 5 to 50 days.

Starting the process of depreciation is in progress from the moment of the coal deposit in warehouse (about 2100 Kcal /Kg), and he diminishes inversely proportionate to the rise of the storage duration, arriving after an average period of about 30 days warehouse staying, missed least 10% of his quality.

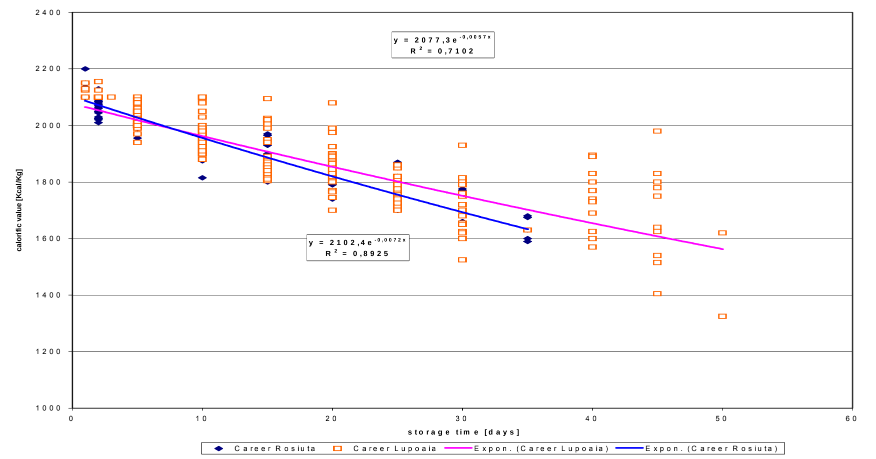
In the case of the career Lupoaia, regression lines specify to the interval January- June, they have as points of starting the value of 2100 Kcal /Kg/(exception does the month January when the initial value is less with about 100 Kcal/ Kg). As the duration of stored coal increases, monthly regression chart lines modified, resulting an important difference between different months.

Regression chart lines equations, in the case of the career Rosiuta there are grouped, against from the career Lupoaia are more scattered. The May month is the period showing the instalment of greatest oxidation rate for both careers.

Comparing correlations equations obtained to both careers, found although waiting duration was less in warehouse Rosiuta is else little (about 30 days), the process of qualitative depreciation is else intense against the career Lupoaia, where the maxim waiting duration were less than 50 days.

Comparative evolution of the calorific value lines, for the career Lupoaia and Rosiuta, is presented in the figure 5.

Fig. 5 Comparative evolulution of the calorific value linesfor the careers LUPOAIA and ROSIUTA



CONCLUSIONS

➢lignite degradation during storage complies with regularities that were established in the laboratory

➢degradation depends environmental factors being emphasized with moisture and environmental temperature increasing

➢the studied processes in storages prove that a continuously degradation takes place without touching self-ignition point

REFERENCES

[1]. VASILIU, F,. *Metode de analiză a calităţii produselor*. Editura Ceres. 1980.

[2]. KRAUSZ ,S., TROTEA, T,. BACALU, I. *Comportarea lignitului din carierele C.N.L.Oltenia la oxidare şi autoîncălzire.* Revista Minelor nr.12/2003.

[3]. PĂTRU, F,. Carierele Lupoaia şi Roşiuţa- *Studiu asupra situaţiei haldelor de steril*, E.M.C. Motru, 2000.

[4]. IACOBESCU, F. *Tehnologii şi echipamente de control*. Editura CERTI, Craiova. 1994.

HOW TO USE THE ZONE CRITERION TOGETHER WITH THE SPECTRAL ANALYSIS IN DECIDING WHICH ONE IS THE ACTUAL COORDINATION WAY FOR THE COMPLEX COMPOUND FORMED BY Pd (II) WITH PYRAZINEAMIDE

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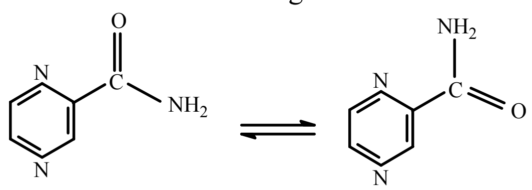
Abstract: The main purpose of this paper is finding the actual coordination manner of pyrazineamide (denoted as PZA) to Pd (II), by performing a quantum-molecular study that uses the zone criterion, in connection with a study based on the UV-VIS and IR spectral analysis. The absorption maxima occurring in the UV-VIS spectra of both PZA and $[Pd(PZA)_2]^{2+}$ have been interpreted by using appropriate programs, such as HYPERCHEM 8 (trial version) and ICONC; then, EHT calculations have been made, taking into account the zone criterion, and a comparison to the IR spectra was finally performed.

This paper deals with the complex compound that is formed by Pd (II) with pyrazineamide, whose formula is the following:



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The elemental analysis shows that this complex exhibits the formula $[Pd(PZA)_2]^{2+}$.

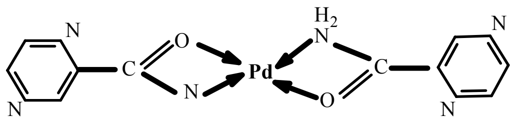
Moreover, it was previously proved to be square-planar, having a diamagnetic behavior.

It still has to be elucidated the problem regarding the actual coordination way of PZA to Pd(II).

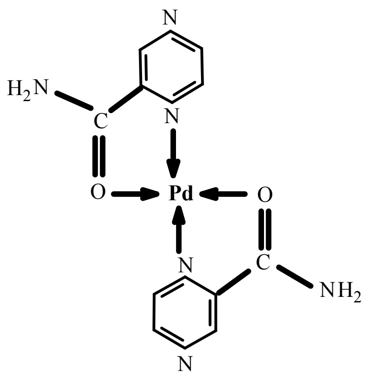
The ligand has four heteroatoms: beside the oxygen atom in the carbonyl group, there are two nitrogen atoms (equivalent to each other) in the pyrazine heterocycle and another one outside it, in the amidic group.

Consequently, PZA may theoretically coordinate to the central metal ion in three different ways, as following.

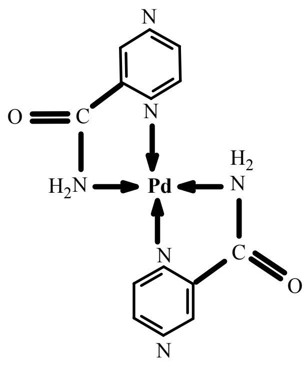
A possible coordination way is using oxygen and nitrogen in the amidic group; then, the complex would look like this:



Another possible coordination way is by means of the oxygen atom and one nitrogen atom in the pyrazine heterocycle; in this case, the structure would be as shown bellow:



The third possible coordination way is by means of the nitrogen atom in the amidic group and one nitrogen atom in pyrazine; the complex would have the following structure:



To decide which one of these is the real one, we shall make use of quantum-molecular methods, having the spectral analysis as a basis of our study. Both the complex and the ligand were previously characterized by UV-VIS and IR spectral analyses.

To be more specific, the UV-VIS spectra (190 - 1100 nm) - presented in Figure 1 - were obtained in 10^{-3} M DMSO solutions, by using an Ocean Optics spectrophotometer.

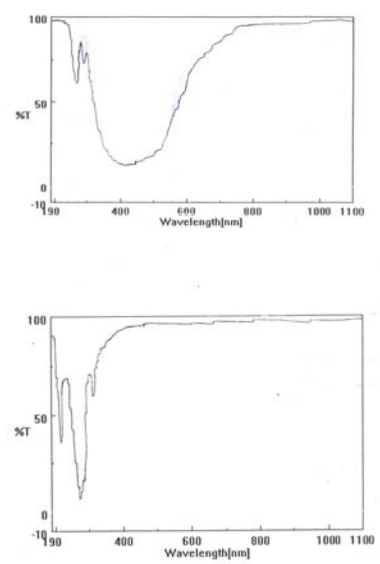


Figure 1. The UV-VIS spectra for the complex (above) and the free ligand (below)

The IR spectra (4000 - 400 cm^{-1}) - presented in Figure 2 and Figure 3 for the complex compound and the free organic ligand respectively - were recorded on a Perkin-Elmer FT-1600 Hewlett Packard instrument in anhidrous KBr pellets.

The first step in getting information about the actual coordination manner of PZA to Pd(II) is performing a comparative quantum-molecular study of the absorption maxima proper to the organic ligand and the ones proper to its complex compound.

Initially, the molecular geometry for both of them was optimized using the Molecular Mechanics approach (MM^{+}).

The chartesian coordinates for all the atoms being obtained by using HYPERCHEM 8 (trial version).

In the following table the energies and the occupation state for each of the most important molecular orbitals of the free ligand and the Pd(II) complex are comparatively presented, as well as the atom mainly involved in each of them.

PZA			**$[Pd(PZA)_2]^{2+}$**		
M.O.	**-ε (eV)**	**Atom mainly involved**	**M.O.**	**-ε (eV)**	**Atom mainly involved**
ψ_{20} unocc.	6.94	N (-NH_2) O (C=O) N (pyrazine)	ψ'_{40} unocc.	7.23	O (C=O) N (pyrazine) Pd(II)
ψ_{21} unocc.	7.27		ψ'_{42} unocc.	7.35	
ψ_{23} unocc.	7.31		ψ'_{43} unocc.	8.61	
ψ_{25} occ.	11.25	N (pyrazine) N (pyrazine) O (C=O) N (-NH_2)	ψ'_{44} occ.	8.81	Pd(II) N (pyrazine) N (-NH_2) O (C=O)
ψ_{26} occ.	11.83		ψ'_{48} occ.	11.32	
ψ_{27} occ.	11.89		ψ'_{49} occ.	11.64	
ψ_{29} occ.	12.64		ψ'_{50} occ.	11.98	

The information in the previous table constitute the theoretical basis for performing the most probable assignments for the absorption maxima occurring in the UV-VIS spectra of both PZA and $[Pd(PZA)_2]^{2+}$.

The first absorption maximum - in order of increasing wavelength - in the electronic spectrum of PZA (which is experimentally observed at 210 nm) is assigned to a transition between Ψ_{29} and Ψ_{20}, i.e. between two molecular orbitals of the nitrogen atom from –NH_2 (whose theoretical value of the wavelength is 218 nm).

The second absorption maximum (which is experimentally observed at 270 nm) is assigned to a transition between Ψ_{27} and Ψ_{21}, i.e. between two molecular orbitals of the oxygen atom from the carbonil group (whose theoretical value of the wavelength is 268 nm).

The third absorption maximum in order of increasing wavelength (which is experimentally observed at 310 nm) is assigned to a transition between Ψ_{25} and Ψ_{23}, i.e. between two molecular orbitals of a nitrogen atom from the pyrazine heterocycle (whose theoretical value of the wavelength is 315 nm).

In assigning the transitions, quantum-molecular methods have been used.

Beside the energetic criterion, the “zone criterion” has got to be taken into account.

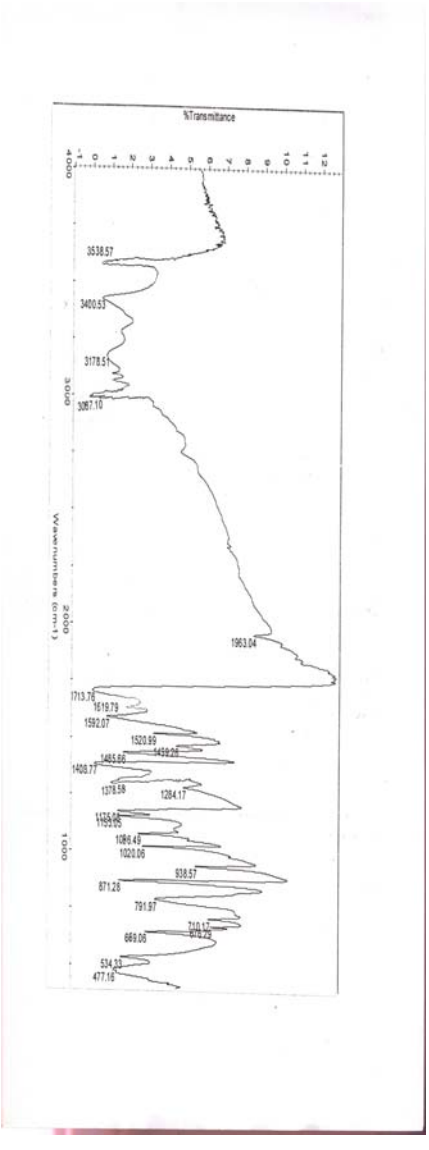


Figure 2. The IR spectrum of the complex

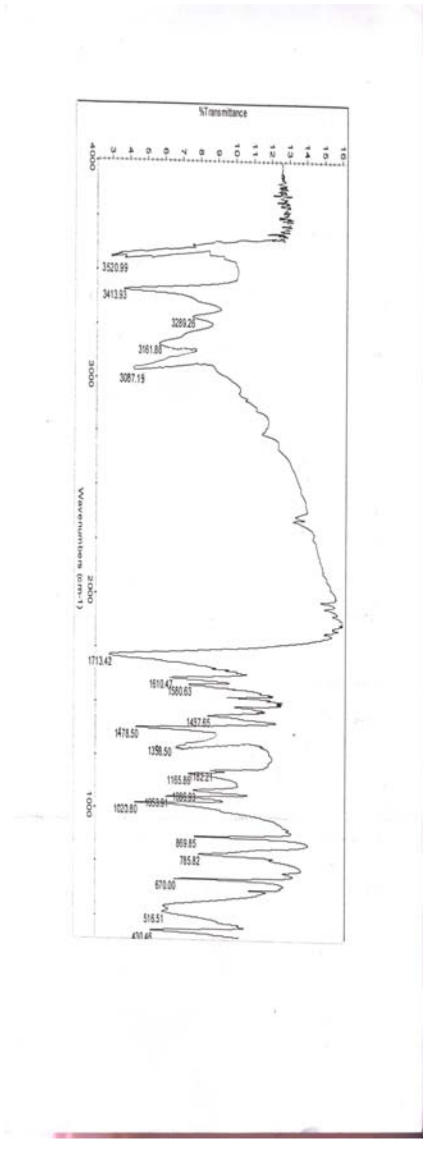


Figure 3. The IR spectrum of the free ligand

According to this criterion, it is very less probable for a transition to occur between two molecular orbitals practically localized on heteroatoms situated in two completely different areas of the molecule.

At contrary, it is correct to presume that is possible for a maximum to be attributed to a transition involving lone pairs of the same heteroatom, even though this one might not exhibit a great compatibility with the experiment.

For instance, energetically counting, the transition at 270 nm from the UV-VIS spectrum of PZA might be equally assigned to a transition between Ψ_{26} and Ψ_{21} (whose theoretical value of the wavelength would be 272 nm), but this assignment is much less probable than the one previously presented, if taking into account the aspect of the orbitals Ψ_{21}, Ψ_{26} and Ψ_{27} (respectively shown in Figure 4).

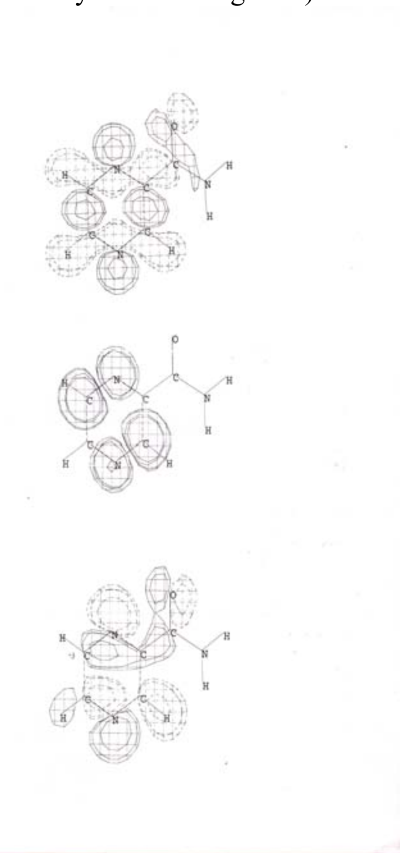


Figure 4. The aspect of the orbitals Ψ_{21}, Ψ_{26} and Ψ_{27}

As far as the electronic spectrum of the Pd(II) complex is concerned, one may see that the first and the second absorption maxima in order of increasing wavelength (at 270 and 300 nm) can be respectively assigned to transitions that are similar to the second and the third transition in the spectrum of the free ligand.

Namely, the maxima observed at 270 nm in the spectrum of $[Pd(PZA)_2]^{2+}$ can be interpreted as being due to a transition between two molecular orbitals of the oxygen atom from the carbonil group, specifically between Ψ'_{50} and Ψ'_{40} (the theoretical value of the wavelength for this transition is 268 nm).

Similarly, the maxima observed at 300 nm in the spectrum of the complex can be interpreted as being due to a transition between two molecular orbitals of a nitrogen atom from the pyrazine heterocycle, namely between Ψ'_{48} and Ψ'_{42} (the theoretical value of the wavelength for this transition is 312 nm).

Finally, the maximum that is experimentally observed at 420 nm may be assigned to a charge transfer transition (L→M) occurring between Ψ'_{49} and Ψ'_{43}, i.e. from an occupied orbital of a nitrogen atom from the amidic group to the only unoccupied *d* orbital of the metal ion (the theoretical value of the wavelength in this case is 409 nm). Thought it belongs to the visible range, it is unlikely to be regarded as a ***d-d*** transition. Even if such a transition occurs, it cannot be perceived because it is theoretically not Laporte allowed, proving one more time the square-planar geometry of $[Pd(PZA)_2]^{2+}$, which provides a high symmetry for this complex compound.

On this basis, we are now able to provide the real coordination manner.

The fact that the first maximum in the electronic absorption spectrum of the free organic ligand was not found again in the one of its complex compound with Pd(II) shows that the nitrogen atom from $-NH_2$ is involved in the coordination.

The great similarity between the second maximum in the UV-VIS spectrum of PZA and the first one in the spectrum of $[Pd(PZA)]^{2+}$ is a prove that the oxygen atom exhibits no involvement in the coordination whatsoever, which is already to say that, among all the possible structures of the complex compound, the actual one is the last one - using the nitrogen atom in the amidic group and a nitrogen atom belonging to the heterocycle (in fact, the orbitals Ψ'_{50} and Ψ'_{40} of the complex seem to come themselves from the former orbitals Ψ_{27} and Ψ_{21} of the free organic ligand).

In the same way, a remarkable concordance appears between the third maximum in the UV-VIS spectrum of PZA and the second one in the spectrum of $[Pd(PZA)]^{2+}$ (moreover, the orbitals Ψ'_{48} and Ψ'_{42} of the complex seem to originate in the former orbitals Ψ_{25} and Ψ_{23} of the ligand). Therefore, it shows that at least one nitrogen atom has nothing to do with the coordination, which is in agreement with the previous statement regarding the real coordination way.

The assignment of the last transition in the spectrum of the complex once more confirms that the nitrogen atom in the amidic group is mixed up in the coordination process.

In order to verify the conclusion obtained by performing the quantum-molecular calculation based on the zone criterion connected to the UV-VIS spectral analysis, let us now take a comparative look at the IR spectra of PZA and $[Pd(PZA)]^{2+}$.

As known, the amidic group is a complex exhibits three characteristic bands in the 1300-1750 cm^{-1} range.

To be more specific, in our particular case, for the free ligand, the first amidic band, at 1713 cm^{-1}, due to the vibration of the carbonil group (ν_{CO}) appears again - unshifted - in the spectrum of the complex, proving that the oxygen atom in PZA does not participate to the coordination. The second amidic band, due to the deformation of the N-H bond, appearing at 1580 and 1610 cm^{-1} in the spectrum of PZA, is shifted towards bigger wavenumbers after the coordination (1592 and 1619 cm^{-1}). The third amidic band, due to the valence vibration of the bond between the carbon atom in amide and the amidic nitrogen atom, occurs at 1398 cm^{-1} for PZA and at 1378 cm^{-1} for $[Pd(PZA)_2]^{2+}$

All the bands that are specific for the C-C and C-H bonds in the heterocycle remain practically unshifted after the coordination process: γ_{CH} (around 670 cm^{-1}), β_{CH} (around 1020 and 1053 cm^{-1}), ν_{CH} (around 3087 cm^{-1}) and ν_{CC} (around 1478 and 1497 cm^{-1}).

The bands involving $-NH_2$, at 3413 cm^{-1} (ν_{NH_2} sym.) and 3520 cm^{-1} (ν_{NH_2} antisym.) for the ligand are hardly shifted, appearing for the complex at 3400 cm^{-1} (ν_{NH_2} sym.) and 3538 cm^{-1} (ν_{NH_2} antisym.), confirming the involvement of the amidic nitrogen in the coordination.

One more time it is thus confirmed that the nitrogen atom in $-NH_2$, as well as one of the nitrogen atoms in pyrazine are responsible for the coordination process, while the oxygen atom in the carbonil group plays no part in it.

Consequently, the coordination is realized by means of two nitrogen atoms having different environments, so that PZA prove itself to be a bidentate (N, N) ligand that combines with Pd(II) in a 2:1 ratio.

The quantum-molecular interpretation presented above is brand-new, the assignment of the electronic transition being never reported before, neither for the free organic ligand pyrazineamide (PZA), nor for the complex compound that it formes with Pd(II).

References

[1]. Ganescu, I., Muresan, V., Sbirna, L. S., Ganescu, A., Sbirna, S., Preda, C., *Acta Chim. Slov.,* **49**, 545, 2002

[2]. Ganescu, I., Muresan, V., Sbirna, L. S., Ganescu, A., Sbirna, S., Preda, C., *South. Braz. J. Chem.,* **10**, 89, 2002

[3]. Muresan, V., Sbirna, S., Lepadatu, C.I., Sbirna, L.S., Muresan, *N., Acta Chim. Slov.,* **49**, 447, 2002

[4]. Sbirna, L.S., Sbirna, S., Lepadatu, C.I., *Rev. Roum. Chim.,* **48**, 413, 2003

[5]. Sbirna, L.S., Sbirna, S., Lepadatu, C.I., Muresan, V., Muresan, *N., J. Indian Chem. Soc.*, **79**, 409, 2003

[6]. ***Sbirna, L.S., Sbirna, S., Lepadatu, C.I., Muresan, V., Muresan, N.,*** *J. Indian Chem. Soc.,* **81**, 115, 2004.

DESIGN OF CENTRIFUGAL HYDRAULIC CLASSIFIERS BASED ON HYDRODYNAMIC SIMILITUDE

ROMULUS SÂRBU *

Abstract Today, the hydrocyclon design starts from some technological parameters and empirical calculus relations. The present paper offers a few mathematical models by hydrodynamic similitude, based on experimental research (at laboratory scale) of quartziferous sands. Based on laboratory results, on the correlations between the hydrodynamic and construction parameters, it was carried out a hydrocyclon to the industrial scale. This new type of hydrocyclon was tested to the quartziferous ores from the Faget-Timisoara processing plant.

Key words: hydrocyclon design, mathematical models by hydrodynamic similitude.

1. MANUFACTURE AND HYDRODYNAMICS OF ADDITIONAL WATER FLOW HYDROCYCLON

The special role the hydrocyclon plays in the field of useful mineral substances processing and within the related industries arises from its multilateral usage. This equipment can be used either for classification, thickening, slime pulp de-sliming and finally as concentration equipment.

The additional water flow hydrocyclon (see fig. no 1) consists of one relatively high cylindrical part (1) where the raw slime pulp is fed in by means of a feeding pipe (2) placed tangent to the cylindrical part.

At the bottom of cylindrical part certain concentric cones (3) are placed, which are tangentially fed with an additional water flow by means of the inlet pipe connections (4) placed at the same level with the free spaces between the above mentioned cones.

At the moment when the rotary downward slime pulp flow gets into the concentric cones area, named washing area, the rotary additional water flow interferes with this one involving the following:

- an increase of particles’ tangential motion velocity; this fact brings about an increase of the centrifugal force;
- an increase of dilution which involves a better washing of the fines in the centrifuged material layer and a better aerated re-stratification depending on the sizes;

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- driving of s lime pulp containing small size particles - onto the hydrocyclon axis, this phenomenon being also favored by the conic shape of the elements within the washing area.

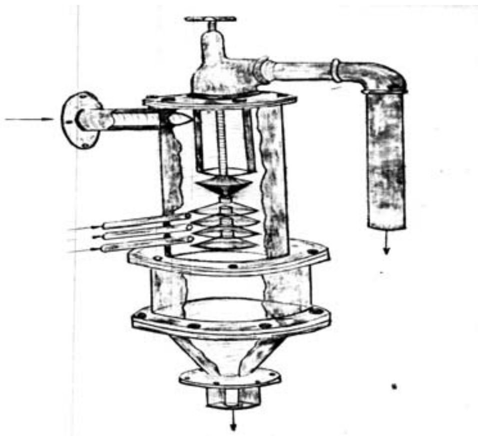

Figure no.1. - Additional water flow hydrocyclon

The slime pulp containing mainly large size particles continues its downward motion, arriving into the lower cylindrical part (5) having larger diameter but lower height which is followed by a conical part (6); these elements can be easily assimilated both in manufacture and operation process with a classical hydrocyclon.

The *radius fracture* involved by the lower cylindrical part leads to a new re - stratification and re-arrangement of the material on size basis, having as final effect a reduction of under-size grains quantity, and implicitly an increase of classification efficiency.

Close to the cone point, a part of downward slime pulp flow changes its motion direction and it is forming an upward helical flow current which is overlapping over the existing upward flow current within the washing area.

The slime pulp flow, containing mainly fines, in its upward motion meets a deflecting cone (7), which can be adjusted upon its vertical axis by means of the threaded rod (9) in the view of adjusting the overflowing and, implicitly, the separation size.

The upward pulp slime flow is forced to wrap up onto the lateral face of this cone, and interferes with the central part of the main pulp slime flow, where a relative stratification has already occurred, and takes over a large part of the fines and drives them to the siphon tube (9).

- More over, in comparison with the conventional hydrocyclon, the new additional water flow hydrocyclon allows utilisation of certain simple and flexible methods for controlling the sizing process; it can be easily automatized and makes the sizing process be more accurate in accordance with the requirements of modern engineering concerning the processing of mineral resources.

The disadvantages consisting of more complicated construction and additional water consumption are compensated by the special results obtained with this equipment.

With the aim of improving the sizing efficiencies, and, especially, the uniformity rate of the products obtained at Faget – Timis siliceous sand processing plant on one hand and with the aim of establishing the interdependences between the sizing results and the hydrocyclon constructive and hydrodynamic characteristics – on the other hand - a set of 14 sizing tests on raw sand (grit) have been performed with an additional water flow hydrocyclon having the following characteristics:

- diameter of upper cylindrical part d_2 = 90 mm
- diameter of feeding inlet pipe d_a = 25.4 mm
- diameter of overflowing outlet pipe d_s = 25.4 mm,

Whose values depend on the deflecting cone position. For this reason the equivalent diameter (d_s) is considered for calculations.

- diameter of coarse product discharging outlet pipe, d_e = 5 – 10 mm

With the aim of transposition the laboratory research results onto industrial scale, the first step consisted in appraising the influence of the constructive characteristics (d_e and d_s) and of the technological characteristics (dilution "n", and additional water flow rate "q_a" expressed in percentages of feeding flow rate) upon the sizing result expressed by the separation size.

For this purpose the correlation and regression method was used, which, as it is very well known, not only allows determining the linear dependence (with good approximation) but also provides information regarding the intensity with which a variable influences the response. /1/

For a better evaluation of all these dependences, and due to the fact that the dependent variable is the same for all correlations, we proceed to the overlapping of all dependences onto the same diagram, (see figure no. 2).

Analyzing the figure no.2, it can be noticed the variation law of separation size depending on the constructive and technological parameters, as well as their antagonism.

While the separation size increases at the same time with the increase of overflow outlet pipe's equivalent diameter, of feeding dilution and of additional water flow rate, it was registered the decreasing of the under granulation into the thickened product, which leads to the improvement of sizing efficiency. At the same time, an increasing of fines content in overflow is obtained; all these together lead to the increase of the sizing accuracy.

2. TRANSPOSITION OF LABORATORY RESEARCH RESULTS ONTO INDUSTRIAL SCALE

For the design of the hydrocyclon main industrial subassemblies based on hydrodynamic similitude, it was used the mathematical model called **"Criterion M"** within the specialized reference material, which establishes the relationship between hydrocyclon constructive parameters and processing flow rate.

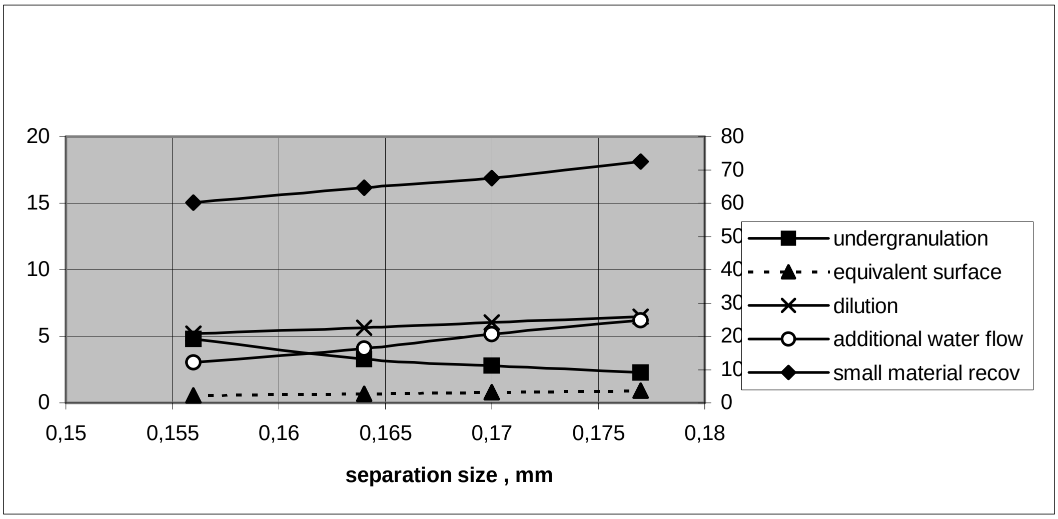

Fig. no. 2 – Variation of separation size with technological parameters

It will be considered that two models of different dimensions will behave identically from hydrodynamic point of view only if the criterion M has the same value. /2/

$$M=(d_2'- d_1') \times \left[(d_2^2 - d_1^2)/Q' \right]^3 \qquad (1)$$

Where:

d_2'– diameter of laboratory hydrocyclon's cylindrical part

d_1' – diameter of laboratory hydrocyclon's siphon pipe

Q' – feeding flow rate in laboratory conditions

At the same time it was taken into account the specialized reference material recommendation regarding the ratio between the feeding pipe diameter "d_a", the siphon pipe diameter "d_s", the discharging pipe diameter "d_e", as well as the cylindrical part diameter at the level of feeding pipe "d_2", namely:

$$d_a=(0.4 - 1)\, d_s \ ; \qquad d_s=(0.2 - 0.4)\, d_2 \qquad (2)$$

Under the conditions of HCCAD (additional water flow hydrocyclon) - laboratory model the value M = 26.763 was obtained.

For example: under the condition of a flow rate established by the beneficiary of Q=100 m^3/h, for the same M value, the following constructive dimensions have resulted: d_2 = 0.400 m, d_s = 0.160 m, and da = 0.128 m.

The slime pulp ingoing velocity at the level of the feeding inlet pipe results from the law of continuity:

$$Q = u_{t2}.S_a \ , \qquad (3)$$

from where:

u_{t2} = 2.16 m/sec.

In order to calculate the tangential velocity at the level of siphon pipe, it was used the relationship of Kellsal /2/:

$$u_{ti} = \frac{u_{t2} r_2}{r_i} \frac{1 + \ln\left(\frac{r_i}{r_1}\right)}{1 + \ln\left(\frac{r_2}{r_1}\right)} \tag{4}$$

This way it was found: u_{t1}= 2,81 m/sec, and u_{t2}/u_{t1} = 1,30.

Dynamic pressure at the siphon pipe level is:

$$P_{di} = \frac{u_{ti}^{2} \Delta_T}{2} \tag{5}$$

Where:

Δ_T – slime pulp density

Dynamic pressure considered for 250 g/l concentration of solid phase in feed is of 4540 N/m^2.

The separation size achieved by the industrial hydrocyclon results from the condition of equilibrium of centrifugal forces and of forces of resistance to motion into the separation area, resulting from following relationship:/2/

$$d_p = \frac{3}{u_{ti}} \sqrt{\frac{Q \eta_{st}}{\pi h_i (\delta - \Delta_t)}} \tag{6}$$

Where:

η_{st}= dynamic viscosity of slime pulp,

$$\eta_{st} = \eta \frac{1}{(1 - c_v)^{25}} \tag{7}$$

where:

η = water viscosity, 10^{-3} [Ns/m^2]

c_v = volumetric concentration in parts of unit

h_i = height of rotating fluid coaxial area at the siphon pipe area's level

δ = solid phase density

In order to calculate the siphon pipe immersion depth, it is imposed the sizing dimension obtained for laboratory conditions, 0,2 x 10^{-3} m.

Under these conditions, from relationship (8), the siphon pipe immersion depth against the upper level of feeding pipe will be of 0,22 m. Once this height value is known and using its calculus relation /2/, the apical angle of hydrocyclon conical part will be obtained:

$$h_i = \frac{r_2 - r_1}{tg\frac{\alpha}{2}} + d_a \qquad (8)$$

The resulted apical angle is $\alpha = 105^0$, which represent another characteristic of this type of hydrocyclon; this type of angles are met only at the thickening equipment.

Calculation of additional water inlet pipes' diameter and of water penetration tangent speed into the washing area cones' free spaces results from the condition that the additional water rotaries flow rate dynamic pressure of should be greater than the main slime pulp flow rate. Following the above-presented algorithm it results a diameter of 30 mm for the inlet pipes and an additional water flow velocity of minimum 2,79 m/sec, to which corresponds a dynamic pressure of 3917 N/m^2.

Based on the above-presented theoretical principles, as well as on the similitude mathematical models and on specialized reference material recommendations was designed the additional water flow hydrocyclon HCCAD 400 presented in figure no.3.

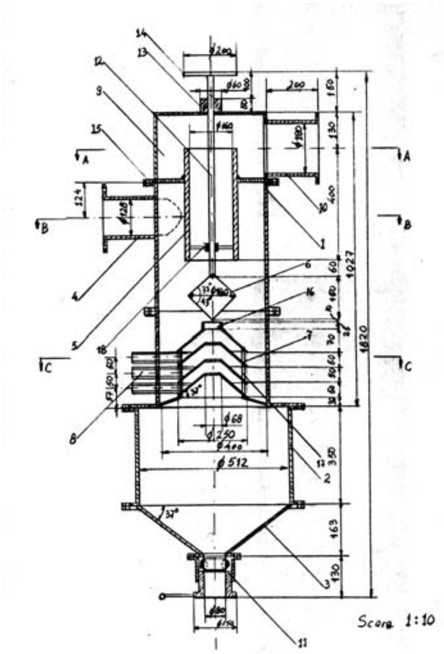

Figure no.3 Additional water flow hydrocyclon – HCCAD 400

1. Upper cylindrical body
2. Lower cylindrical body

3. Conical body
4. Feeding pipe
5. Siphon pipe
6. Deflecting cone
7. Overlapped cones (hoppers)
8. Injection inlets
9. Collecting room
10. Overflow discharging pipe
11. Adjustable discharging device
12. Throated rod

CONCLUSION

Nowadays, for the design of sizing equipment, in general, and of hydrocyclons, especially, it is proceeded from a few technological pre – established parameters and by means of calculus relationships – which generally are of empiric type – the equipment main constructive elements are dimensioned.

In the present paper, based on a correlation and regression study it is established the influence of constructive and process parameters onto the sizing results, and further on, based on the results obtained and using for this purpose the hydrodynamic similitude mathematical models it is designed an industrial hydrocyclon type HCCAD 400 with nominal processing flow rate of 100 m^3/h.

The truthfulness of this dimensioning calculation method was verified in practice at Faget – EXTRACERAM – TIMIS Quartziferous Sand Processing Plant.

BIBLIOGRAPHY

[1]. Simionescu A., Nagy B. – *Preparation processes' optimization,* Technical Publishing House, Bucharest 1979.

[2]. Sarbu R. – *Gravitational Preparation, Vol. I,* Petrosani University Lithography, 1993.

[3]. Sarbu R. – *Additional Water Flow Hydrocyclon,* Application for invention patent, Brevet OSIM, no.119930 / 30. 08. 2006.

THE COAGULATION OF ARGILLACEOUS SUSPENSIONS FROM WASTEWATER IN ELECTRIC FIELD FROM COAL WASHING PROCESS

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Abstract: Water resulted from mining industry and coal processes are characterized by a high concentration in colloidal solid suspension, argillaceous, which doesn't deposit free not even in weeks. To increase the sedimentary speed for waste water are used different cleaning – coagulated – flocculated reactive which must realize a solid faze concentration in the cleaning water corresponding to the evacuation in the emissary or to be re circulated in washing equipment. This study proposed and did to replaced Zetag reactive – with coagulation role, used in present time at Coroesti processing plant with electro coagulation in continue electric field with consumable anode.

Key words: colloidal solid suspension, flocculated reactive, electro coagulation

STABILITY AND THE DESTRUCTION OF COLLOIDAL SYSTEMS

The stability of colloidal systems is provided by two factors who independently or synergic act for impeding or delaying the union of particles from disperse faze:

- electrostatic factor
- steric factor

Assuring the stability with electrostatic factor is realized because it is forming the double electric layer on colloidal particles and in this way the particles are rejected.

Intervention of steric factor is the results of the absorption of some amfifile molecules or some polymeric substances on colloidal particles surface which act like a mechanical charge for particle collision.

Destroying the disperse systems through particles agglomeration, resulting lowing the dispersion grade and the separation of the aggregates by sedimentation, can

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be produce by 2 methods: the coagulation and flocculation, which have in essence the same results.

The coagulation is the process who unite the disperse particles destroyed by electrolytes or by modifying other influence factors who produce the destruction of the elements and facilitate the attractive force between particles. The agents who produce the coagulation are coagulants.

Destroying the disperse systems with a flocculants agent, a macromolecular compound is made by creating some connections between particles without some substantial modification of the elements that stabilize the system.

Destroying the disperse systems by coagulation involve approaching the particles of disperse faze to some distance where the attraction forces can manifest and lead to the union of the particles and the forming of some big aggregates capable to sedimentation on gravity action. Approaching the particles of disperse faze it is realized because of Brownian moving or mechanical agitation of the system. When the particles of disperse faze approach, electrostatic rejecting forces appears because the diffuse double layer interpenetrate and Van der Waals physical attraction forces.

Specialized literature recommends many substances with the role of flocculants agents. The coagulants are generally salts of some polyvalent metals Fe^{3+}, Al^{3+}, $Ca^{2+,}$ etc, which by hydrolysis or by dissociation liberates metallic ions which cancel the negative electric charge of colloidal particles from water, specially argillaceous particles and it is produce the coagulation of disperse faze and the its rapidly sedimentation in the cleaning process.

Aluminum ions for example, metal use in the experimental analysis, forms with water aluminum hydroxides, liberate hydrogen ions.

Waste water from U.P. Coroesti washing technological process has a lot of argillaceous colloidal substances and is recalcitrant in cleaning.

Because the dispersion grade is high $1/d_m = 7,14$, where d_m is medium diameter for solid particles, these particles have a big specific surface and in this way can be explained the high value of surface energy and their high capacity for absorption the ions from water. Because they will have the same electrical sign they will also have a high gravitational stability of the suspension.

So the flocculation process is a complex one, by electrical, chemical and mechanical nature where the cations tied by anionic group of flocculants challenge the inversion of the solid particles charge from stabiles waste water and in this way they lose the water layer adherent at their surface.

The most efficient process is **electrical discharge of the particles**.

The coagulation can be provoked by:

- addition of ion salts (Zetag)
- addition of macromoleculars organic salts (Magnafloc)
- the action of electric field or galvano chemical process

Some research shows that between electrodes happened similar phenomena with water electrolyze, liberating H^+ ions:

$$H_2O + e^- \rightarrow H^+_{ads} + OH^-$$

which are absorbed at hydrated part of micelle, changing its sign, or liberating Al^{3+} ions from consumables electrodes, who in their way to cathode meeting some minerals particles negative charged, they partially neutralized this particles and provoked their coagulation by decreasing the electro kinetic potential Zeta (Z_p).

The galvanic chemical process for cleaning permits to reach the cleaning level necessary, based on the utilization of elements galvanic elements formed by electrodes pairs, placed in the solution that must be cleaned, by applying a current from an exterior source, without utilize chemical coagulants reactive.

Galvanic chemical oxidation speed of the galvanic pair components depends of some factors like:

- electric power parameters
- environment temperature
- galvanic pair shape and characteristic
- Potential of galvanic pair components
- Galvanic pair components dimension
- Interaction with waste water
- Solubility of formed metallic hydroxides
- System ohm resistance
- Distribution of electric power density
- Other technological parameters

The electric power density cause the speed process of galvanic chemical dissolved for galvanic pair components.

The constant value for the speed of coagulation process is determined by:

$$K = -\frac{1}{t \lg \frac{c}{c_0}} \qquad (1)$$

Where K is the constant value for the process; t is processing time (s); c_0 is initial wastewater concentration (g/l); c is final concentration for waste waster

In this way for $c_0 = 52$ g/l, c = 0,65 g/l, t = 25 s, we obtain K = - 0,021 s^{-1}.

For understanding the process is necessary a description of metal solubility (aluminum).

Aluminum, choose for manufacture electrodes, is in the third group of periodic system, has 13 atomic number and 26,9815 atomic mass .

Aluminum atoms have in the exterior electric layer 3 electrons and the maximum oxidation position in +3.

General reaction for anodic dissolved of aluminum and forming the hydrated ions is:

$$[Me] + H_2O = Me_{aq}^{z+} + ze^-$$

The process speed for this kind of electrode V_m can be determined with:

$$V_m = \frac{d\Delta_m}{dt} \qquad (2)$$

where Δ_m is substance quantity and dt is time for passing the substance in solution.

Corresponding to the first law of Faraday $\Delta_m = k_e \cdot Q$ where Q is electricity quantity equal with intensity of electric power I multiplied with time t, and k_e is a proportionality coefficient called *electro chemic equivalent.*

Ascribe the law to an gram equivalent E, the quantity of electric power is Q = I t = 1F and the result will be:

$$E = k_e F \tag{3}$$

Respective,

$$k_e = \frac{E}{F} \tag{4}$$

E for aluminum is E = 26,9815/3 = 8,993

In this way $$\frac{EIt}{F} = \frac{8{,}993 \times 0{,}17 \times 25}{96494} = 3{,}93 \times 10^{-4} \tag{5}$$

Conforming to the second law of Faraday, he is proportionally with chemical equivalent A/z, where A is element atomic mass.

Modifying the electrode mass in the electro chemical dissolve process can be determined: if (a) is ion's mass and N in ion's number, we will have $\Delta_m = a \cdot N$. Ion's mass is equal with element atomic mass A divided with Avogadro number N_a; ion's number N which pass in solution is equal with he ratio of total electric charge Q which pass through system and ion's electric charge:

$$N = \frac{Q}{z_e} \tag{6}$$

Results:

$$\Delta_m = \frac{Q}{z_e} \times \frac{A}{N_a} = \frac{QA}{F} \tag{7}$$

Where F is Faraday number $F = N_a \cdot z_e = 96486.7$ C/moli

The equation which ties both Faraday shows that specific speed for electric chemical dissolve of the substance is proportionally with its mass and with electricity quantity that pass from the system.

Because between the metal quantities dissolved in anode and electricity exist a direct proportionality, based on the above relation it can be written:

$$\frac{d\Delta_m}{dt} = \frac{dK_e \times Q}{dt} = k_e I \tag{8}$$

In this way the speed of electrical chemical reaction in proportional with current intensity I; it can be express substance equivalent gram if current intensity is ascribed to Faraday unity, respectively I/F, or gram /ion unities, taking account of particles charge, respectively I/zF

The speed depends of the dimension of separation surface between electrode's faze – electrolyte and there for the speed has to be divided to the surface and due to a electric charge density:

$$I_s = \frac{I}{S} \, [A/m^2] \qquad (9)$$

In laboratory instrument condition the surface of one aluminum plate is S = 0,055 m^2. For 14 anode plates S = 0,77 m^2. For current intensity corresponding to the recommended value I = 0,17 A, the current density is I_s = 0,18 A/m^2.

The electricity quantity necessary for obtain an equivalent gram from a substance, it is determined from F value and the electric energy consumption is F.E.

For evaluating the electricity quantity which participates to electrode reactions were considered:

At cathode

$$2H_2O + O_2 + 4e = 4\ OH^-$$

By passing 4 electrons mol through galvanic pair , will be formed 4 hydroxyl ions; 1 electron mol is 1 faraday and 1 hydroxyl ion is a gram atom, respectively 17 g. In this way electricity quantity necessary is 96486 C. Because 1C =1 Ampere. Second results that through galvanic pair pass 96486 C, if for example current intensity in 10 A and passing time will be 9649 s.

At anode $Al = Al^{3+} + 3e^-$ 3 farazy dissolve 26,9815 Al gram atoms.

At anode is also possible the reaction:

$$2H_2O = O_2 + 4H^+ + 4e^-$$

Results that passing 4 electricity unities it is emitted 32 O grams.

In one month functioning 24 hours/ day and 30 days in a month.

$$\Delta_m = \frac{EIt}{F} = \frac{8{,}993 \times 0{,}17 \times (30 \times 24 \times 3600)}{96494} = 41\,[g]\,Al \qquad (10)$$

We must say that changing electrodes polarity it can be realized a rational Al consume. Unfortunately experimental checking for the extraction at metals galvanic chemical dissolving, in cleaning waste water, in hard enough to realize.

Next it is studied the replacing possibility for Zetag 7195 reactive use like coagulant with the electro coagulation, use for this purpose an electrizor (sketch 1), where is an electrodes pair (plate shape 58 x 95 x 0,5 mm) made by aluminum and connected to a continue electric power by low tension.

The 4 mm space between electrodes and the connection of this to continue electric power assures electrolyze. In this way Al ions pass in solution by dissolving the anode and migrates to cathode and in their way discharge electric negative mineral particles and coagulate them.

Cloudiness feeding it is made by up to down and in this way the space between electrodes in always full.

Technologic parameters very influence in the cleaning process is feeding debit, parameter hard enough to control in practice, and because of that are accepted variations in stabilized limits. The debit puts in good condition action time for the electric power on cloudiness or in other words passing time for cloudiness through electrizor. Correlation between feeding debit and cleaning speed, calculated on the registered influence parameters and experimental results from the table data, is presented in figure 1 and described with a good estimation.

As we expected growing the debit determines lowing sedimentation speed, showing the role of stationed time for cloudiness in electrizor.

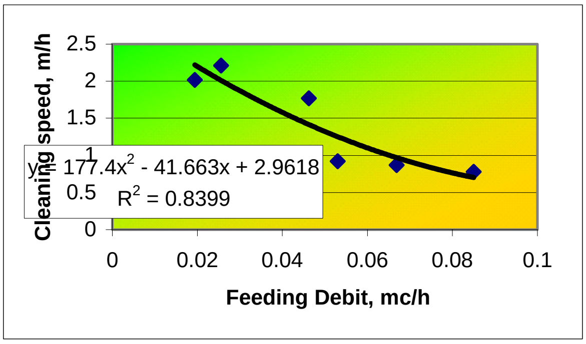

Fig. 1. Correlation between feeding debit and sedimentation speed

Regarding the correlation between work tension a sedimentation speed, this has a low intensity (correlation coefficient R=0.59), described by a decreasing first grade equation. This means that lower tensions are better in the process.

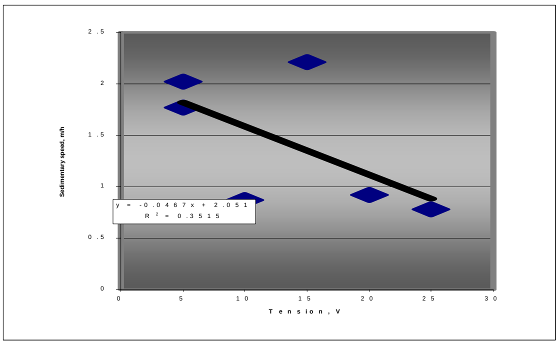

Fig. nr. 2. Correlation between tension and sedimentary speed

An important parameter which makes the connection between other process parameters is consumed energy, W.

$$W = P.t = U.I.t = U.I.V / Q \quad [kWh] \qquad (11)$$

Where

- P is power in W;
- U – tension, V;
- I – intensity , A;
- T – passing time of cloudiness through instrument, h;
- V – utile volume for electrizor m^3;
- Q – Cloudiness feeding debit, m^3.

Correlation between electric power consumed and sedimentary speed who was choused by purpose, is presented in fig. 3 and described by a second grade equation and the connecting law is of medium intensity R = 0,75.

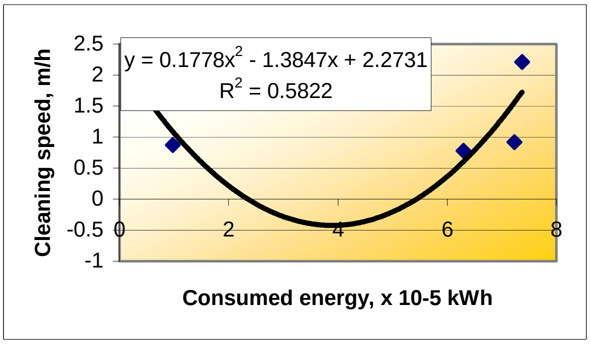

Fig. nr. 3. Correlation between electric power consumed and sedimentary speed

Overlap the diagrams v = f(Q); v = f(U) and v = f(W), where v is sedimentary speed, we obtain 2 variation domains where the results are acceptable.

W € (0 ÷ 1.10^{-5}) kWh where Q debit and the tension have small values and

W € (6 ÷ 8.10^{-7}) kWh where Q debit and the tension have high values.

This thing shows the connection between feeding debit and work tension, who is described by a growing second grade law and medium intensity, R=0.65 (fig. nr. 4)

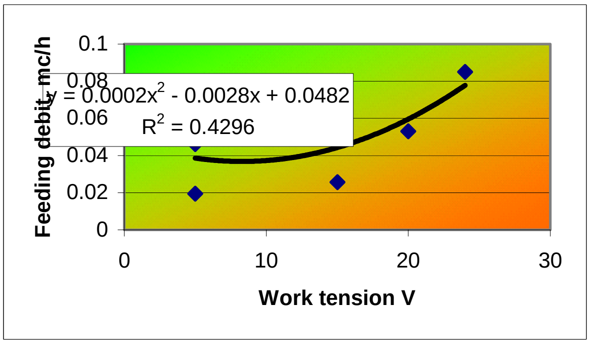

Fig. nr. 4. Correlation between feeding debit and work tension

On this reasons next experiments set was realized on the same solid phase concentration, the same Magnafloc flocculent consume and the 24 V tension considered un dangerous. Were made 4 analyses for big tension values who determine high intensity and decreasing the interior resistance of the instrument a high quantity of aluminum is dissolved. On the obtained data it was recalculate the correlation between the consumed energy and the cleaning speed, presented in fig. 5

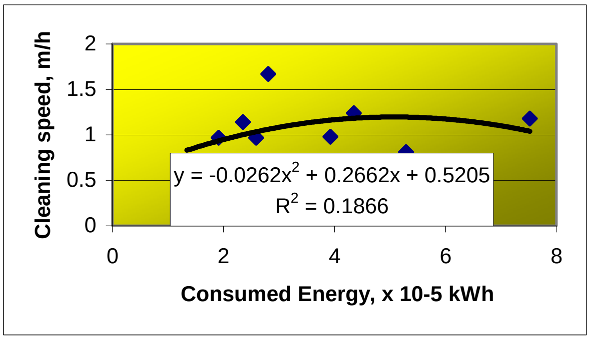

Fig nr. 5. Correlation between consumed energy and the cleaning speed at over 24 V tensions

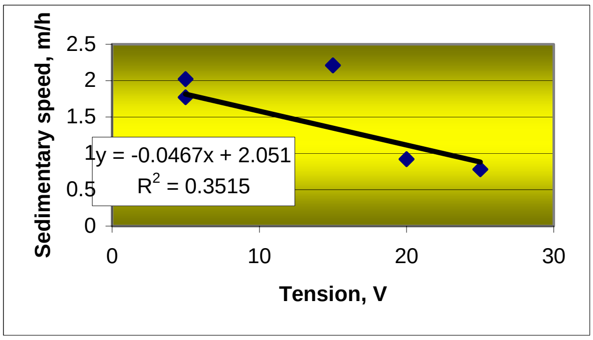

Fig nr. 6. Correlation between electric power tension and sedimentary speed

It can be observed that the energy value is over 4 x10^{-5} kWh, which means high power much stationing time in detriment of processing debit.

In these conditions for putting the experimental results on industrial scale we purpose the next work plan:

-Work tension 24 V
- Consumed power 4, 08 x 10^{-3} kW
- Electric power specific consume 0,047 kWh/m^3, treated cloudiness
- Electric power density in electrode 0, 18 A/m^2
- Aluminum specific consume at anode, 41g/month
- Cleaning speed 1.67 m/h
- Solid phase concentration in clean water 0,65 g/l

The final conclusion is that treating method in continuous electric field with consumable anode it is proper for wastewater from Coroiesti and the processing cost are more reasonable (smaller) comparing with Zetag reactive.

The method can be implemented in the process and the battery can be put on the actual flux without important outlays.

BIBLIOGRAPHY

[1]. Valentin A., Solojenkin P. Krausz S. - *Theoretical ads practice base for galvanic chemical waste water cleaning,* Ed. Universitas Petroşani 2004.

[2]. Beral E., Zapan M. - *Inorganic chemistry* Ed. Tehnică Bucureşti 1968.

[3]. Sârbu R. ,Bekesi C. *Waste water treatment in electric field* ROPET 2001 Scientific Symposium, Petroşani.

[4]. Sârbu R. Bădulescu C., Traistă E. - *Treating waste water procedures and equipment* Univ. of Petroşani litography, 1998.

COMPOSITIONS FOR BUILDING MATERIALS BASED ON INDUSTRIAL AND DOMESTIC WASTES

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ION NEDELCU[***]

Abstract: The present paper refers at the possibility of obtaining certain light cellular concretes without autoclavisation type BCfA by using as composite materials, in addition to the usual ones, different industrial and domestic wastes, as there are: the flying ash from power plants, the sized expanded polystyrene and strips of PET-s.

Key words: cellular concrete, waste, flying ash, PET, mechanical froth.

In this aim, in present paper there are proposed few formulas for producing light cellular concrete based on cement, flying ash, sized expanded polystyrene, hydrated lime and/or strips of PET-s, mechanical froth and water up to the necessary consistency of mixture.

The good qualitative characteristics of these materials (porosity, free density, compression strength) as well as the thermal and sound insulating properties recommend their usage in special works of thermal and sound insulation. In the same time they replace successfully the conventional BCfA within the building works, due to a good mechanical strength.

As result of their good characteristics such as the extension strength and non reaction with chemical reagents, melting point of over 300 ^{0} C, as well as affinity to bituminous substances, the PET-s cut in strips can be successfully used for reinforcing the road bitumen mixtures (asphalt) both in the basic layer and in the surface wearing layer.

It is well known the fact that the cellular concrete has a structure consisting in mineral aggregates within a hydraulic matrix based on Portland cements and hydraulic ads as it is the flying ash, hydrated lime powder, and mechanical froth.

The wastes representing the object of our research are: **flying ash** resulted from the power plants that use solid fuels such as the energetic bituminous coal, **expanded polystyrene** properly sized, which usually is used especially as packing

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material, and strips of **PET-s** that are used mainly as recipients for refreshments and alcoholic drinks, as well as other substances, excepting the fat ones.

By using these wastes in certain specific conditions, building materials can be obtained with characteristics almost similar with the ones obtained from conventional raw materials. In the same time it is achieved the reduction of costs involved for prospecting, mining and processing the natural mineral ores and implicitly for their conservation.

Usage of the flying ash from power plants, stored in settling ponds or recovered directly from the production installation, within the concrete composition, allows for re-usage of lands where this are deposited, as well as reduction of the interface waste/environment factors (water, air, soil). In the same time it is well known the fact that in our neighbourhood there is a lot of packing made of expanded polystyrene and PET-s, which are not biodegradable.

In our country it is estimated a quantity of about 4 kg of polyethylene in every 2 m^3 of domestic wastes, respectively 200 pieces of PET-s.

The problem solved by this research consist in stabilisation - by means of solidification – of different wastes such as the flying ash from power stations, the expanded polystyrene and the polyethylenetereftalat (which the PET-s are made of) by means of their proper size degradation.

The strips obtained by cutting the PET-s can be included both in the tiles poured from concrete, and in the asphalts for roads, which these are reinforcing.

The composition, as regard the percentages, according to the analysed formulas, consists of the followings: 13 – 15 % Portland cement; 19 – 45 % flying ash from power station; 27 – 28 % river sand with size below 3 mm; 5 – 10 % hydrated calcium slime; 0.4 – 0.5 % sized expanded polystyrene; 1 – 5 % PET-s as grains or strips; 0.04 – 0.1 % mechanical froth; water up to the necessary consistency.

For the road asphalts, the composition consist of 40 – 45 % broken stone size class 3 – 8 or 8 – 16 mm, as well as their mixture, 40 – 50 % sand of size class 0 – 3 mm, 6 – 8 % oil bitumen, 10 – 12 % filler of limestone and PET-s cut in strips.

By using the proposed process the following advantages can be obtained:

- usage of certain industrial and household wastes in the process of manufacturing the light cellular concrete without autoclavisation, and their inertisation into a hydraulic matrix in the view of achieving the ecological elimination;
- obtain certain products with characteristics that are comparable to the conventional ones;
- as result of the characteristics of products obtained, these can be used at different thermal and sound insulation works;
- reduction of manufacture price, by partial replacement of cement and sand with flying ash and other composing materials;
- the cellular concrete do not include aluminium powders;
- react very well to every type of plaster;
- very good supporting capacity;
- the tiles that are reinforced with PET strips do not disintegrate in the moment of breaking;
- environment protection by recycling non biodegradable materials.

Further on, there are presented few examples regarding the way of obtaining compositions in accordance with invention.

There are elaborated certain hydraulic matrixes for three types of light cellular concrete without autoclavisation and tiles poured from concrete, as well as a composition for road asphalts, which include industrial and domestic wastes.

In table no.1 there are presented the compositions for cellular concrete marked with BCUCN, BCUPOL, BCUPET, the composition for tiles TIAPET, and the composition for road asphalt ASAPET. The composite materials are expressed in kg for 1 m^3 of concrete.

The composite materials presented in the table no.1 are:

- composite **Portland cement** type II/B – M 32.5 R SR1500/1996;
- hydrated calcium **slime** CL 70 SR ENV 459 – 1/1997, for activating the ash;
- **flying ash** from power plants, resulted following the burn of energetic bituminous coal, included in the category of silicate – aluminium ashes, with the ratio % SiO_2/ %Al_2O_3 > 2 and % CaO < 15, presented as compact siliceous powders or as micro-porous spheres, the milling size being of 70 % class – 0.074 mm, with high wearing strength, low permeability and a free density of 910 kg/m^3;
- **sand** from river or crushed in size class 0 – 3 mm;
- **expanded polystyrene**, usually used for packing easy breakable or deformable objects, can be used as thermal and sound insulating material, etc. In order to include the polystyrene into the light concrete, this is firstly transformed in grains by means of mechanical breaking; the grains obtained have the diameter of 1 – 3 mm, and they are further on watered in the aim of increasing the hydrophilic properties. Its free density does not exceed 8 kg/m^3.
- **PET** (POLYETYLENETEREFTALAT), polymer used for bottling the mineral water, refreshments, alcoholic drinks and other substances, as result of its main characteristics such as the low adsorption of moisture, high temperature of deformation, good chemical corrosion strength, stable electrical and size properties to which is added a good processing characteristic. The free density of PET strips is 100 kg/m^3. Similar to polystyrene, the PET-s have a high hydrophobia; due to this fact they are treated with a tension-active substance in order to increase the hydrophilic properties, which is totally required for achieving the proper contact to the cement.
- **mechanical froth reagent** type Spumar, or other similar tension-active substances from the country or from outside the country, used both for increasing the hydrophilic properties of polystyrene and PET, and for obtaining the mechanical froth that provides necessary porosity for cellular concrete without autoclavisanion. The Spumar is a brown red and thick liquid with density of 1145 kg/m^3, neutral pH, viscosity of 1.89 ^{0} E, frothing coefficient of 7 and recovering time of 3 minutes at stability of 88%.
- **oil bitumen** with following main characteristics: melting point 72^0 C, insoluble in CCl_4 0.75, inflammability point of 275 ^{0} C, density of 965 kg/m^3;
- **limestone filler**;
- **broken stone,** size class 3 – 8, respectively 8 – 16, depending on utilization field;

The real dosages are presented in table no.1.

The concrete samples have been performed in accordance with a standard procedure. Inside of a regular mixer there are forcedly mixed the cement and the solid adds for about 2…3 minutes; after this, the water is added until a plastic consistency of concrete is obtained, in the same time with a continuous homogenisation for 1…2 minutes. Further on, there are added the PET strips and/or grains after these were previously hydrophilated by keeping them at least 5 minutes inside of a bath with solution containing 5 – 10% tension-active substance (frothing reagent). The mechanical froth obtained with frothing devices is incorporated into the mixture and is homogenizated continuously for 1…2 minutes. Finally, the mixture is poured in the testing test-pieces: cubs with side of 14.1 cm, which are compacted by vibration.

After 28 days of keeping in standard conditions, certain tests are performed in regarding the apparent density, mechanical strength and porosity degree. The results are presented in table 1.

Depending on the market demands, the concrete can be poured under different shapes, from prismatic blocks with different sizes up to big panels eventually reinforced or not with metallic wire mesh.

As result of their good characteristics such as the extension strength and non reaction with chemical reagents, melting point of over 300 ^{0} C, as well as affinity to bituminous substances, the PET-s cut in strips can be successfully used for reinforcing the road bitumen mixtures (asphalt) both in the basic layer and in the surface wearing layer.

In figure no.1 it is presented the dependence of compression strength to the proportion of composite materials and their ratio.

Fig. 1 BCfA not included PET

Fig. 2 BCfA with PET

In figure no.3 it is presented the cutting machine by means of which the PET-s are cut in strips, having the OSIM License no A 00307/6.04.2004 and in figure no.4 it is presented the device for mechanical froth, having the OSIM License no C-A / 00632/23.07.2003.

Fig. 4 device for mechanical froth

Fig. 3. The cutting machine of PET

In figure no.5 it is presented the technological flow for producing BCfA.

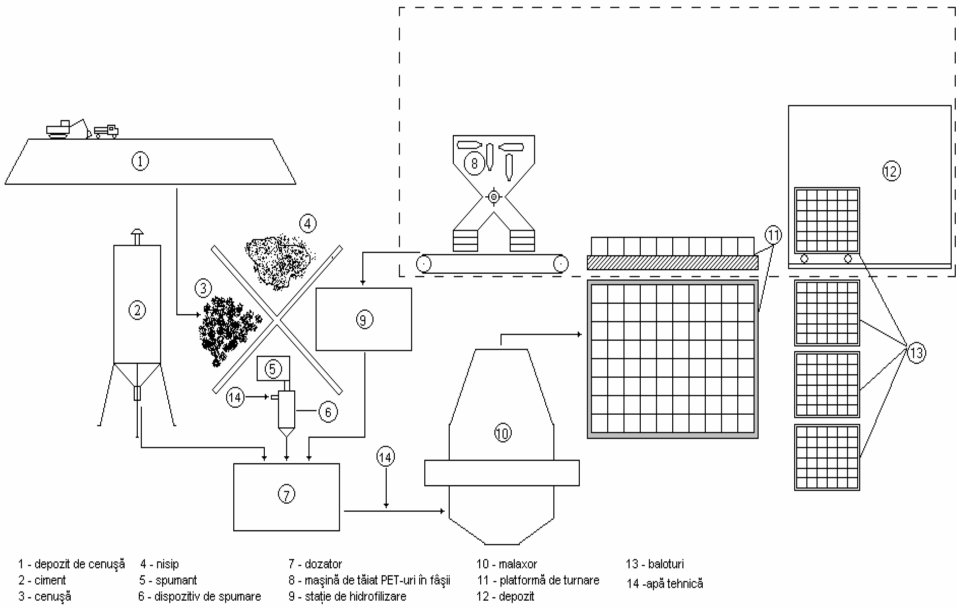

Fig. 4. Technological flow for producing BCfA.

Table 1

Symbol	COMPOSITION, kg/m^3									CHARACTERISTICS		
	Bitumen	Sand 0 – 3 mm	Broken stone	Portland cement I/32.5	Flying ash	Hydrated lime^1/ limestone filler^2	Expanded polystyrene	PET strips	Froth reagent	Compression strength daN/cm^2	Porosity %	Apparent density Kg/m^3
BCUCN	-	214	-	285	428*	-	-	-	5.5	32.6	36	930
BCUPET	-	-	-	121	242*	90^1	-	38.0^2	5.0	68.0	32	980
BCUPOL	-	-	-	223	312**	45^1	4.5	-	5.0	28.0	35	950
TIAPET	-	432	-	432	303*	-	-	17.2^2	-	141	5	1580
ASAPET	87	522	580	-	-	145^2	-	116	-			

* Anhydrous ash
** Hydrated ash
^{1} Hydrated lime
^{2} Limestone filler
ASAPET – Road bitumen reinforced with PET strips

BCUPOL – Light cellular concrete with polystyrene
BCUCN - Light cellular concrete with unhydrated ash
BCUPET - Light cellular concrete with PET strips
TAPETF – Tiles reinforced with PET strips

WASTEWATER TREATMENT BY FLOTATION

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LORAND TOTH**

Abstract: The flotation is successfully applied as cleaning method of the wastewaters refineries, textile fabrics (tissues), food industry, paper plants, oils plants, etc. In the flotation process with air released, first of all the water is saturated with air compressed at pressures between 0,3 – 3 bar, followed by the relaxed phenomenon of the air-water solution, in a flotation cell with slowly flowing. The super saturation condition could be applied on the wastewaters treatment. In this case the wastewaters which is in atmospheric equilibrium is introduced in a closed space where the depression is 0,3 – 0,5 bar. Our paper presents the hypo baric flotation cell and the technological flow of the cleaning the domestic wastewaters.

1. INTRODUCTION

In practice, the normal (natural) flotation process is different by the flotation with air. In the first case, the material particles lighter than the water (oils, greases) eventually associated with gas bubbles have the tendency to raise to the liquid stationary surface. In the flotation process with air, the material particles heavier than the water are transported to the liquid surface by attaching them with air bubbles.

In this case, the air could be introduced in water likes a very fine bubbles by porous surfaces or by mechanical agitation (flotation with dispersed air); a second modality to obtain the gaseous phase is by the releasing of the solved air in water, as a consequence of abrupt decreasing of the gas pressure lied in equilibrium with the water, case when the became supersaturated with gaseous phase [1].

The main advantages of the aerating system with air released from pulp are:

- the gas micro bubbles are formed directly on the solid hydrophobic particles surfaces; this aspect excludes the necessity of the collision between the particles and bubbles without negative effect on the selectivity of the process;
- the micro bubbles are in a high number offering a liquid-gas surface greatest than the normal bubbles dimension, in correlation with the specific surface of very fine particles from pulp [2].

We can appreciate that the bubbles from the floater device after a pressurization of the wastewater at 2-5 atm is between 30 – 120 microns.

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The ascension velocity follows the Stokes low and the elevating velocity of the complex bubble-particle is between $(0.4 - 2)10^{-3}$ m/s, but this velocity increases with air/suspensions report. [4].

The air releasing takes place in reverse condition those which determines the air solving in liquid phase; if a pressure increasing of the pressure from p_1 to p_2, the air quantity solved in the water will be in accordance with the Henry low:

$$q = k_h(p_2 - p_1)$$

to a decreasing of the pressure under the p_2 value, will takes place a releasing of an adequate quantity of air.

Rays pointed out that the saturation degree is in correlation with the type (shape) of the pressurization container. So, the static containers conduct to a saturation rate about 50 %, but the using of agitation system increases the air solubility to the 90 % comparatively with the conventional retention time.

The air quantity released theoretically from pulp when the pressure will be reduced from p2 to p1, can be calculated with the relation:

$$q' = q_a[fp_2 / p_1 - 1]$$

where: q_a –the water saturation with air to the atmospheric pressure, cm^3/dm^3
f –the saturation fraction in the pressurization container [4].

The influence parameters of the process are: the pressure difference, the expansion duration and the solid concentration.

The suspension concentration is in correlation with the air/suspensions report (A/S). When it is used recycling water for pressurization, A/S report is calculated with the formula:

$$A/S = 1.3R(p_2 - p_1)/ p_1 \cdot Q \cdot c$$

where: R is the volume of recycling water pressurized, dm^3
Q is wastewater flow, dm^3
c is the suspensions concentration from feeding, mg/dm^3

To increase the separation efficiency often is necessary to add flocculation agents in feeding, before their mixing with the recycling water.

2. THE DESIGN AND THE FUNCTIONING OF THE HYPOBARIC FLOTATION CELL

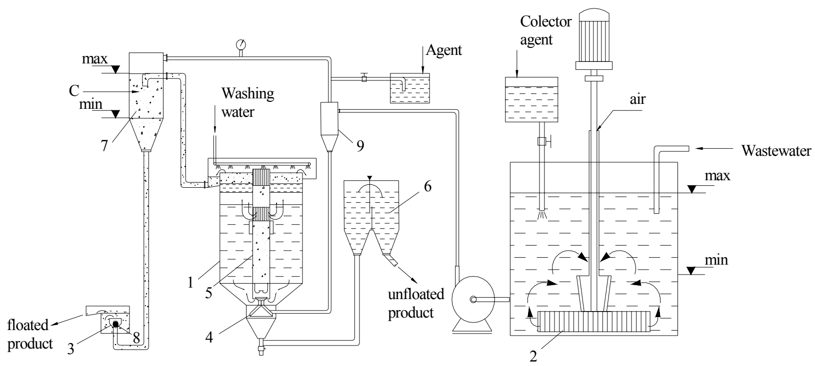
The hypo baric cell flotation cell is an installation with depression, with two novelty elements e.g. a hypo baric static cell and a hydroairator (a special device) which realize the necessary depression above the water mirror and on the other hand, enriching with air of the recycling water.

In the technical references there are some types of vacuum flotation cells whose functioning principle consists of the saturation of pulp with air followed by their introducing in a closed space with lower air pressure. To a decreasing of air pressure a part of solved air releases under micro bubbles form and in their elevating will rally in the froth layer the hydrophobic particles. In order to assure the resistance of bubbles, in the pulp is added frothing agents.

The main disadvantages of these installations are in connection with the products evacuation, because the flotation cells are disposed in vacuum spaces, great energy consumptions and moving parts of installation.

The hypo baric flotation installation presented in figure 1 eliminates these disadvantages, having in component part a flotation cell (1) with hydroairator (9), hermetically closed and with any part in moving. The feeding saturated with air by agitating in the agitator (2), assures the depression necessary to the air releasing and to the froth elevating in the separation basin (7). In this basin, the pulp weight containing the floated product is greater than the ball weight with role of valve of the evacuation hydraulic device (8).

The unfloated product is evacuated to the bottom of cell by the device (6). A part of this product is the recycling water, which feed the hydroairator (9). The emulsion water-air fed tangentially in the accelerating device (4) is interfered with the pulp feeding in floatator device (5), which has oblique slits trough to go out the mineralized bubbles. The floated product is evacuated by the cell overflow in the basin (7). This product that is rich in organic matter can be used in future agricultural activities, like fertilizer agent. The rest of unfloated product can be used in another domains or can be treated in a secondary cleaning phase. [3]



HYPOBARIC FLOTATION CELL

1 - flotation cell
2 - Agitator
3 - Flotated product basin
4 - Accelerating device
5 - Flotator device
6 - Unfloated product device
7 - Separation device
8 - Hydraulic device
9 - Hydroairtor

Figure no.1.

3. EXPERIMENTS AND RESULTS

The research to the laboratory scale was carried out on domestic wastewaters from Danutoni station and the aim of these researches was to eliminate the organic matter (CCO) and the suspensions from waters. The technological parameters were: the agitation time; the recycling report; the temperature and the separation time.

The simple flotation (without flocculant reagents adding), at recycling reports between 10 – 30 % pointed out the experience of a linear correlation between the process efficiency (the organic matter removal) and the recycling report. To a conditioning time about 3 minutes, the efficiency process of the suspensions removal was in the domain 60 – 80 % and for the organic matter removal, between 45 – 75 %. An increasing of the conditioning time by agitating had a low influence on the flotation efficiency.

4. CONCLUSIONS

This new hypo baric flotation installation presents some advantages such as:

- A higher efficiency of collision between the solid suspensions and the released bubbles gas;
- The flotation machine has no moving part and the novelty character is absolutely by the fact that whole process (aerating, adhesion, internal circulation, the products evacuation) is a consequence of a synergism between the gravimetric and centrifugal field;
- The obtained results justify the continuation of the research on other wastewaters types.

REFERENCES

[1]. Haneş N., Sârbu R., Bădulescu C. – *Protecţia mediului şi a muncii în procesarea resurselor minerale, Ed. Infomin, Deva, 1999.*

[2]. Sârbu R. – *Instalaţie de flotaţie hipobarică, Brevet OSIM, 199992 / 30. 08. 2006 Medaille d'or, Brussels 2003.*

[3]. Krausz S. – *Teoria şi tehnologia flotaţiei, Ed. Matrix, Bucureşti, 2001.*

ECOLOGICAL BRICKS PRODUCING USING INDUSTRIALS WASTE

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Abstract: There is a national and international seek for solutions of turning to account the existing offals and also for trying to create ecological conditions in the areas where they have been stored. This offas' turning to account are also necessary due to the considerable diminution of the fossil fuels. This thesis presents one possibility of turning to account the produced offals in the mining, petrochemistry and wood processing industries through their briquetting by a recipe that can satisfy not only the consumers' demands regarding the caloric power, granulometry, mechanic resistance, burning behaviour, but also those regarding the composition of the given gases as a result of the burning. The diminution of the dioxide sulfur given off as a result of the fossil fuels' burning becomes an important problem and that is why in all my tested recipes I have introduced a desulphurization agent, even though it brings to a diminution of the caloric power.

Key words: slurry, coke, molasses, lime, sawdust, non polution bricks

1. INTRODUCTION

As much on internal how much plan and internationally is searched the solution for the capitalization residues produced in industry. The capitalization coal sludge result in follows the process of processing, deposited on the ponds of decantation and to create ecological conditions in the areas presenting the numerous object studies.

Coal sludge he researched the possibility to briquetting with vegetable binding agents and the desulphurization agents as CaO, $Ca(OH)_2$, $CaCO_3$.

Through bricks continuations obtain of a what product can be used-up of to domestic consumer, with an which resistance to assure the transport and the storage without the these degradation from granulation viewpoint, to how much costs of productions the low concomitant maul with decrease amount of dioxide of emitted sulphur in he follows the burning.

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Used materials

Coal sludge utilizes for the effectuation attempts is from the mud-setting pond the number II from Coal Plant Processing Coroesti. The pond of decantation the number II were operated in the year 1968, in the present moment is out of action. Is locates afterwards mud-setting pond nr.I in right to Jiu riverside.

The surface busy total is of 10,8 ha, to the level beach having a surface of 7,5 ha. Up to flush out of the use on this pond he stored an amount of approximate 2 millions tone coal sludge arise from the washing coals.

For the experimental attempts heaving the many maul analytical sampling, from different point and depths, after homogenization we determine the content of ash (60, 6%) and caloric content (2700 kcal kg). From the granulation viewpoint, in follow analyses, can say that material he is composed prevailingly from fine grains with sizes below 0,2 mm. The humidity of coal sludge is placed around values of 20-35%.

Molasses is produced the result to the manufacture sugar from white beet or sugar cane, from which don't else he can extract sucrose through technology of crystallization and centrifugal action. Is a dense viscid sticky liquid of colour brown as far as closed brown. Used the molasses in different percentages by weight (6-15%) with the role of bonding agent of solid components entered in recipe of bricks.

The coke of petroleum is a solid substance obtained through the heating and maintain to of a fever heat dreg liquid oil.

The process of carbon producing is a middle of desulphurization indirectly, for prime matter oil, with different from contents sulphur. Prove wherewith they did the attempts, is a coke, (from prime matter of primary remaking crude-oils). Are a spongy appearance, with little pits and bound of relative bulk walls. Has erect content of sulphur and impurity, than other category of oil coke.

The utilization of oil cokes in the shape of fuel with ash slenderized for central heating plant, furnaces for cement or to domestic focus, is limited of erect caloricity and of the big content of sulphur.

Major typically for used-up cokes in the experiment are presented in the table nr. 1.

Table nr. 1 ***Major typically for used-up cokes***

Composition	U.M.	Value
Density	[g/cm^3]	0,64
Humidity	[%]	6,2
Volatile	[%]	26,72
Ash	[%]	18,53
Calorific power	[%]	5807

Through the utilization oil cokes obtain for briquettes a caloric power what does feasibly their utilization in usual focus.

Desulphurization agent he utilized $Ca(OH)_2$, in proportion of 7% from total blend of bricks.

The woody sawdust is one residue of an industries of remake the woods. This utilization in recipe of briquettes is incident to low temperature of ignition.

2. EXPERIMENTAL RESULTS

Starting from output previous researches unfurled as much on internal how much plan and international established several recipe in which varied material used-up weight and pressure of thing the effect on which have it in the of a corresponsive briquettes accordingly from viewpoint resistances, caloric power and compositions gas result in follows the burning.

In the table 2 am presented some among used-up recipe for the bricks manufacturing.

Table 2. ***Experimental testing***

The compozition of some bricks	slurry (%)	coke (%)	molasses (%)	lime (%)	sawdust (%)
1	37,0	37,0	6	7	13
2	43,5	43,5	6	7	0
4	43,0	43,0	7	7	0
5	36,0	36,0	8	7	13
6	42,5	42,5	8	7	0
7	35,5	35,5	9	7	13
8	42,0	42,0	9	7	0
9	35,0	35,0	10	7	13
10	41,5	41,5	10	7	0
12	41,0	41,0	11	7	0
15	33,5	33,5	13	7	13
18	39,5	39,5	14	7	0

Analyse the resistances to pressure depending on the used-up blend composition (figure 1) indicates us the fact that to pressures of as far as 300kN bricks have in composition sawdust (the recipe nr. 9 and 15) they have a resistance an erect maul than one in which sawdust absents ones. Also he ascertained that for the blends with sawdust the growth pressures of thing to across 300kN he don't produce a considerable growth resistances to pressure.

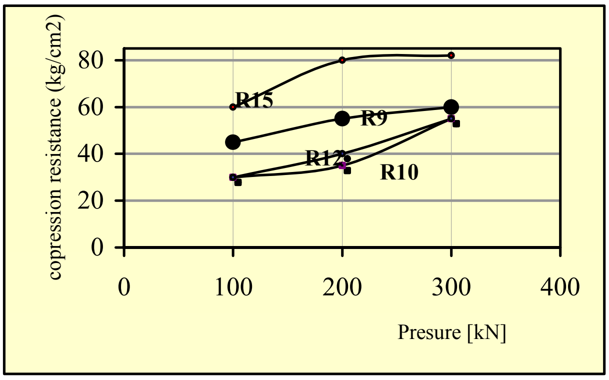

Figure 1. Resistances to pressure depending on the used-up blend composition

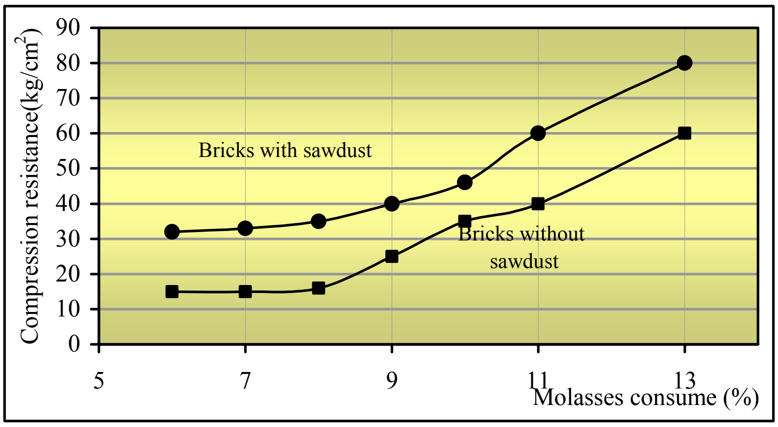

Figure 2. Resistances depending on the consumption of bonding agent

Conversely, for bricks obtained from coal sludge, oil coke, lime and molasses the growth pressures has a positive effect about briquettes resistances but this thing leads to the considerable cost of production.

Chart resistances depending on the consumption of bonding agent (figure 5) denote that for consumptions of feather to 8% registered an easy growth resistances to compression gift to consumptions across this value the briquettes resistance breeds significantly. Of a settlement optimum consumption of bonding agent is due to directs to the resistance to pressure, the resistance to cohesion, incident to appearance the costs of acquisition and transportation binding agent how much and technological appearance. In this sense he noticed that to consumptions of across 13% is produced a fluidization of materials, in the moment press to pressures of across 100kN, what leads to his transmigration and thus appear technological problems. Also is can noticed that the sawdust improves characteristics property of resistance for briquettes obtained to same consumption of bonding agent.

Analyse, through Fast Vac., Recipes 18 and 15, I carry corresponding from viewpoint resistances to pressure and they have an index of erect cohesion, indicates us the presence of substance (table 3):

The utilization of sawdust present the advantage that reduces the molasses consumption, he breeds the resistance to pressure, the index of cohesion and improves the process of ignition.

Is can noticed from assays values the reduced crown which content plough can pass able to boat. Also noticed the presence gallium and zirconium in the blends whit sawdust but breed contained of carbon.

3.CONCLUSION

The utilization sawdust’s leads to the growth bricks resistances obtained to same pressure of thing and same consumption of bonding agent.

For bricks with sawdust the growth pressure of thing across 300kN don't leads to the considerable improvements resistances again for bricks without sawdust a pressure of elder thing is absolute necessary.

Table 3. ***Chemical compozition of some bricks***

Substance	Chemical compozition for brick no.15 (%)	Chemical compozition for brick no. 18(%)
SiO_2	14,1	17,0
C	56,8	57,4
Na_2O	0,317	0,243
MgO	0,436	0,457
Al_2O_3	7,85	9,95
P_2O_5	0,0377	0,0373
SO_3	6,03	5,27
Cl	0,0566	0,0273
K_2O	1,77	1,37
CaO	9,83	5,55
TiO_2	0,408	0,433
V_2O_5	0,119	0,0818
Cr_2O_3	0,0127	0,0173
MnO	0,0252	0,0206
Fe_2O_3	2,11	2,03
NiO	0,0336	0,0253
CuO	0,0111	0,00807
ZnO	0,0151	0,00824
Ga_2O_3	-	0,00232
As_2O_3	0,0160	0,0000445
Br	0,0142	0,0112
Rb_2O	0,00739	0,00780
SrO	0,0184	0,0152
Y_2O_3	0,00532	0,00386
ZrO_2	-	0,0122
Pt	0,00594	0,00525

Breed the content treacly breeds the resistance briquettes obtained but an elder consumption of 15% creates technological problems.

The sawdust improves the comportment to ignition and burns due to temperatures of ignition the low maul than oil cokes and coal sludge.

For the storage and the commercialization obtained bricks from these blends are enforced sacking and the preservation in safe from places humidity.

The flow sheet manufactured this guy of bricks is enough of simple from enforces the supplementary incident to costs the utilization heat carrier.

The presence agent desulphurization reduces the emissions of oxides of sulphur again the ash result, due to presences gypsums and contained very diminished crown difficult, is can utilized for the improvement soils.

To bricks improperly from viewpoint of resistances to pressure they noticed fissure to bur.

Figure 3. Bricks with coal sludge, oil coke, sawdust, Ca $(OH)_2$ and molasses

REFERENCES

[1]. Cîşlariu G, Toth L. – *Brichetarea, o soluţie de valorificare a deşeurilor petroliere*, Universitaria Simpro 2005, Editura Universitas, Petroşani 2005

[2]. Haneş, N., Bădulescu, C- *Condiţii calitative pentru producerea combustibililor de tip brichete ecologice*, Simpozionul Ropet -Univ.Petroşani, 2001.

[3]. Haneş, N - *Factori de influenţă asupra calităţii brichetelor ecologice*, Revista Minelor nr. 4/2003

[4]. Haneş, N. - *Brichetele ecologice o ofertă pentru piaţa combustibililor solizi*, Revista Minelor nr. 5/2004

[5]. Haneş, N., Sârbu,R.ş.a. - *Studiul posibilităţii valorificării reziduului petrolier la producerea brichetelor combustibile pentru consumul casnic*, Contract de cercetare U P nr. 8 /2002.

[6]. Hayami H., Wake Y., Kojima T., Yoshioka K. - *Bio-coal briquettes and planting trees as an experimental CDM in China*, Keio Economic Observatory Discussion Paper G-No. 136, WG4-30, September 2001

[7]. www.det.csiro.au

[8]. www.coalbriquettes.com/bb-activities.html

RECOVERING OF CARBONIFEROUS FRACTION AND OTHER AVAILABLE MINERAL CONSTITUENTS, ECOLOGICAL CHANGE OVER OF THE STERILE DEPOSITS FROM JIU VALLEY

BOLD OCTAVIAN *,
CRISTEA NICOLAE*,
HANEŞ NICOLAE*

Abstract: The sterile deposits resulted from drawing and processing the coal from Jiu Valley, are contain in proportion of over 5% fuel mass, which is the subject of the research regarding the possibility of recovering and economical taking over. The non-combustible mineral constituents can be capitalized as basic materials in the construction materials' industry or for some available minerals' drawing. The ultimate sterile must be stored according to the new environmental regulations.

The dirt-heaps resulted from coal mining has different structures, as a consequence to the green coal's processing, to the storing of the filter-press cakes resulted from the filtration of the sterile coaly sludge, that is existing into the waste waters, as well as of the ash from the heating stations. In order to prevent and reduce the pollution of the areas affected by these dirt-heaps, for the ecological change over and the rehabilitation of the affected areas from the coal field, an environmental management project has been made out. The main deficiency of this project consists in the non-evaluating of the capitalization of the secondary resources that exists in these deposits. The present paper work represents an approach of this meaning, making an option on the reduction of the mineral mass volume that is the subject of the ecological rehabilitation by supplying the energetically, mineral and basic materials for construction resources, which exists in the present sterile deposits.

THE REUSABLE SECONDARY RESOURCES are made up of the secondary resources' share that can be taken out and economical effectively reused and they are depending of the resources' potential, the recovering technologies' development level and the energy and reusable materials' costs' reference level, being time dynamic.

The presence of an important fuel potential in the stored sterile mass justifies the research of its recovering possibilities, at least partial and its' capitalization in energetic together with the current production. Thus, in some of the sterile deposits'

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areas the combustion value is over 1500 kcal/kg and they are constituted as secondary energetically resources resulted from the primary technological process of valuing the exhausted coal.

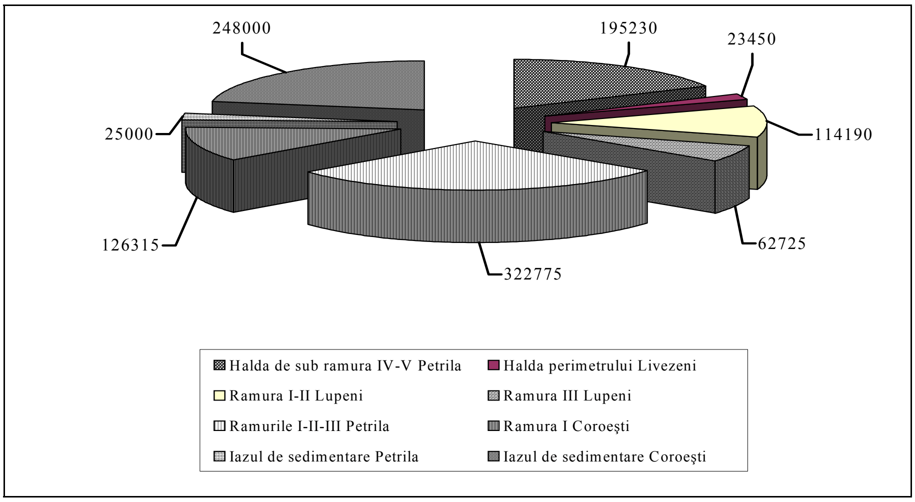

Fig. no. 1. *The situation of the carboniferous sterile deposits' surfaces*

The combustible material's recovering activity must be linked to the clay-bearing and siliceous minerals' constituents' utilization activity for producing of construction materials, possibly of taking out of some usable mineral constituents. The mineralogical composition of the material from the deposit, mixed with the sludge from the water treatment stations and other ingredients can become an improvement of the damaged soils.

The preliminary research of the physico-mechanical and preparation characteristics of the deposits that show energetically potential is highlighting a few parameters which are presented in the following.

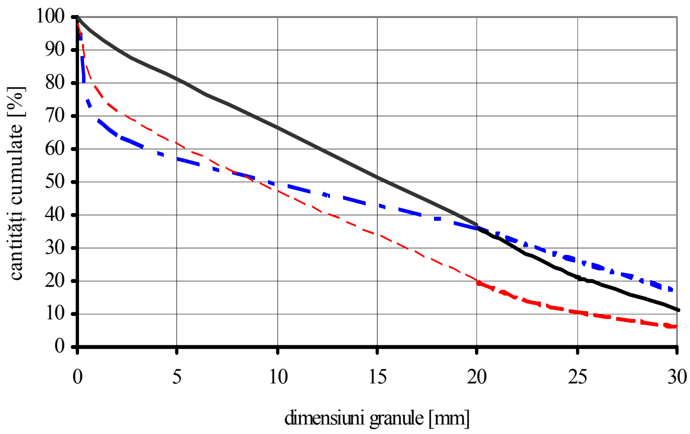

Fig. no. 2. *The grading composition of the sterile from the deposits*

The content in macroelements of the steriles from the three studied dirt-heaps shows a high weight of SiO_2 and Al_2O_3 and relatively low weight of the other macroelements.

The researches point out the possibility of fictile blocks' producing, roof tiles and other construction materials.

Tabel 1. The comparative mineralogical analysis between the carboniferous schist and the clays:

Mineralogical constituents	**Compositions, %**		
	Carboniferous schist	**Yellow clay**	**Grey clay**
Minerale argiloase	-	30 - 40	35 - 40
Cuarț	5 - 10	20 - 40	20
Feldspat	5	10 - 15	10
Caolinit	30	-	-
Calcit	5	-	-
Hidrobiotit	10	-	-
Muscovit	5	2 - 5	3

The steriles' reprocessing for **some usable constituents' taking out** remains a less explored field and that can transfer the mining sterile dirt-heaps from the Jiu Valley into Reusable Secondary Resources. From what it is known so far it seems that such elements are much more linked to the all-in-one ash from the combustible mass and so they are available in a too high spreading level inside the combustion products' ash.

Tabel 2. The comparative chemical analysis of the carboniferous schist with the clays:

Chemical constituents	**Compositions, %**		
	Carboniferous schist	**Yellow clay**	**Grey clay**
SiO_2	34,72 - 40,03	46,31 - 67,56	45,31 - 49,57
Al_2O_3	16,02 - 19,9	13,87 - 16,84	16,14 - 16,59
Fe_2O_3	2,62 - 3,97	4,53 - 7,31	6,38 - 6,74
TiO_2	0,37 - 0,67	0,00 - 0,89	0,00 - 0,93
CaO	1,40 - 2,8	1,95 - 11,69	7,68 - 10,93
MgO	0,90 - 1,55	1,35 - 2,60	2,47 - 2,88
Na_2O	0,23 - 1,65	0,90 - 1,38	1,03 - 1,22
K_2O	0,27 - 1,74	1,93 - 2,34	2,06 - 2,39
S	0,08 - 1,00	-	-
SO_3	0,00 - 1,74	0,00 - 0,09	0,00 - 0,09
P.C.	30,94 - 41,08	5,42 - 14,39	12,42 - 13,9

The steriles' reprocessing for **some usable constituents' taking out**, remains a less explored field and that can transfer the mining sterile dirt-heaps from the Jiu Valley into Reusable Secondary Resources. From what it is known so far it seems that such elements are much more linked to the all-in-one ash from the combustible mass and so they are available in a too high spreading level inside the combustion products' ash.

Tabel 3. The densimetric analysis on samples from the sterile stored in different areas:

Densimetric class [kg/ dm^3]	Petrila q_i [%]	Coroeşti q_i [%]	Lupeni q_i [%]
- 1,48	6,67	2,79	8,19
1,48 – 1,65	3,20	1,15	2,58
1,65 – 1,75	1,67	1,32	2,19
1,75 – 1,9	5,31	2,29	3,02
+ 1,9	83,15	92,45	84,02

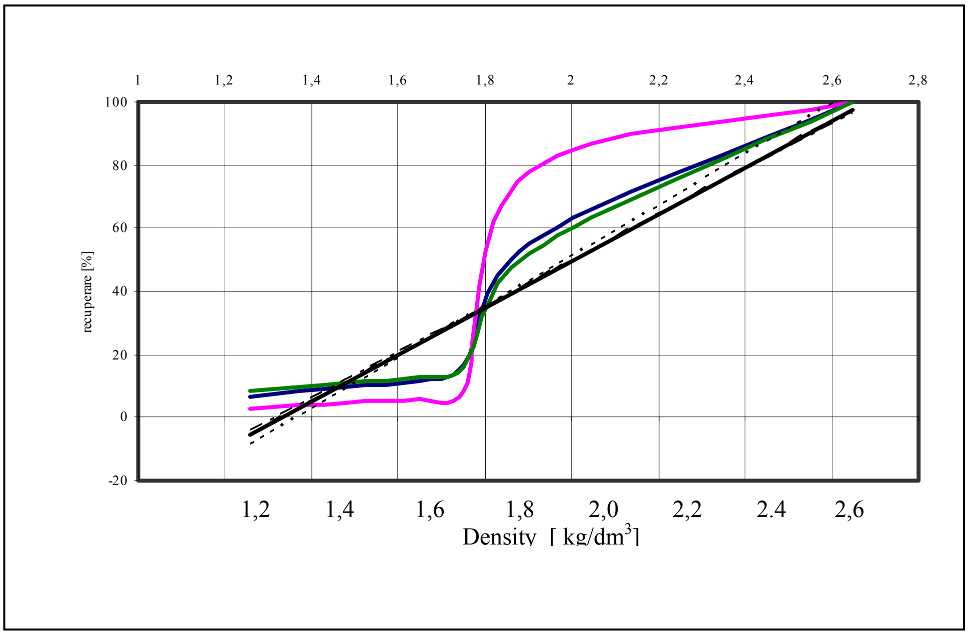

Fig. no. 3. The variation of the combustible mass' recovering from the dirt-heaps' sterile in the Jiu Valley

Tabel 4. The theoretical recovery of combustible mass in the researched areas:

Ash content [%]	Recovery ratio [%]		
	Petrila	Coroeşti	Lupeni
40	29	14	36
45	40	24	44
50	51	33	54

The combustible constituents' taking out from the sterile dirt-heaps will require changes of the current deposits' earth-surveying configurations, an opportunity to foresee ecological rehabilitation works.

We estimate that the restoring of the ultimate sterile will rise specific problems due to the more greater clay-bearing minerals' weight then they can be found, nowadays, in the dirt-heaps, to which the much more fine-grained structure is added, since the wet processing will encourage the further on degradation of the mineral material's constituent. The sterile material will be carried to the construction area of the ultimate sterile dirt-heap's barrier placing, and the settlement will be controlled made, depending of the aggregate grading, in such way that the deposit stability to be ensured. The designing of the final deposit will take into consideration the exigencies required for achieving the ecological deposits.

CONCLUSIONS

✓The presence of an important fuel potential in the stored sterile mass justifies the research of its recovering possibilities, at least partial and its' capitalization in energetic together with the current production.

✓The capitalization of the secondary energetically resources existing in the mass of the deposits moulded in time at each processing plant require detailed knowledge of the areas with higher contents of combustible mass that can make the subject of taking out and processing.

✓The aggregate grading analysis by categories, of the densimetric fractions and the ash content corresponding to these quantization of the green sterile, shows that there are not categories or fractions that can be selectively taken out from the mining mass.

✓The densimetric analysis of the sterile with a grading under 20mm, it is showed for the dirt-heaps from Petrila, Coroesti and Lupeni processing plants, from where results that in the density range of 1.75 – 1.85 kg/dm^3 a stressed rising of the recovering it is produced, in this area being placed the separation densities for the taking out of the combustible mass existing in the coal.

✓The shape of the processing curves and the calculation of the variation statistical index of the material's gravitational concentration from Petrila dirt-heap, points out a very difficult processing behavior.

✓The biggest recovering are possible in the sterile dirt-heaps of Lupeni processing plant and the lowest, in the deposits achieved at Coroesti processing plant, with go-between values are the probable results from Petrila processing plant.

✓The presence in the mining mass of a high weight of clay-bearing constituents and fine damaged schistose minerals, is encouraging the option for applying the method of concentration in autogenous dense environment, with positive consequences regarding the technological water' specific consumption.

✓The organizing of the taking out activity linked to the processing activity, and mostly to the sterile restoring activity, will ensure the reducing of the area's ecological rehabilitation costs.

REFERENCES

[1]. Haneş, N., s.a. - *Evaluation of the secondary resources from Petrosani Coal Processing*, Scientific Symposium – Petrosani University, 2000.

[2]. Rădulescu, M. ş.a. - *Rehabilitation of the mining dirt-heaps from Jiu Valley*, Scientific Paper Works of Petrosani University, 1998.

THE IMPACT OF MINING ACTIVITIES ON WATER QUALITY OF RIVER ARIEŞ

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Abstract: This paper presents the main mining exploitations from the hydrographic basin of river Arieş, which significantly on pollution with heavy metals of the river Arieş, as a result of extraction and processing of different types of ores from various mining perimeters. By mining activities resulted and continue to result significant quantities of waters and solid residual wastes, which accumulated in the environment, on large surfaces, by hundred hectares. For illustrate the pollution with heavy metals of river Arieş, was graphically represented the evolution of concentrations with heavy metals in the sections supervised by National Administration of Romanian Waters. As well, the paper presents the main accidental pollutions which have place in the last years on the river Arieş.

1. INTRODUCTION

The hydrographic basin of river Arieş is situated in the west-central part of Romania and occupies, in the superior and middle sector, the central part of the Apuseni Mountains, and in the inferior sector the depression zone Turda - Câmpia Turzii from the western extremity of Transilvania Depression.

Arieş, the biggest rightish affluent of Mureş, picks-up its springs from the Mountain of Bihor, from the north-eastern versant of the Massive Curcubăta (1849 m), on a altitude of 1108 m, near by the boundary between Alba county and Bihor County.

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Fig. 1. - The hydrographic basin of river Arieş

The medium temperature of the air is approximately 9,3^{0}C in the low meadows, 8-9^{o}C in the piemontain regions, 4^{o}C at 1300-1400 m and 2^{o}C at 1600-1800 m. In depressions, because of specific conditions have place temperature inversions.

The atmospheric precipitations present a maximum in June, between 85,5 and 137,7 mm and a minimum between 22,8 and 66,2 mm, registered in February.

2. MATERIAL AND METHODS

In this paper was used information obtained from Cuprumin Abrud, and dates from the analyses made in October 2005, by the National Administration of Romanian Waters in five monitoring sections of water quality along river Arieş. Also, were used analyses effectuated on the affluent rivers of Arieş, which are directly affected by the pollution sources, in the sections from upstream.

The Mining Exploitation of Cooper Roşia Poieni. The Commercial Society CupruMin S.A. Abrud has as activity object the opening and putting in good use of the cupriferous pauper ores from Roşia Poieni. Roşia Poieni represents the biggest cupriferous deposit of Romania and the second in Europe, possessing over 1 billion tones mineral with 0,36 % Cu, representing 64,5% from Cu reserve of the country. The sterile resulted by uncovering and the mineral with a low content in Cu, under 0,2 % totals a quantity of 120 millions tones.

The dump Valea Cuibarului represents the most important deposit of sterile within the exploitation perimeter. It has a total surface by 148 ha, and the occupied surface by 64 ha, storing a volume of 44.568 thousands sterile.

The dump Geamăna has a total surface by 67 ha, from which, in present are accupied 21 ha. In the dump are deposited about 4.458 thousands m^3 sterile. The highness of the dump is 150 m, and the angle formed by the slope is 30^o.

The dump Obârşia Muntari has the dumping platform at the altitude 1170 m and a surface by 46 ha. In this dump are stored 5.300 thousand m^3 sterile which occupies a surface by 27 ha. The highness of the dump is 120 m, and the general angle of slope is 30^o.

The decantation lake Valea Şesei. The quantity of sterile deposed until now in the lake is about 36,9 millions tones of sterile. The lake surface at 689 m is 127 ha.

The decantation lake Valea Ştefancei I. In present is in conservation, it was put in function in 1983. It contains approximately 1,1 millions tones sterile and occupies a surface by 9 ha.

The damages lake Valea Ştefancei II. Is a valley lake having a store capacity by approximately 2 millions tones sterile.

The Mining Exploitation Auriferous-Argentiferous Baia de Arieş. Although it suspended its activity in 25.08.2004, in present continues to exert pressures on quality state of the soil by stocking the sterile in 7 dumps, on a surface by 3,9 ha and by the 3 decantation lakes of flotation sterile.

The decantation lake Valea Sartăş. Contains a quantity by 1,55 millions tones of flotation sterile and occupies a surface by 6 hectares. It entered in conservation and ecologization in 2004 according with HG.1846/2004.

The lake Valea Cuţii and the lake Brăzeşti in present are in conservation and are grassy in proportion of 50% from entire surface. The lake Valea Cuţii contains a quantity by 2,5 millions tones of flotation sterile and occupies a surface by 3,8 hectares, while the lake Brăzeşti stores 5,55 millions tones of sterile and occupies a surface by 10,7 ha.

The Mining Exploitation Auriferous-Argentiferous Roşia Montană. The Branch Roşiamin SA Roşia Montană suspended its activity since 1 June 2006. Its activity object was the extraction and the preparation of minerals (*auriferous and argentiferous*) from the perimeter of Roşia Montană and possesses 12 dumps of sterile. The flotation sterile was deposed in the lake of decantation Valea Sălîştei, lake which brings problems of stability.

The lake Valea Seliştei stores a quantity by 5,5 millions tones of flotation sterile and occupies a surface by 15,7 ha.

The lakes 1, 2 and 3 Gura Rosiei are actually in conservation. They store a total quantity by 9,58 millions tones of flotation sterile and occupie a surface by 8,8 ha.

The Mining Exploitation of the Iron, siliceous sand and dolomite Iara. Its activity object is extraction and processing of iron minerals, siliceous sand and dolomite (Fe, SiO_2).

The lakes Fagetul Ierii (active) owned in 2002 a surface by 5,84 hectares and stored at that time a quantity by approximately 1 million tones.

The lakes Baişoara (active) owned in a surface by 8,5 hectare and stored a quantity by approximately 4,6 millions tones.

3. RESULTS AND DISCUSSIONS

a). The water pollution with heavy metals of river Arieş

For establish the pollution degree of the water of river Arieş were taken into consideration the analyses made in October 2005, because this month was the most stable from the viewpoint of debit fluctuations. As limits were taken the maximum admissible values necessary to include the water in the First Class of Quality. This class represents the maximum admissible values which reflect the natural conditions of reference or the content concentrations in areas (sections) where the anthropic influence is lower than 10%.

The Copper. At he level of hydrographic basin Arieş was found that the value of this element in all sections exceeds the limit value by 1 µg/l admitted in waters so that these could be included in the 1st Class of Quality. (fig. 2). It could be observed a very big increase of Cu concentration in Baia de Arieş, principally due to its evacuation in large quantities from CupruMin Abrud (18,64 mg/l). Then could be observed a decrease of concentration especially because of the increase of dilution debit.

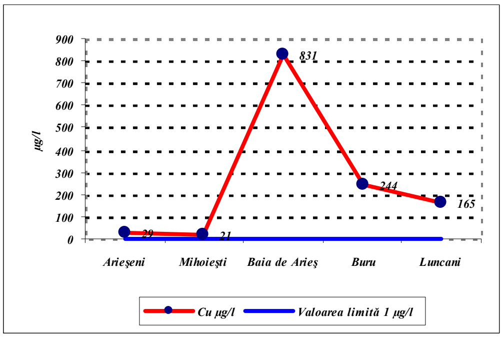

Fig. 2. – Evolution of Copper concentration

The Lead appears in the composition of water since with the section Baia de Arieş (fig. 3), where reaches the maximum value by 10,2 µg/l, then its value gradually decreases because of increase of dilution debit of the river Arieş. This increase is due principally to the Cu brought by the river Abrud (10,2 µg/l), which collects the mining waters and the evacuated waters by the lake of decantation Valea Săliştei, which owns to Mining Exploitation Roşia Montană.

As well as river Abrud, the river Arieş brings important quantities of Lead, by its affluents – Iara (7,66 µg/l) and Hăşdate (6,54 µg/l).

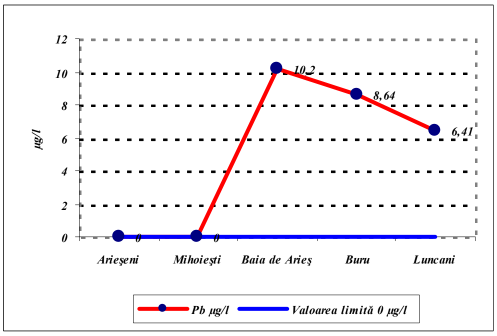

Fig. 3. – Evolution of Lead concentration

The Zinc appears in the river Arieş starting with its source, and has values by 77 µg/l in Arieşeni and 118 µg/l in Mihoieşti (fig. 4). In the section Baia de Arieş, its value reaches 511 µg/l, principally due to the contribution of river Abrud (1222 µg/l), as well as the contribution of waters from Mining Exploitation Baia de Arieş, which contain a quantity by 3104 µg/l Zinc.

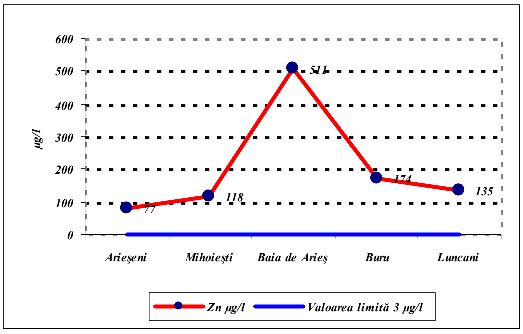

Fig. 4. – Evolution of Zinc concentration

The Manganese (fig. 5) appears since from the source of river Arieş, but until section Mihoieşti it not exceeds the limit value by 50 μg/l, the water being thus included in the 1st Class of Quality. In Baia de Arieş the value of Manganese reaches 1248 μg/l, especially because of contribution of river Abrud, and 7790 μg/l, because of the Manganese resulted from Mining Exploitation Roşia Montană. Downstream of Baia de Arieş is evacuated a quantity bigger of Manganese, 8993 μg/l), resulted from Mining Exploitation Baia de Arieş. Its value in the water course gradually increases, reaching 304 μg/l in section Luncani.

The Cadmium appears only in the analyses made in the section Baia de Arieş, having a value by 2,1 μg/l. this value appears because of contribution of river Abrud - 2,1 μg/l.

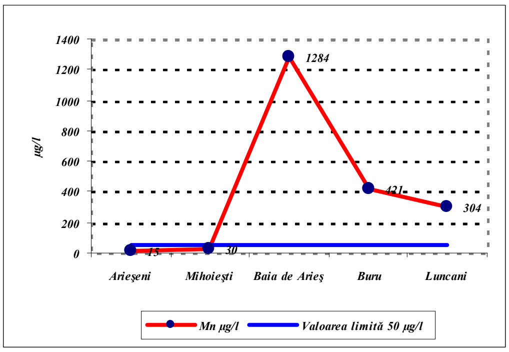

Fig. 5. – Evolution of Manganese concentration

b). The natural bacterial leaching of the sterile dumps resulted from Copper exploitation. Starting with 1990, the dumps Cuibarului and Obârşia Muntari located on Steregoi Valley entered in a process of natural bacterial leaching of the metallic sulfides contained by the stored material (phenomenon that was intensified in the last years) and this process leads to the charging of waters which wash these dumps (meteoric waters, underground waters which come to the soil surface as springs) with concentrations of ions and heavy metals (Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+}) by hundreds mg/l. Thus, the two brooks Şesei Valley and Steregoi Valley, which collect the acid waters flowed from the dumps, arrive in the tail end of the decantation lake having a pH between 1,5 and 2,5, with a mineralization between 10-20 g/l and a debit medium annual by 10000 mc/day.

These brown-reddish waters (due to the big content in Fe^{3+} by 2-10 g/l) come in the lake where meet the basic waters with a pH between 10-12, resulted from the sterile hydromass from the Processing Factory.

Because the two types of acid and basic waters are mixing only partially, by diffusion in the feeble water currents that exist in the zone, the acid waters were billeted in the end of lake in very large quantities, and created their own preferential directions to the evacuation sound of levigated waters.

The polluting effect of acid waters on Şesei Valley , downstream of the barrage and on river Arieş, is stronger in the last period, because in the last years the debit of sterile hydromass that enter in the lake was lower than debit of acid waters flowed from dumps, because is functional only a single processing line from the four existing.

Thus, from the decantation lake Şesei Valley were evacuated permanently acid waters with a pH between 3,0 and 3,5 and a content of Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+} by milligrams or tens of milligrams/l, and Fe^{3+} in tens or hundreds mg/l. The polluting effects of Şesei Valley on river Arieş was accentuated in the drought periods, when the debit of river decrease much, reaching minimal values which represent 15-20% from its multiannual medium debit.

c). Accidental pollutions due to mining activities

In the period 2000 – 2005 in the hydrographic basin of river Arieş have place some accidental pollutions with major implication on water quality and other parameters.

In 25.03.2000 because of the dam breakage from decantation lake Băişoara (Mining Branch Iaramin Iara), has place a damage at the spare decantation lake which allowed the slooping of a volume by approximately 250 mc of sterile turbulence, but the pollution does not arrive till the emissary

In 2001, was produced a pollution of river Arieş because of the big quantities of precipitations which led to a large amount of acid waters slooped in the decantation lake Şesei Valley, by approximately 100 l/s, with a pH between 1,5-2,5 and a mineralization by 10-20 g/l (Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+}).

In 2004, on river Arieş, in August and September, due to the abundant precipitations, were registered two accidental pollution with acid waters (pH between 2 and 3), charged with ions of heavy metals: Fe^{2+}, Cu^{2+}, Zn^{2+} and Mn^{2+}, evacuated from the decantation lake of Şesei Valley. Both pollutions ended in piscicultural mortality.

REFERENCES

[1]. Creţu G. – *Hidrologie* - Lito IP Timişoara 1988;

[2]. Forray Ferenc Lazar – *Aplicarea analizei factoriale în studiul poluării râului Arieş (Munţii Apuseni)* – Universitatea Babeş Bolyai, Geologie XLVI, 1, 2001;

[3]. Rotunjanu Ilie - *Stabilitatea versanţilor şi taluzurilor.* Ed. INFOMIN Deva 2005;

[4]. *****SC „Cupru Min" SA Abrud** – *Programul general de exploatare 2005;*

[5]. *****SGA Alba*** – *Material documentar – sinteza calităţii apei;*

[6]. *****Varduca A**. – *Hidrochimie şi poluarea chimica a apelor* – Ed. H.G.A. 1998;

[7]. *****Varduca A.** – *Monitoringul integrat al calităţii apelor* – Ed. H.G.A. 1999;

[8]. *****Varduca A**. – *Protecţia calităţii apelor* – Ed. H.G.A. 2000.

MÉCANISMES FLEXIBLES POUR FACILITER LA RÉDUCTION DES ÉMISSIONS DE GAZ À EFFET DE SERRE

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Abstract: While the world's climate has always varied naturally, the vast majority of scientists now believe that rising concentrations of "greenhouse gases" in the earth's atmosphere, resulting from economic and demographic growth over the last two centuries since the industrial revolution, are overriding this natural variability and leading to potentially irreversible climate change.

Keywords: effet de serre, émissions, gaz, mécanismes, Protocole de Kyoto.

1. INTRODUCTION

L'objectif primaire que vise le Protocole de Kyoto ne s'accomplit pas aisément. La réduction de gaz à effet de serre représente un problème environnemental grave qui requiert des solutions créatives et flexibles.

Le Protocole de Kyoto a établi certains mécanismes économiques pour faciliter la réduction des émissions de gaz à effet de serre. Ces mécanismes sont au nombre de trois: le mécanisme d'action conjointe, le mécanisme de développement propre et le mécanisme d'échange des droits d'émissions. Ils sont aussi connus sous l'appellation mécanismes flexibles. Les avantages rattachés à ces projets sont nombreux en ce qu'ils favorisent le développement durable et le transfert des capacités tout en permettant aux entreprises de choisir le meilleur moment, en fonction de leurs caractéristiques propres, pour réduire leurs émissions de gaz à effet de serre. Ces mécanismes fournissent aussi l'occasion d'exporter le savoir-faire. Malgré les avantages rattachés à ces mécanismes, il faut noter qu'une certaine incertitude demeure quant à leur réalisation. En effet, plusieurs détails opérationnels restent encore à être précisés avant même que ces mécanismes puissent prendre leur envol.

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Le Protocole de Kyoto est une entente de principe par lequel les pays industrialisés et les pays en transition vers une économie de marché, soit les Parties énoncées à l'annexe I de la Convention se sont engagés à réaliser des objectifs quantifiés en matière de diminution de leurs émissions de gaz à effet de serre. En date du 20 mars 2003, 84 pays avaient signé le Protocole de Kyoto et 106 l'avaient déjà ratifié ou approuvé, représentant 43,9 % des émissions. Parmi les parties de l'Annexe I, seuls le Liechtenstein (0 %), Monaco (0 %), la Suisse (0,3 %), l'Australie (2,1 %), la Russie (17,4 %) et les États-Unis (36,1 %) n'ont par encore ratifié le Protocole de Kyoto.

De façon générale, le Protocole de Kyoto encourage la coopération financière et technique afin que le pays en développement puisse mettre en œuvre des politiques et des techniques moins nocives pour le climat. Il fixe aussi des objectifs et des échéances pour la baisse des émissions sur le territoire des Parties énumérées à l'Annexe I de la Convention. Ainsi, ces états doivent faire en sorte que leurs émissions anthropiques agrégées de gaz à effet de serre ne dépassent pas les quantités qui leur sont attribuées, et ce en vue de réduire le total de leurs émissions d'au moins 5 % par rapport au niveau de 1990, et ce pour la période 2008-2012. Ces objectifs se situent à l'intérieur d'une plage allant de réductions de 8 % pour l'Union européenne à une augmentation de 10 % pour l'Islande. Le Canada devra réduire ses émissions de 6 %. Ces objectifs couvrent les émissions de six gaz à effet de serre: dioxyde de carbone (CO_2), méthane (CH_4), oxyde nitreux (N_2O), hydrofluorocarbones (HFC), hydrocarbures perfluorés (PFC), hexafluorure de soufre (SF_6).

Pour atteindre leurs engagements chiffrés en matières de limitation et de réduction des émissions de ces gaz, les Parties doivent élaborer des politiques nationales tout en tenant compte de leur situation particulière. À cet égard, les Parties s'engagent à coopérer et à s'efforcer d'appliquer ces politiques de manière à réduire au minimum les effets négatifs tels que les répercussions sur le commerce international et les conséquences sociales, environnementales et économiques.

2. DES OBJECTIFS CONCERNANT LA RÉDUCTION DES GAZ À EFFET DE SERRE

Conférence de Marrakech avait pour objectifs de traduire en termes légaux les accords politiques signés à Bonn. Plus particulièrement, le but de la rencontre était de mettre au point les procédures et les institutions qui manquaient au Protocole de Kyoto pour qu'il soit opérationnel. Malgré l'existence d'accords politiques entre les Parties, les négociations ont été difficiles et soutenues. Cependant, la Conférence de Marrakech a permis d'obtenir des accords, entre autres, dans les domaines suivants:

- *Renforcement des capacités des pays en développement et des pays en transition vers une économie de marché.* Ceci a pour but d'aider les pays en développement à se doter d'une capacité nationale propre leur permettant de participer entièrement au processus de la Convention et de respecter leurs obligations en vertu de celle-ci;
- *Développement et transfert des technologies.* Ce point a pour but de fournir un cadre pour des actions judicieuses et efficaces permettant de renforcer la

mise au point et le transfert des technologies et de savoir-faire écologiquement rationnels, plus particulièrement aux pays en développement;

- *Opération de mécanismes financiers.* Des directives supplémentaires à l'intention de l'entité chargée d'assurer le fonctionnement des mécanismes financiers ont été établies;
- *Financement au titre de la Convention.* Il a été décidé de créer un fond spécial sur les changements climatiques pour financer les activités et programmes relatifs aux changements climatiques de même qu'un fond pour les pays moins développés;
- *Projet-pilote d'actions conjointes.* Les parties se sont entendues pour poursuivre la phase pilote d'actions conjointes. Ces actions portent sur des projets visant à réduire les émissions de gaz à effet de serre ou à renforcer l'absorption par les puits dans les territoires d'autres parties. Durant ce projet-pilote, les parties doivent faire rapport sur les activités mises en place conjointement;
- *L'utilisation des terres et changement d'affectation des terres et foresterie.* Les parties se sont entendues à l'effet de devoir adopter une décision portant sur l'utilisation des terres et le changement d'affectation des terres et foresteries édictant des définitions de termes tels que: "forêt", "boisement", "reboisement". Elles se sont également entendues sur l'établissement de règles relativement à l'utilisation des terres;
- *Procédures et mécanismes relatifs au respect des obligations en vertu du Protocole de Kyoto.* Les parties se sont entendues sur une décision à adopter en ce qui concerne les procédures et mécanismes relatifs au respect des obligations en vertu du Protocole de Kyoto. Cette décision crée un comité de supervision ainsi que les procédures qui en découlent. Ce comité comportera deux sous-comités: un pour favoriser l'application et l'autre pour assurer le respect des obligations;
- *Plan de travail sur les mécanismes flexibles.* Les Accords de Marrakech ont permis d'énoncer la nature et la portée des articles 6, 12 et 17 du Protocole de Kyoto, lesquels fournissent les assises juridiques des trois mécanismes flexibles.

Le Protocole de Kyoto sera une source de travail majeure avec des enjeux globaux prioritaires. Il supposera des fonds pour sa réalisation et imposera des procédures en cas de non-respect de l'engagement. Les besoins de surveillance des principaux stocks de C terrestre en général et des forêts en particulier, requis dans le cadre du Protocole de Kyoto, attireront donc les principales sources de financement et méritent à cet égard un effort soutenu.

La poursuite de Kyoto permettra cependant de ne pas devoir reconstruire totalement le processus en conservant la structure actuelle et en essayant pour la seconde période d'engagement d'intégrer les pays en développement plus avant.

Du fait que toutes les nations jouent un rôle important dans processus du protocole de Kyoto, l'Europe par sa politique volontariste en matière d'environnement global, la Russie par son rôle devenu central dans la ratification de Kyoto, les US par leur mainmise sur le marché des permis d'émissions et les pays en développement par leur rôle clé pour la seconde période d'évaluation, font qu'à court terme il n'y ait pas de réelle alternative au protocole de Kyoto.

3. MÉCANISME INTERNATIONAL D'ÉCHANGE DES DROITS D'ÉMISSIONS

L'expression "échange des droits d'émissions" renvoie simplement à l'achat et à la vente de "permis d'émission". Un permis d'émission de gaz à effet de serre autoriserait son titulaire à émettre une unité de gaz à effet de serre, par exemple une tonne de dioxyde de carbone. Ces permis s'achèteraient et se vendraient sur un marché semblable au marché boursier ou au marché des produits. Comme c'est le cas pour d'autres polluants qui sont devenus, au sein d l'Union européenne, des produits commerciaux comme l'anhydride sulfureux, les oxydes d'azote et le plomb, ces échanges entraîneront l'émergence d'un marché international des permis d'émission de carbone.

L'article 17 du Protocole de Kyoto permet l'échange de droits d'émissions entre les pays de l'Annexe B du Protocole de Kyoto, soit les pays ayant les engagements chiffrés en matière de réduction d'émissions. Ces pays peuvent ainsi acheter et vendre une partie des émissions de dioxyde carbone qui leur ont été assignées. La Conférence des parties définit les principes, les modalités, les règles et les lignes directrices à appliquer en ce qui concerne la vérification, l'établissement de rapports et l'obligation de reddition en matière d'échange des droits d'émissions. À cet égard, la décision 18/CP.7, adoptée lors de la Conférence des parties à Marrakech, établit les modalités, règles et lignes directrices applicables à l'échange de droits d'émission. De plus, la décision définit les unités d'émission, et établit les critères requis afin qu'une partie membre soit autorisée à vendre ou acheter ces droits d'émissions.

Une certaine problématique découle de ce dernier mécanisme. En effet, certains pays tels que la Russie pourront atteindre plus facilement leurs objectifs et vendre de grandes quantités de droits d'émissions. Lors des négociations ténues à Marrakech, la Russie a obtenu la totalité des puit de carbone qu'elle réclamait (33 millions de tonnes), soit presque le double de ce qui lui fut accordée à Bonn. Le système établi fait en sorte que les dispositifs permettant de déduire des objectifs chiffrés les "puits de carbone", à savoir le carbone que les forêts et terres agricoles peuvent absorber, permettra à la Russie d'atteindre ses objectifs sans réduire substantiellement ses émissions totales tout en ayant la possibilité d'échanger une partie des émissions de carbone lui étant assignée. Ainsi, plusieurs pays pourraient avoir d'avantage tendance à se fier à l'acquisition de droits d'émissions pour atteindre leurs objectifs plutôt que de veiller à prendre des mesures permettant la réduction des émissions. En somme, certains pays risqueront d'être moins prompts à prendre des mesures internes pour modifier la tendance à long terme de leurs propres émissions.

Le Protocole de Kyoto met donc en place un système international d'échange des droits d'émissions. Par contre, un système d'échange des droits d'émissions pourra aussi être établi au niveau national et les entités privées en seront les principaux acteurs. Par conséquent, il est fort probable que le mécanisme international d'échange des droits d'émissions et les mécanismes nationaux d'échange des droits d'émissions évolueront de façon parallèle.

4. ACTION CONJOINTE

Afin de remplir ses engagements quantifiés, toute partie céder à toute autre partie de même statut ou acquérir auprès d'elle, des unités de réduction des émissions découlant de projets communs visant à réduire les émissions anthropiques ou à renforcer l'absorption par les puits. Il faut souligner qu'il sera impossible pour une partie d'acquérir des unités de réduction des émissions si une des parties aux projets ne se conforme pas aux obligations prises en vertu des articles 5 et 7 du Protocole de Kyoto. L'acquisition d'unités de réduction des émissions doit par ailleurs être en complément des mesures prises au niveau national dans le but de remplir les engagements quantifiés. Ce système connu comme le mécanisme d'action conjointe, permettra la participation d'entités privées sous réserve de l'autorisation des parties (pays) participant au projet.

Le programme d'action conjointe permettra ainsi à des sociétés de pays développés d'investir dans d'autres pays développés, y compris dans les économies en transition du centre et de l'est de l'Europe, en vue de réduire ou d'éviter les émissions de gaz à effet de serre. Les crédits seront alors accumulés sous forme d'unités de réduction des émissions.

5. MÉCANISME DE DÉVELOPPEMENT PROPRE

L'article 12 du Protocole de Kyoto établit le mécanisme pour un développement propre. L'objet de ce mécanisme est d'aider les pays en développement à parvenir à un développement durable ainsi qu'à contribuer à l'objectif ultime de la Convention, tout en aidant les Parties de l'Annexe I à remplir leurs engagements chiffrés de limitation et de réduction de leurs émissions. Autrement dit, les pays industrialisés recevront des crédits pour les rejets évités grâce à ces projets. Ce mécanisme est accessible aux entités publiques et privées. Une part des fonds provenant d'activités certifiées (2 %) est utilisée pour couvrir les dépenses administratives et aider les pays en développement, qui sont particulièrement vulnérables aux effets du changement climatiques, à financer le coût des adaptations nécessaires. La Conférence de Marrakech a par ailleurs permis de préciser les modalités d'application de ce mécanisme notamment en reconnaissant les réduction à partir de l'an 2000. Ainsi, la décision 17/CP.7 a été élaborée afin de préciser les modalités et les procédures se rapportant au mécanisme de développement propre. Entres autres, la décision décrit le rôle de la Conférence des parties, élabore la fonction du comité exécutif, explique la méthode d'accréditation d'entités opérationnelles, la désignation d'entités opérationnelles, énumère les exigences de participation, et explique le processus de validation d'enregistrement, de vérification et de certification.

Ce mécanisme a toutefois certaines limites. Le mécanisme de développement propre prévoit des crédits pour l'élimination des émissions dans les pays en développement qui ne sont pas assujettis aux objectifs chiffrés du Protocole de Kyoto. Ainsi, les activités au titre de ce mécanisme ne se traduiront pas par une compensation nette au sein de l'enveloppe de Kyoto. En effet, quoique la diminution des émissions dans les pays en développement soit à encourager et quelle sera bénéfique à l'ensemble de la planète, les objectifs de Kyoto sont définis comme étant la réduction que le pays développés doivent attendre, à savoir que leurs émissions anthropiques agrégées de gaz à effet de serre ne dépassent pas les quantités qui leur sont attribuées, et ce en vue de réduire le total de leurs émissions d'au moins 5 % par rapport au niveau de 1990 pour la période 2008-2012.

6. CONCLUSIONS

L'objectif de la Convention est de fournir un cadre à l'action visant à maîtriser les émissions de gaz à effet de serre. Plus précisément, la Convention el les ententes qui en découlent visent à stabiliser les concentrations atmosphériques de gaz à effet de serre à un niveau permettant d'empêcher les activités anthropiques de donner lieu à des interférences dangereuses avec le système climatique.

Les Parties, soit les États ayant ratifié ou approuvé la Convention, ont convenu de divers moyens pour d'atteindre cet objectif. Ainsi, les parties doivent préserver le système climatique sur la base de leurs capacités respectives, tout en tenant compte des besoins spécifiques des pays en développement. De façon générale, les politiques nationales doivent favoriser le développement durable et doivent prendre en compte la diversité des contextes socio-économiques. Ces mesures doivent s'étendre à toutes les sources d'émission et à tous les puits d'absorption. La Convention met par ailleurs en avant plan le respect du principe de précaution, c'est à dire que l'absence de certitude scientifique ne doit pas servir de prétexte en cas de risques de perturbation grave et irréversible. La Convention interdit aussi toute forme de discrimination arbitraire ou injustifiable en matière de commerce international.

BIBLIOGRAPHIE

[1]. Houghton, J.T., Jenkins G.J., Ephraums, J.J., *IPCC First Assessment Report. Scientific Assessment of Climate Change – Report of Working Group*, Cambridge University Press, 1990.

[2]. Houghton, J.T., Meuira Filho, L.G., Callender, B.A., Harris, N., Kattenberg, A., *Second Assessment report. Climate Change 1995: The Science of Climate Change. Contribution of Working Group 1 to the Second Assessment of the Intergovernmental Panel on Climate Change,* Cambridge University Press, 1995.

[3]. Kirby, P., *Emission Trading in the International Context: Kyoto Implementation and International Trade Agreements,* Conférence Infonex, Calgary, 2003.

[4]. Turmel, A., *La protection de l'environnement et les accords nord-américains de libre-échange, Développements récents en droit de l'environnement,* Service de la formation permanente, Quebec, 1994.

[5]. Watson, R.T., Noble, I.R., Bolin, B., Ravindranah, N.H., Verardo, D.J., Donken, D.J., *Land Use, Land-use Change and Forestry. Special Report of the Intergovernmental Panel on Climate Change,* Cambridge University Press, 2000.

TWO DIFFERENT FORMULATIONS WHICH RESOLVE THE COAL STOCKPILES IGNITION PROBLEM

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Abstract: Two approaches which employ the finite element method to solve for large-scale, coupled, incompressible flows through adjacent porous and open domains are developed and evaluated in a model for the spontaneous ignition of coal stockpiles. Both formulations employ the Navier-Stokes equations to describe flow in the open region; two different descriptions, Darcy's law and the Brinkman equation, are employed to model flows within the porous region. A direct comparison of model results shows that the Darcy-slip formulation produces solutions which are more accurate and more economical to compute than those obtained using the Brinkman formulation.

Keywords: coal, model, spontaneous ignition, stockpiles

1. PROBLEM SPECIFICATION AND FORMULATION: THE SPONTANEOUS IGNITION OF A COAL STOCKPILE

We employ the coal stockpile ignition problem as our model system for evaluating solution strategies for coupled flows within porous and open domains. In this problem the shape of the coal pile is assumed to be a frustum surrounded by a homogeneous air region (see Figure 1, *a*). The coal pile is considered to be an isotropic porous medium in which an exothermic oxidation reaction is occurring. Oxygen from the surrounding air enters the pile to fuel the reaction; the subsequent release of heat raises the temperature of the pile, which in turn drives buoyant flows within and outside the stockpile. We assume that the temperature, concentration, velocity and pressure fields are axisymmetric and solve for steady states of the system.

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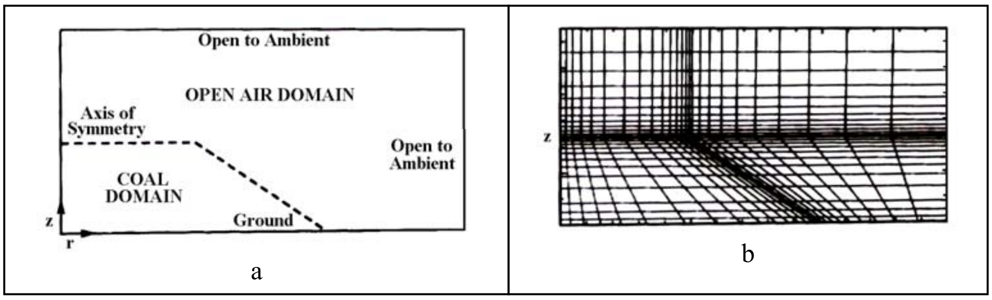


Figure 1. The coal stockpile ignition problem is used to study numerical formulations for a porous/open fluid system: a – the axisymmetric domain includes the coal region and the surrounding air; b – the mesh used for all calculations comprises 600 elements.

1.1. Heat and mass transfer and chemical reaction

Governing equations for heat and mass transfer through the system must account for the different thermophysical properties in each domain as well as the chemical reaction occurring in the coal stockpile. In the open fluid domain these equations take the non-dimensional forms

$$v \cdot \nabla T = \frac{1}{Pr_0} \nabla^2 T \tag{1}$$

$$v \cdot \nabla C = \frac{1}{Sc_0} \nabla^2 C \tag{2}$$

Within the coal stockpile

$$v \cdot \nabla T = \frac{1}{\mathrm{Pr}_p} \nabla^2 T + \beta \cdot Da \cdot C \cdot \exp\left(\gamma \frac{T}{1+T} \right) \tag{3}$$

$$v \cdot \nabla C = \frac{1}{Sc_p} \nabla^2 C - Da \cdot C \cdot \exp\left(\gamma \frac{T}{1+T} \right) \tag{4}$$

In the above equations v is the dimensionless velocity, T is the dimensionless temperature, C is the dimensionless oxygen concentration, β is the Prater number (adiabatic temperature rise) and γ is the Arrhenius number. The dimensionless Prandtl number Pr and Schmidt number Sc take different values in the open air and porous coal pile domains, as indicated by subscripts “o” and “p” respectively.

Along the centerline and top of the open domain (see Figure 1, *a*) no-flux conditions are set for heat and mass transfer. Along the ground the temperature is set to its ambient value and a no-flux condition is applied for oxygen transfer. Along the outer edge of the computational domain the temperature and concentration fields are set to ambient values.

1.2. Flow in the open domain and boundary conditions: Navier-Stokes equation

The flow in the open domain is governed by the steady state, Navier-Stokes equations, written here in dimensionless stress divergence form for an incompressible fluid with the Boussinesq approximation:

$$v \cdot \nabla v = \nabla \cdot \sigma_o + \frac{Ra}{\beta \cdot Pr_p} T e_z \quad (5)$$

$$\nabla \cdot v = 0 \quad (6)$$

where Ra is the dimensionless Rayleigh number and e_z is a unit vector oriented upwards against the direction of the gravitational force vector. The total stress tensor for a Newtonian fluid in the open fluid region, σ_o in equation (5), is given in dimensionless terms by

$$\sigma_o = -P \cdot I + \left(\nabla v + \nabla v^T\right) \quad (7)$$

where P is the dimensionless dynamic pressure, I is the identity tensor and superscript T denotes the transpose operation.

The Navier-Stokes equations require the application of two distinct boundary conditions along all surfaces in this two-dimensional geometry. At the porous/open fluid interface we require continuity of normal stress [5]:

$$n \cdot n \cdot \sigma_o = n \cdot n \cdot \sigma_p \quad (8)$$

where σ denotes the total stress tensor for the fluid in each domain. The second boundary condition is a specification of the shear stress at the interface, $t \cdot n \cdot \sigma_o$, and depends on our choice of the flow equation in the porous region.

To complete the specification of boundary conditions for the Navier-Stokes equations and the open fluid domain, the following choices are made. Stress-free boundary conditions are imposed along the outer and upper surfaces of the computational domain. No-slip conditions are specified along the ground surface outside the coal pile and axisymmetry is enforced along the centreline in the open region.

1.3. Flow in the porous domain and matching conditions

1.3.1. The Darcy-slip formulation. If we choose to apply Darcy's law, we assume that the fluid is incompressible, apply the Boussinesq approximation and express Darcy's law in stress divergence form to yield

$$-\nabla \cdot \sigma_p = -\frac{1}{\lambda} v + \frac{Ra}{\beta \cdot Pr_p} T \cdot e_z \quad (9)$$

$$\nabla \cdot v = 0 \tag{10}$$

where λ is the dimensionless permeability (sometimes referred to as the Darcy number). The total stress tensor associated with Darcy's law is given by

$$\sigma_p = -P \cdot I \tag{11}$$

This form is used to satisfy the normal stress continuity condition of equation (8). Note that the total stress tensor is isotropic, so the shear stress in a Darcy fluid is identically zero.

Only one boundary condition is needed for Darcy's law. This condition [4] is chosen to require continuity of the flow normal to the boundary of the porous domain:

$$n \cdot v_p = n \cdot v_o \tag{12}$$

For the second boundary condition for the Navier-Stokes equation [6] one might be tempted to balance shear stresses tangential to the interface; however, this is not tenable, since, as discussed above, there are no shear stresses associated with Darcy's law. In reality the shearing force from the flow in the adjacent open region will be exerted on the fluid within the porous medium and on the solid porous structure itself. If the viscous shear force is not all transferred to the fluid in the porous region, it is reasonable to assume that the volume-averaged tangential velocity is discontinuous over the interface.

When using Darcy's law, we employ a slip condition at the porous/open fluid interface for the shear stress boundary condition of the Navier-Stokes equation. The following dimensionless, vectorial form modification to the Beavers-Joseph condition

$$t \cdot n \cdot \sigma_o = \frac{\alpha}{\lambda^{1/2}}\left(t \cdot v_o - t \cdot v_p\right) \tag{13}$$

is applied at the interface between the coal pile and surrounding air in our Darcy-slip formulation. The quantity t in the above equation denotes a unit vector tangent to the porous/open fluid interface. No normal flow boundary conditions are applied at the remaining boundaries of the porous domain, namely the system centerline and the bottom of the coal pile [2].

1.3.2. The Brinkman formulation. The application of the Brinkman equation to describe flows in the porous medium is straightforward. The dimensionless representation for an incompressible, Bousinesq fluid is given in stress divergence form by

$$-\nabla \cdot \sigma_p = -\frac{1}{\lambda} \cdot v + \frac{Ra}{\beta \cdot Pr_p} T \cdot e_z \tag{14}$$

$$\nabla \cdot v = 0 \tag{15}$$

with the total stress tensor

$$\sigma_p = -P \cdot I + \eta\left(\nabla v + \nabla v^T\right) \tag{16}$$

where $\eta \equiv \mu'/\mu$ is the ratio of the effective viscosity of the Brinkman equation to that of the fluid in the open region. The stress tensor has the same form as that for the Newtonian fluid, equation (7), with the exception that the effective viscosity μ' multiplies gradients of velocity rather than the true fluid viscosity μ. This form of the total stress tensor is supplied to equation (8) for continuity of normal stress across the porous/open fluid interface.

The higher-order derivative of the velocity field in Brinkman's equation results in the need to specify two boundary conditions. These are supplied by matching normal and tangential velocities across the porous/open fluid interface:

$$n \cdot v_p = n \cdot v_o \tag{17}$$

$$t \cdot v_p = t \cdot v_o \tag{18}$$

When the Brinkman equation is used in the porous region, the secondary boundary condition for the Navier-Stokes equation requires the shear stresses to balance over the interface. It should be noted that the physical interpretation of this condition remains an open issue. Nevertheless, we follow past convention and simply equate the fluid shear stresses at the interface:

$$t \cdot n \cdot \sigma_o = t \cdot n \cdot \sigma_p \tag{19}$$

No slip conditions are provided along the bottom of the coal pile and axisymmetry is imposed along the centerline.

2. NUMERICAL METHODOLOGY TO SOLVE

We employ the Galerkin finite element method [1] to solve the system of partial differential equations resulting from each formulation. A finite element mesh consisting of qadrilateral elements is constructed over both porous and open domains, with elemental boundaries falling along the interface between the domains (see Figure 1, *b*). Within each domain the appropriate governing equations are discretized and the proper boundary conditions are implemented.

The finite element expansions are substituted into the Galerkin residual equations and nine-point Gaussian quadrature is employed to convert the integral equations into a large set of non-linear algebraic equations. The Newton-Raphson method is used to solve this system iteratively and pseudo-arc-length continuation is implemented to track the steady state solutions as a function of the Damkohler number. The resulting Jacobian matrix has an "arrow" structure; it is banded except for the final row and column, which are full owing to components associated with the continuation routine. A direct solver written specifically for this type of matrix structure is used to solve the linear system.

Figure 1 , *b* displays the finite element mesh used in all calculations performed here. This mesh consisted of 600 biquadratic elements and produced numerically convergent results for the Darcy-slip formulation under the conditions considered here.

2.1. The coal stockpile ignition problem

We first present typical solutions to our model problem to set the stage for a critical examination of the different numerical formulations. Figure 2 shows a bifurcation diagram for the coal stockpile ignition problem where the maximum dimensionless temperature of the coal pile is plotted for each steady state solutions as the Damkohler number *Da* is varied. The system exhibits multiple steady state solutions over a large range of Damkohler Numbers $10^{-3} \leq Da \leq 1$.

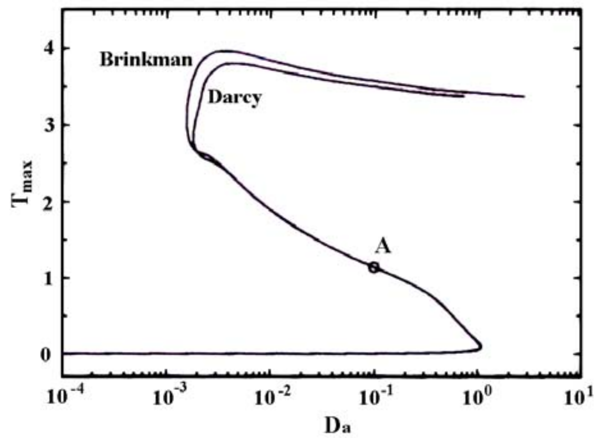


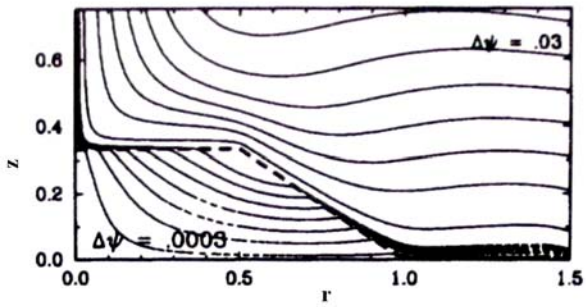
Figure 2. A bifurcation diagram plots the maximum temperature of steady state solutions versus the Damkohler number *Da* for both the Brinkman and Darcy formulations.

The S-shaped curves shown here are commom for systems which display hysteresis phenomena and consist of three separate branches. The lower branch, near $T_{max} = 0$, consists of stable, extinguished steady states. This solution branch terminates at a turning point near $Da \approx 1$, which is termed the ignition point. The central section of the curve, where the slope is negative, represents temporally unstable steady state solutions. The upper branch is formed by stable, ignited solutions where reaction and transport rates are high enough to sustain vigorous combustion in the coal pile [3]. The ignited branch is bounded by a turning point, termed the extinction point, at lower values of Damkohler number.

2.2. A comparison of Brinkman and Darcy formulations

Typical features of steady states for this system are displayed in Figure 3, whichshows streamfunction, temperature and concentration contours associated with a solution calculated with the Darcy-slip formulation; the solution corresponds to point

A in Figure 2 and will be used to compare results from the next two formulation. The streamlines indicate that fluid is flowing over and through the porous medium, with a strong plume rising from the top centre of the pile. The absolute magnitude of the streamfunction drops dramatically from the open fluid region to the interior of the coal stockpile, thus indicating much weaker flows within the porous medium. Smooth temperature and concentration contours within the porous region indicate thet heat and mass transfer are dominated by diffusive phenomena within the coal pile. Distorted contours shaped by the buoyant plume above the pile show the importance of convective transport in the open fluid region.



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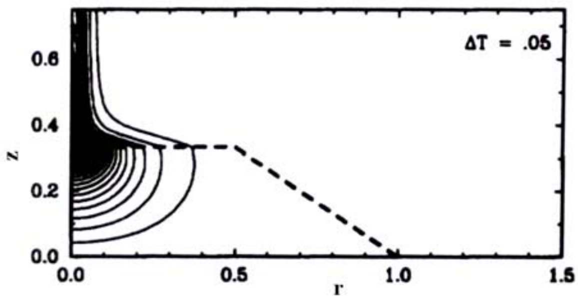

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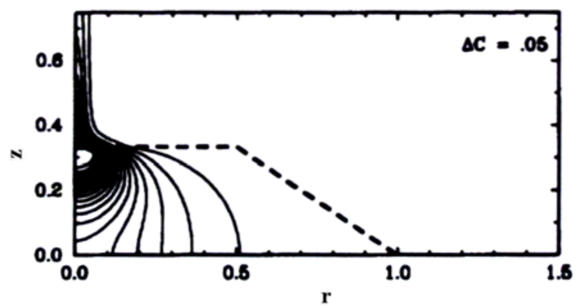

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Figure 3. The dimensionless (a) streamfunction, (b) temperature and (c) concentration contours corresponding to point A on Figure 2 for the Darcy formulation. The contour spacing are indicated on each plot.

The bifurcation diagram discussed previously (Figure 2) shows curves obtained from both the Darcy and Brinkman formulations. Interestingly, although the position of the ignited branches clearly differs, the formulations yield results which appear to be quite similar along the lower and middle branches of the diagram. However, a careful comparison of the predicted flows within the porous medium reveals significant differences between the two formulations.

3. CONCLUSIONS

Two different formulations which simultaneously resolve incompressible flows in a porous medium and a surrounding open fluid were applied to the coal stockpile ignition problem. Interestingly, the two curves in the bifurcation diagram of Figure 2 were very similar, indicating that the overall behaviour of the system was not strongly affected by the choice of formulation. This result is not surprising, since prior studies of this system have shown that ignition-extinction phenomena are most strongly affected by convective transport through the open fluid region and diffusive transport within the porous medium rather than by flows within the coal pile.

Each formulation presented certain advantages and disadvantages for solving the model problem considered here. The darcy-slip formulation proved capable of yielding smooth solutions on a mesh which proved to bee too coarse for the Brinkman formulation. Accurate solutions for the Darcy-slip formulation would likely be obtained with still coarser meshes than that employed here.

The great advantage of the Brinkman formulations is the simplicity of its formulation and implementation, especially with regard to matching conditions between the porous and open fluid domains. However, this simplicity carries with it a significant computational burden to resolve the thin boundary layer at the surface of the porous medium. Indeed, this additional computational effort may not be justified in all situations, such as when the thickness of the porous boundary layer is much smaller than characteristic length scales of the system.

REFERENCES

[1]. Johnson, C., *Numerical solution of Partial Differential Equations by the Finite Element Methods*, 1987, Cambridge University Press, Cambridge.

[2]. Kim, S., Russel, W.B., *Modelling of porous media by renormalization of the Stokes equations*, 1985, J. Fluid Mech. vol.154, p.269-286.

[3]. Neale, G.H., Nader, W.K., *Prediction of transport processes within the porous media: creeping flow relative to a fixed swarm of spherical particles*, 1974, AIChE J, vol.20, p.530-538.

[4]. Richardson, S., *A model for the boundary conditions of a porous material*, 1971, Part.2, Fluid Mech., vol.49, p.327-336.

[5]. Ross, S.M., *Theoretical model of the boundary conditions at the fluid-porous interface*, 1983, AIChE J, vol.29, p.840-846.

[6]. Taylor, G., *A model for the boundary conditions of a porous material*, 1971, Part.1, Fluid Mech., vol.49, p.319-326.

COMPOSITION OF BODIES IN THE CLIMATE CHANGE PROCESS AT WORK

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Abstract: Increasing scientific evidence of human interference with the climate system, coupled with growing public concern over global environmental issues, began to push climate change onto the political agenda. The Convention on Climate Change is opened for signature at the UN Conference on Environment and Development. Parties have met annually in the Conference of the Parties (COP) to monitor its implementation and continue talks on how best to tackle climate change. The many decisions taken by the COP at its annual sessions now make up a detailed rulebook for the effective implementation of the Convention.

Keywords: bodies, composition, climate change, process, work

1. THE PARTICIPANTS

1.1. Parties

Each Party to the Convention is represented at sessions of the Convention bodies by a national delegation consisting of one or more officials who are empowered to represent and negotiate on behalf of their government.

Based on the tradition of the UN, Parties are organized into five regional groups, mainly for the purposes of electing the Bureau, namely: Africa, Asia, Central and Eastern Europe, Latin America and the Caribbean states, and the Western Europe and Others Group (Australia, Canada, Iceland, New Zealand, Norway, Switzerland and the US, but not Japan, which is in the Asian Group).

The five regional groups, however, are not usually used to present the substantive interests of Parties and several other groupings are more important to the climate negotiations.

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Developing countries generally work through the *Group of 77 and China*, founded in the context of the UN Conference on Trade and Development (UNCTAD) and now functions throughout the UN system, comprising over 130 members.

The *Alliance of Small Island States* (AOSIS) is a coalition of some 43 low-lying and small island countries, most of which are members of the G-77, that are vulnerable to sea-level rise. The AOSIS countries are united by the threat that climate change poses to their survival, and frequently adopt a common stance in negotiations.

The 48 countries defined as *Least Developed Countries* by the UN regularly work together in the wider UN system. They have now become increasingly active also in the climate change process, often working together to defend their particular interests.

The members of the *European Union* meet in private to agree on common positions for the negotiations. The country that holds the EU Presidency – a position that rotates every six months – then speaks for the European Community and its member states.

The *Umbrella Group* is a loose coalition of non-EU developed countries, which formed following the adoption of the Kyoto protocol. Although there is no formal list, the Group is usually made up of Australia, Canada, Iceland, Japan, New Zealand, Norway, the Russian Federation, Ukraine and the US.

The *Environmental Integrity Group* (EIG) is a recently formed coalition, comprising Mexico, the Republic of Korea and Switzerland.

Another recent coalition is the *Central Gropu-11* (CG-11).

1.2. Observer organizations

Several categories of observer organizations also attend sessions of the COP and its subsidiary bodies. These include representatives of United Nations secretariat units and bodies, such as UNDP, UNEP and UNCTAD, as well as its specialized agencies and related organizations, such as the GEF and WMO. Observer organizations also include intergovernmental organizations (IGOs), such as tthe OECD and its International Energy Agency (IEA), along with non-governmental organizations (NGOs).

Observers may attend meetings of the COP and subsidiary bodies without the right to vote, unless at least one-third of Parties object.

1.3. The media

Accredited representatives of the media may also attend sessions of the COP and subsidiary bodies as observers. The number of media representatives varies, depending on the profile of the session.

A special press centre is usually set up to each COP to cater for the high media presence, and a wide range of media products are made available, including regular press releases, video news releases and live web casts of many negotiating meetings and special events. The secretariat has encouraged the attendance of journalists from developing countries at negotiating sessions in order to promote media coverage in these countries where awareness of the climate change process is often low.

2. THE PROCEDURES

The proceedings of the COP and its subsidiary bodies are governed by written rules of procedure. However, the COP has not yet formally adopted its rules of procedure, owing to differences in opinion over the voting rule. Discussions are continuing to try to find a compromise. Because all the other rules are agreed, the draft rules of procedure are “applied” at each session, with the exception of the rule on voting.

As there is no agreed voting rule, almost all decisions must be adopted by consensus. Consensus is usually interpreted to mean that there is no stated objection to a decision, and is not quite the same as unanimity.

The Convention text, however, may be amended by three-fourths majority vote if it proves impossible to reach consensus. This is because the Convention itself includes this rule. Once an amendment has been adopted, it must be ratified by three-fourths of the Parties before it enters into force. No amendment to the Convention taxt has yet been adopted.

The draft rules of procedure set out general rules for debating and negotiating. An important rule is that proceedings of formal meetings must be interpreted into all six languages of the UN (Arabic, Chinese, English, French, Russian and Spanish). Delegates may only speak when they are given the floor by the President or Chairperson, and a quorum of two-thirds of Parties must be present for a decision to be taken. The rules also cover the drafting and adoption of agendas and the participation of observers.

3. THE SECRETARIAT

The secretariat is institutionally linked to the United Nations and administered under United Nations Rules and Regulations. It now employs over 150 staff, including short-term staff and consultants, from all over the world. The head, the executive Secretary, is appointed by the Secretary-General of the United Nations in consultation with the COP through its Bureau, and currently holds the rank of Assistant-Secretary-general. The Executive Secretary reports to the Secretary-General through the Under-Secretary General heading the Department of Management on administrative and financial matters, and through the Under-Secretary-General heading the Department for Economic and Social Affairs on other matters.

Every two years, the Executive Secretary proposes a programme budget, setting out the main tasks to be performed by the secretariat in the coming biennium and the funding needed to carry out this work. The programme budget is founded by contributions from Parties, their shares being based on the UN scale of assessment.

The secretariat’s structure is kept under review to ensure that it responds to the changing needs of the climate change process. This structure consists of three programme clusters:

- Executive Direction;
- Technical Programmes;
- Support Services.

Executive Direction comprises the functions and staff of the Executive Secretary, the Deputy Executive Secretary and the Secretary of the COP. These three officials are responsible for promoting the overall coherence of the secretariat's work and its responsiveness to the needs of the Convention bodies. They chair internal management processes that advance these aims and facilitate the effective management of the secretariat. The executive Direction cluster is composed of two programmes: Executive Direction and Management, covering tasks undertaken under the direct supervision of the Executive Secretary and the Deputy Executive Secretary, and the Office of the Secretary of the COP.

The *Technical Programmes* carry out mandates assigned by the COP and its subsidiary bodies they comprise four programmes: Methods, Inventories and Science; Implementation; Sustainable Development and Cooperative Mechanisms.

o *Methods, Inventories and Science* (MIS): MIS provides secretariat services to the SBSTA. In doing so, it carries forward the secretariat's methodological work, including on the land use, land-use change and forestry sector, emission projection, HFCs and PFCs, and vulnerability and adaptation. It coordinates the development of guidelines for reporting greenhouse gas emissions and removals and for the technical review of emission inventories, while organizing these reviews and archiving inventory data. In addition, MIS ensures linkages with international scientific bodies, notably the IPCC and the Global Climate Observing System (GCOS).

o *Sustainable Development* (SD): SD groups activities related to the integration of climate change concerns into the sustainable development priorities and programmes of developing country Parties. It includes support for intergovernmental work on the transfer of technology, adaptation strategies and work on education, training and public awareness.

o *Cooperative Mechanisms* (COOP): COOP works on joint implementation, the clean development mechanism and emissions trading under the Kyoto Protocol. It also collects information on activities implemented jointly under the Convention.

o *Implementation* (IMP): IMP provides secretariat services to the SBI. In doing so, it conducts work on guidelines for national communications by both Annex I and non-Annex I Parties. This programme also ensures liaison with the GEF and facilitates capacity-building activities.

Support Services, which enable the secretariat and the intergovernmental process to function effectively, include three sub-programmes: Administrative Services, Conference Affairs Services, and Information Services.

o *Administrative Services* (AS): AS carries out the overall administration of the secretariat; develops policies and guidance for the management of financial and human resources; manages procurement activities and secretariat-wide operating costs funded from the core budget; and monitors administrative transactions undertaken by administrative teams in individual programmes.

o *Conference Affairs Services* (CAS): CAS is responsible for providing conference facilities and services for all sessions of the Convention bodies and workshops. CAS liaises with Parties and observers, registers participants to sessions of Convention bodies and provides funding and travel arrangements for eligible Parties. CAS is also responsible for planning, editing and coordinating the production and dissemination of official documents.

o *Information Services* (IS): IS - is responsible for information technology support to Parties at sessions of the Convention bodies and workshops, as well as to the secretariat. A key task for the programme is ensuring that Parties have access to official documents and other information over the Internet. IS also maintains key databases needed for registration and document distribution, and support secretariat work through the library. It arranges for the participation of the media in the Convention process and, in cooperation with UNEP and other organizations, publishes information products on the Convention and its process.

4. CONCLUSIONS

The Convention sets an ultimate objective of stabilizing atmospheric concentrations of greenhouse gases at levels that would prevent “dangerous” human interference with the climate system. Such levels, which the Convention does not quantify, should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. To achieve this objective, all Parties to the Convention – those countries that have ratified, accepted, approved, or acceded to, the treaty – are subject to an important set of general commitments which place a fundamental obligation on both industrialized and developing countries to respond to climate change.

REFERENCES

[1]. Ezekiel, R., Harris, J., *Emission Reduction Trading Legal Issues*, Outcomes from Climate Change Central’s Greenhouse Gas Emission Reduction Trading Workshop, Alberta, 2002.

[2]. Hugues, E.L., Lucas, A.R., Tilleman, W.A., *Environmental Law and Policy*, 2d Ed., Edmond MontgomeryPublications Limited, 1998.

[3]. Sheahan, A.M., *Les reductions d’émissions de gaz à effet de serre: des biens ou du vent?,* Développements recent en droit de l’environnement, Yvon Blais, 2002.

THE INFLUENCE OF SOME ELEMENTS OF AGRICULTURAL TECHNOLOGIES ON ACTIVITY OF USEFUL PEDOFAUNA

MĂDĂLINA IORDACHE*
I. BORZA**
D. ŢĂRĂU***

ABSTRACT:
The restoration of soils fertility affected in negative by the intensive system of agriculture represents a desideratum in promotion of the concept of ecological agriculture. In this sense, the renewal of useful pedofauna is absolutely necessary.

Determinations regarding the populations effective and biomass of lumbricids from soil made in rigorously experiments from Didactic Station of USAMVB Timişoara demonstrate that the activity of these organisms is stimulated by introduction in soil of organic matter by any type (manure, green fertilizers, vegetal rests) while the chemical fertilizers and pesticides prejudice their activity. The crop rotations are involved as well in reconstruction of useful pedofauna activity. The perennial plants (lucerne), comparatively with annual plants (maize, oat) helps to renewal of pedofauna`s activity. Determinations of agrophysical parameters (DA, PT, GT) show the improvement of aeration state of soil in the experimental variants where the number and biomass of lumbricids increased.

Key words: lumbricids, culture plants, organic fertilizers, mineral fertilizers, agrophysical parameters.

1. INTRODUCTION

Lumbricids play an extremely important role in the improvement of physical, chemical and biological properties of the soil. These organisms represent major decomposers of organic matter from soil, making available for the plants nourishing

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elements in a form perfect accessible for them. They permit a better circulation of the water and oxygen in soil, improving the microbiological activities at this level.

The most important benefit for soil is represented by their coprolites, excreted structures that increase the humus reserve in soil and which depend by nourishing resource available for lumbricids.

The presence of lumbricids in soil is thus conditioned by the presence of organic matter at this level and by disturbance degree of soil.

The paper proposes to put in evidence the factors that influence the spreading of lumbricids, taking into account the major contribution of these organisms on soil fertility.

2. MATERIAL AND METHODS

Researches took place on the territory of Didactic Station of USAMVB Timişoara, on a cambic chernozem, low gleyed. Experimental emplacement occupies a surface by 1,5 ha. The experience is in fact a crop rotation on 6 years with plants which are considerate to have a special economic importance (wheat, barley, maize for grains and silo-maize) and fodder plants known for their improvement of soil characteristics (oat + pea culture, lucerne, mixture of leguminoses and perennial graminaceous). The experimental scheme includes control variants and variants with organic fertilization (40 t bovine manure/ha).

Extraction of pedobionts (lumbricids) was made in October 2005, using a specific methodology (the method of formaldehyde 1%).

3. RESULTS AND DISCUSSIONS

After extraction of lumbricids from experimental variants realized in October 2005 was registered the dates that are presented in the table 1, respectively figures 1 and 2.

Table 1. **Dynamics of number and biomass of lumbricids in the experimental variants**

Experimental variant		**Lumbricids/m^2**	**Weight (g/m^2)**
Maize	control area	35	3,95
	manure 40 t/ha	49	6,23
Silo-maize	control area	6	1,17
	manure 40 t/ha	20	2,26
Wheat	control area	68	8,47
	manure 40 t/ha	62	10,45
Barley	control area	33	6,62
	manure 40 t/ha	49	8,41
Oat + pea	control area	50	7,42
	manure 40 t/ha	51	10,63
Lucerne + orchard grass	control area	72	15,20
	manure 40 t/ha	89	19,57
Lucerne	unfertilized	194	31,57

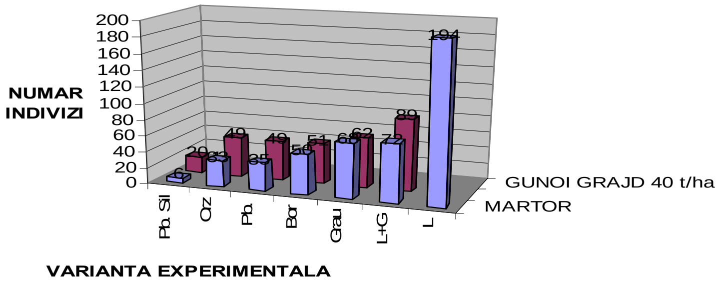

Fig. 1. Lumbricids number (individuals/m^2) in different types of cultural plants

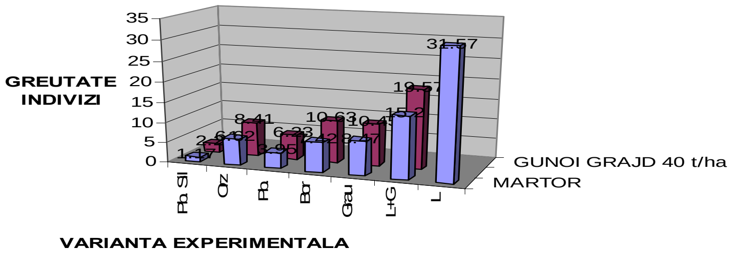

Fig. 2. Lumbricids biomass (g/m^2) in different types of cultural plants

A big number of lumbricids was identified in the plot cultivated with lucerne + orchard grass and fertilized with bovine manure in doze of 40 t/ha (89 fellows/m^2).

Regarding de total weight of the fellows, this plot is representative, with numerous fellows well biologically developed. (fig. 3).

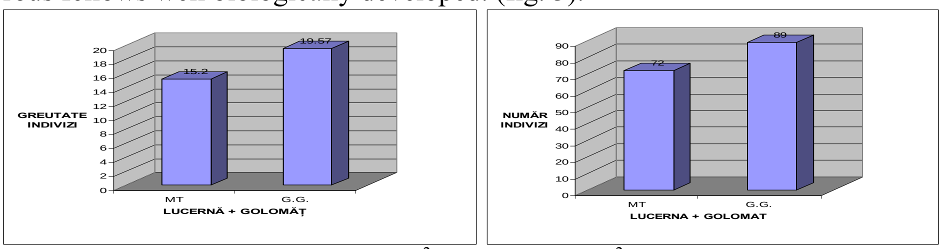

Fig. 3. Lumbricids number (individuals/m^2) and biomass (g/m^2) in lucerne + orchard grass

This situation is explained by the fact that lucerne is a plant with a roots system very ramified and deep, and a big part of dead roots constitute a rich nourishing resource for the living lumbricids from soil. Under the culture of lucerne + orchard grass, the agricultural workings that disturb the soil are more reduced, and the organic matter from the surface is more abundant, which create favorable conditions for the development and multiplication of lumbricids. The bovine manure in dose of 40 t/ha contributed no doubt to the multiplication of lumbricids populations.

The smallest densities of lumbricids were found in the plots cultivated with maize, both in the control-area (6 fellows/m^2) and in the variant fertilized with bovine manure in dose of 40 t/ha (20 fellows/m^2). The same effects were registered in the case of lumbricids biomass. This low density is due to the numerous maintenance works of soil that maize necessitated and which disturb the activity of lumbricids in soil. (fig. 4). This situation is similar for the cultures of silo-maize and barley (fig. 5 and 6).

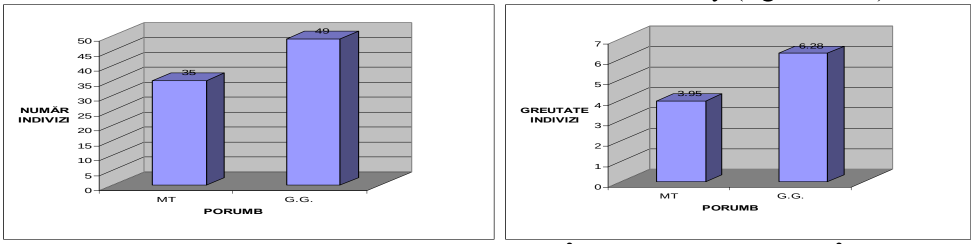

Fig. 4. Lumbricids number (individuals/m^2) and their biomass (g/m^2) in maize

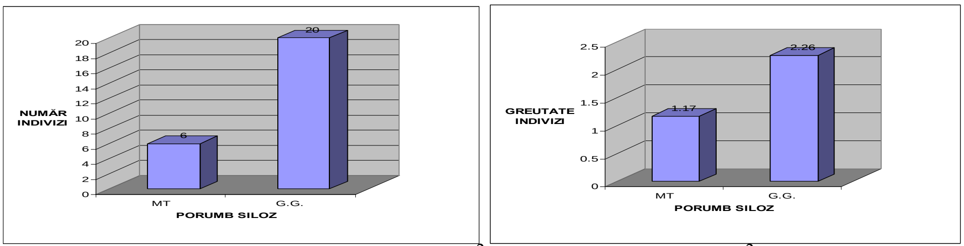

Fig. 5. Lumbricids number (individuals/m^2) and their biomass (g/m^2) in silo – maize

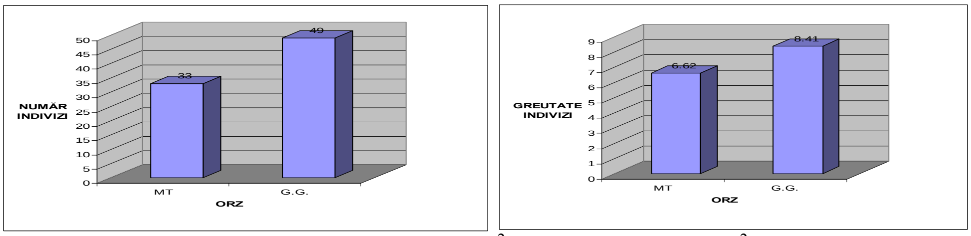

Fig. 6. Lumbricids number (individuals/m^2) and their biomass (g/m^2) in barley

In the case of mixed culture (oat+pea) fertilized with bovine manure was found that number of extracted fellows was not bigger then in grain-maize culture (51 against 49), but their biomass increased approximately with 42 % (from 6,23 g to 10,63 g). Even in the case of mixture oat + pea organically fertilized against that unfertilized (51, respectively 50 fellows), the difference of biomass is considerable, by approx. 31%, fact that shows the evident preference of lumbricids for the bovine manure (fig. 7).

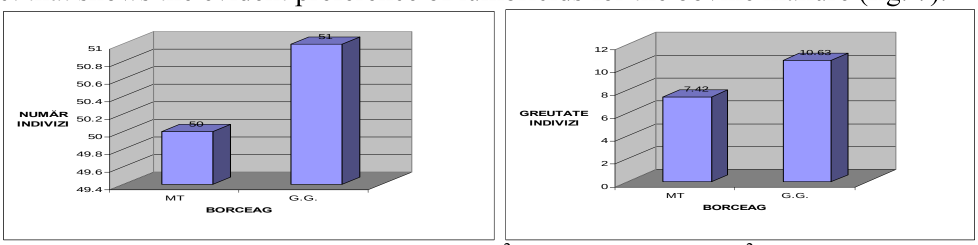

Fig. 7. Lumbricids number (individuals/m^2) and their biomass (g/m^2) in oat + pea

In the case of wheat culture, the percentage of picked fellows slightly increased. Taking into account that extraction of lumbricids was in October, so after cropping, the presence of lumbricids was favored by the vegetable remnants (straws) fallen on the soil during the cropping, which constitutes a mulch layer offering favorable microclimate for the lumbricids development (soil humidity and food assurance (fig. 8).

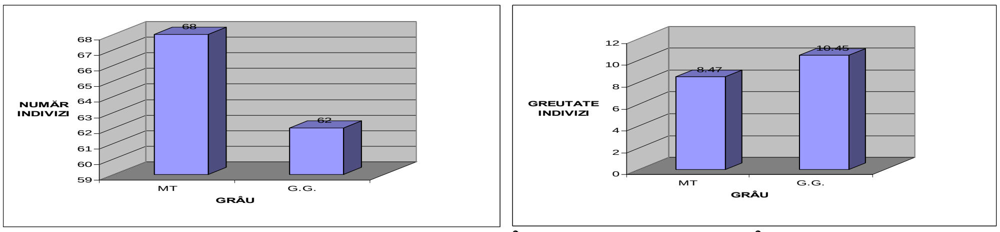

Fig. 8. Lumbricids number (individuals/m^2) and their biomass (g/m^2) in wheat

The largest number of lumbricids was found in the plot cultivated with lucerne (fig. 1 and 2). Here were picked up approx. 10 times more lumbricids than in silo-maize, 4 times more fellows than in oat + pea and 3 times more fellows than in the culture of wheat. In lucerne were extracted mature fellows, well developed, and young fellows, in different degrees of development, fact made obvious by the value of their biomass (31,57 g) which is only 3 times bigger than in the case of mixture of oat + pea.

The largest abundance of lumbricids was found in the plot cultivated with lucerne + orchard grass, respectively in lucerne (fig. 1, 2 and 3), which indicates these to be very adequate as cultures used in crop rotations, as well as in restoration of physical and chemical parameters of soil, increasing their fertility. Finally, is remarked that the lumbricids number considerable increases in no-tillage systems, and in undisturbed systems.

The variations of total porosity (%), apparent density (g/cm^3) and ramming degree on soil profile, under various plant cultures, varying with different applied treatments are shown in the table 2, respectively 3 and 4.

Table 2. **Variation of total porosity (%) in the profile under different types of plants varying with the applied treatments**

Experimental variant		7 – 12 cm	26 – 31 cm
Wheat	control area	47,1	47,6
	manure 40 t/ha	47,6	49,5
Maize	control area	46,9	46,1
	manure 40 t/ha	49,2	48,1
Oat+pea	control area	50,6	40,1
	manure 40 t/ha	51,9	49,5
Lucerne+orchard grass	control area	43,3	40,5
	manure 40 t/ha	44,7	43,9

Table 3. **Variation of apparent density (g/cm^3) in the profile under different types of plants varying with the of applied treatments**

Experimental variant		7 – 12 cm	26 – 31 cm
Wheat	control area	1,42	1,43
	manure 40 t/ha	1,41	1,38
Maize	control area	1,43	1,50

	manure 40 t/ha	1,36	1,50
Oat + pea	control area	1,33	1,63
	manure 40 t/ha	1,29	1,39
Lucerne+orchard grass	control area	1,52	1,43
	manure 40 t/ha	1,41	1,38

Table 4. **Variation of ramming degree in the profile under different types of plants varying with the of applied treatments**

Experimental variant		**7 – 12 cm**	**26 – 31 cm**
Wheat	control area	11,1	10,8
	manure 40 t/ha	10,2	7,3
Maize	control area	11,5	13,7
	manure 40 t/ha	7,2	16,1
Oat + pea	control area	12,5	24,8
	manure 40 t/ha	7,8	7,3
Lucerne+orchard grass	control area	18,3	24
	manure 40 t/ha	15,6	17,8

4. CONCLUSIONS

1. The number of lumbricids population increase in the agroecosystems which can offer big quantities of organic matter, absolutely indispensable for lumbricids surviving, because it constitute their principal food source.

2. The lumbricids number increase considerable in the no-till systems and in undisturbed systems. The fastest mean to increase the lumbricids populations is the reduction of disturbance degree of soil. This objective can be achieved by direct seeding during of many successive years, as it is possible, and/or introduction of perennial plants and/or meadows in the crop rotation.

3. The increase of lumbricids number in soils is favored by the type of culture plant. Cultures of lucerne + orchard grass, respectively lucerne are very propitious, being therefore adequate as plants cultures in crop rotations, for the rehabilitation of physical and chemical characteristics of soils, increasing their fertility degree.

REFERENCES

[1]. Baker, G. H. - *The ecology, management and benefits of earthworms in agricultural soils, with particular reference to southern Australia.* In "Earthworm Ecology", Ed. C. A. Edwards, pp. 229-57, 1998;

[2]. Edwards, C.A., P. J. Bohlen, - *Biology and Ecology of Earthworms, 3rd Edition,* Chapman & Hall Publishing House, London, 1996;

[3]. Lee, K. E. - *Earthworms and sustainable land use.* In "Earthworm Ecology & Biogeography in North America", Ed. P. F. Hendrix, pp. 215-34, Lewis Publishers: Boca Raton, FL., 1995;

[4]. Pankhurst, C.E., B.M. Doube, V.V.S.R. Gupta - *Biological Indicators of Soil Health*, CAB International, Oxon UK, 1997 Pankhurst, C.E., B.M. Doube, V.V.S.R. Gupta - Biological Indicators of Soil Health, CAB International, Oxon UK, 1997;

**[5]. *****http://www.frogwatch.ca/english/wormwatch/about/ecology.html.*

POLLUTANT RELEASE IN THE DISPOSAL OF REA-GYPSUM AND WATER FROM FLUE GAS DESULPHURISATION

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BELA MANG**

Abstract: Mátra Power Plant (Visonta) produces electrical energy from lignite. In flue gas desulphurisation – SO_2 gas neutralisation – REA-gypsum is produced. Most of it is currently not utilised but disposed of and gets into the power plant pulp reservoir in Őzse valley. The gypsum is transported to the dumping place in a pipeline for thick pulp (1:1 water-solid material ratio) together with traditional combustion by-products (slag, ECO-, Ljungström- and filter fly ashes). Research focuses on the investigation of what amount of hazardous material-pollutant gets into groundwater from the solution leaking from the pulp reservoir into the environment of the spoil area and in what concentration. The extent of the release of sulphate (SO_4^{2-}), cadmium (Cd^{2+}), lead (Pb^{2+}) and zinc (Zn^{2+}) ions was investigated through the evaluation of a 5-year observation period. The base is the **starting period** recorded in 1998 measurements. In the research, the data of water samples from three groundwater level observation wells were analysed and evaluated. Research yielded the following results:

- the REA-gypsum getting into the spoil area has not increased the sulphate (SO_4) concentration of groundwater. Groundwater sulphate ion concentration (generally 800-1,000 mg/l) usually exceeds pollution limit values (250 mg/l) but does not steadily exceed salvage limits (700-1,000 mg/l) so it does not justify salvage measures,
- cadmium (Cd) concentration does not change in time, does not increase, does not reach pollution limit values and falls far behind 0.008-0.010 mg/l salvage limits,
- lead (Pb) concentration shows considerable variation (first increase, then decrease) in time, every now and then increasing pollution limits, but the sporadic maximums (0.020; 0.031; 0.040 mg/l) are all considerably below salvage limits (0.075-0.100 mg/l) prescribed in the relevant regulations,
- compared to the 1998 status, zinc (Zn) concentration has not increased in any of the wells but has practically remained constant in the last five years, being around 0 and falling far behind pollution limit values.

Results indicate that the concentrations of sulphate and lead ions getting into groundwater from the spoil area exceed pollution limit values but are lower than salvage limits. The concentrations of cadmium and zinc ions prove that REA-gypsum may be stored in the spoil area without any further measures and without the danger of polluting the groundwater in the environment beyond permitted limits.

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The Visonta power plant of Mátra Power Plants Co. is fired with lignite produced in Visonta or Bükkábrány. The slag and fly-ash produced in combustion has for decades been disposed of in the pulp reservoir in Őzse valley. The REA-gypsum produced in flue gas desulphurisation is partially utilised. The presently unutilised amount is transported to the reservoir together with washwater, slag and fly-ashes with thick pulp technology.

During the several decades the slag and fly-ashes have been stored in the pulp reservoir, there has been no water (groundwater) pollution beyond permitted limits. Research has been targeted at analysing what kind of impact the disposal of REA-gypsum and water in the pulp reservoir has on the environment, in what concentration elements released from the pulp reservoir can be found in groundwater, whether the regulations specifying permitted concentrations of the different elements call for any protective-preventive measures and whether environmental effects/impacts require special measures or intervention.

From the power plant and the desulphuriser, slag+ashes+gypsum+washwater get to the spoil area in Őzse (Őzse valley) in the form of thick pulp.

In the research, water samples from Őzse-1, Őzse-2 and Őzse-3 groundwater level observation wells of the monitoring system were collected, analysed and then evaluated. On the basis of the evaluation, conclusions were drawn concerning the environmental impacts (groundwater quality) of the spoil area.

Őzse-3 well is located higher than the spoil area on the north side, while Őzse-1 and Őzse-2 are on a lower level in the direction of groundwater flow on the south side of the spoil area. This setup involves that elements released from the spoil area can primarily appear in the water of the southern wells. In the well on the north side, groundwater supply comes from precipitation from the direction of the Mátra mountains.

The operation license of groundwater observation wells defines background concentration (A) and verified background concentration (Ab) values according to the 1998 status. These reflected the environmental characteristics of the area on the one hand, and former pollution loads on the other. These values can thus be regarded as ‘starting level’ specifications for the dumping place in question and its environment. **Starting level** (Ab) water quality data are the following for 1998:

Table 1

	Őzse-1	**Őzse-2**	**Őzse-3**
Sulphate, SO_4^{2-} [mg/l]	1,028.32	1,336.57	164.40
Cadmium, Cd^{2+} [mg/l]	0.005	<0.002	0.006
Lead, Pb^{2+} [mg/l]	0.005	0.007	0.006
Zinc, Zn^{2+} [mg/l]	0.006	0.050	0.022

Following the installation of the power plant flue gas desulphurising system at the end of 2000, regular groundwater sampling has been carried out in the observation wells established in the neighbourhood of the spoil area since 2001. Of analysis data, research focused on the variations of sulphate (SO_4^{2-}), cadmium (Cd^{2+}), lead (Pb^{2+}) and zinc (Zn^{2+}) concentrations.

According to the relevant ministerial order, the **pollution limit values** for the 4 elements concerned are the following:

Sulphate	250 mg/l	Cadmium	0,005 mg/l
Lead	0,010 mg/l	Zinc	0,200 mg/l

Prior to the impact analysis of the dumping of REA-gypsum, it was also investigated in what amount REA-gypsum contained the elements concerned. Sulphate content of gypsum was 400 mg/l. Sulphate content of the ashes constituting the bulk of the spoil area was 2,600-5,600 mg/kg.

The amount of cadmium that could be released from REA-gypsum with water was 0.001 mg/l, with ammonium acetate solution it was 0.008 mg/l and with nitric acid it was <0.010 mg/l. The lead content of gypsum is insoluble in water, the amount released with ammonium acetate was 4.6 mg/l, with nitric acid it was 0.75 mg/l. The amount of zinc soluble with water was 0.04 mg/l, with ammonium acetate it was 0.31 mg/l and with nitric acid it was 3.00 mg/l. The latter data reveal that the release of the lead and zinc content of REA-gypsum from the spoil area primarily depends on the acidity of the spoil area or pulp.

Concentrations and their fluctuations in time are shown in the figures. They show starting levels (verified background concentration), concentration fluctuations in time and pollution limit values alike. In the interpretation of the relevant regulations, the latter are risk concentrations specified with the consideration of drinking water quality and water ecosystem demands. With these values, groundwater may be used to ‘produce’ drinking water (after certain treatment) without endangering the ecosystems of the area.

Figure 1 shows that sulphate concentration considerably varies in time with the maximum concentration value being around 1,000 mg/l. While it exceeds pollution limit values, it does not go beyond starting levels (verified background concentration). (The dumping of REA-gypsum and washwater in the area started in 2001.)

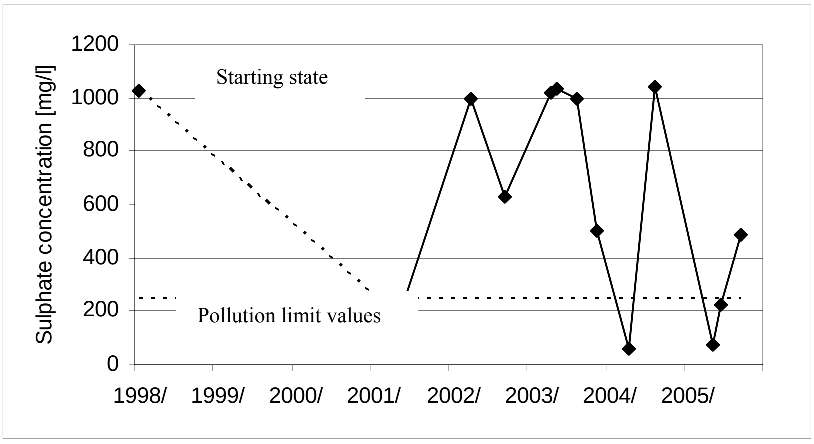

Figure 1
Sulphate concentrations, data from Őzse-1 well

Őzse-2 well (Figure 2) basically shows a similar situation. Sulphate concentration exceeds pollution limits, varies considerably in time but practically does not go beyond starting levels. The very significant fluctuations of sulphate concentration shown in Figures 1 and 2 may primarily arise from the changes in time of precipitation in the spoil area i.e. that with a higher precipitation amount groundwater (runoff) sulphate concentration is lower, too.

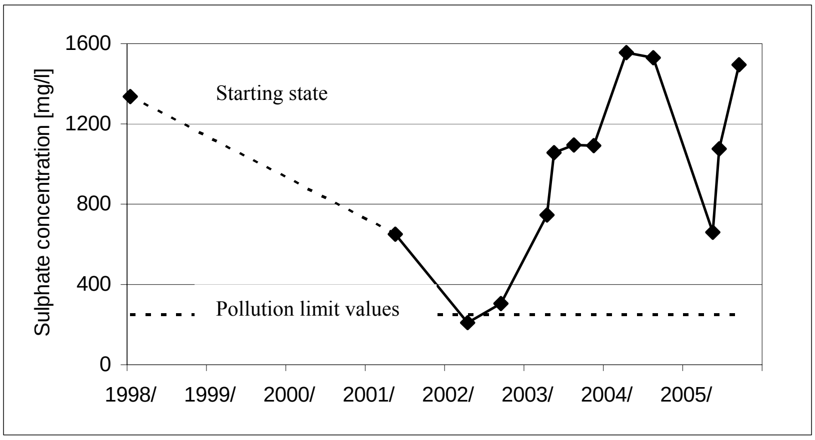

Figure 2
Sulphate concentrations, data from Őzse-2 well

Figure 3 shows fluctuations of sulphate concentration in Őzse-3 well established north of the spoil area. Both starting and actually measured concentration values fall far behind pollution limits.

The comparison of the three diagrams (Figures 1-3) reveals that no release from the spoil area affects the groundwater sulphate concentration in well 3. Obviously, the direction of groundwater flow is north-south in both the region and the spoil area environment with any release appearing in the water of the wells (1 and 2) lying south of the spoil area.

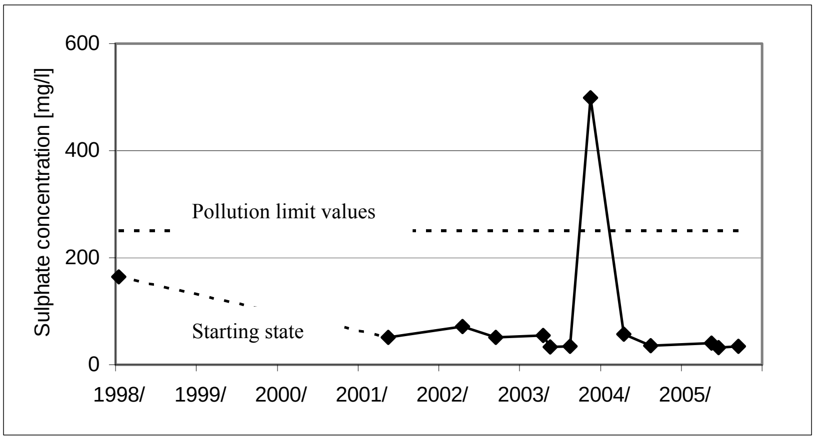

Figure 3
Sulphate concentrations, data from Őzse-3 well

Then, as regards sulphate concentration (wells 1 and 2), the question is where the SO_4^{2-} ion content comes from and whether its value is affected by the storage of REA-gypsum and washwater or not.

Data in diagrams 1 and 2 indicate that there was already a 1,000 mg/l sulphate concentration in the spoil area environment (south) prior to the disposal of gypsum and washwater there (in 1998) and neither of them has increased groundwater sulphate concentration.

In the spoil area of the power plant, sulphate has been released from the ashes getting there (slag, fly-ash) for decades. According to earlier investigations, the sulphate content (SO_4^{2-}) of the fly-ash dumped in the spoil area in Őzse valley is 2,600-5,600 mg/kg and release can only affect this. The data of investigations made between 1982-1985 concerning the analysis of groundwater samples taken from the environment of the spoil area in Őzse valley are the following:

sludge in the spoil area	SO_4^{2-} concentration 1500-6500 mg/l
waters in the pulp reservoir	SO_4^{2-} concentration 1200-1600 mg/l
waters seeping through the pulp	SO_4^{2-} concentration 1000-1600 mg/l
waters near the pulp reservoir (groundwater in observation wells)	SO_4^{2-} concentration 400-2600 mg/l
waters away from the pulp reservoir (dewatering wells for K-I. open cut)	SO_4^{2-} concentration 20-40 mg/l

On the basis of the latter data, it can be concluded that the sulphate concentration of the fly ash and pulp (water) in the spoil area and that of the groundwater seeping through the reservoir and appearing in the observation wells was higher in the period preceding the disposal of REA-gypsum and washwater than the SO_4^{2-} concentration measured after the disposal of the material (slag, fly-ashes, gypsum, washwater) transported with thick pulp technology, i.e. with a smaller amount of water, after the years 2000 and 2001. Thus the disposal of flue gas desulphurisation residues in the spoil area did not increase the sulphate content of groundwater in the neighbourhood.

Comparing the maximum sulphate concentration (1,000 mg/l) in the last five years with the 700-1,000 mg/l salvage limit (C_2, C_3) prescribed in the valid regulation, it can be concluded that the 200-1,000 mg/l sulphate concentration that has been typical in the neighbourhood of the spoil area in recent years does not call for any salvage measures. With regard to the 1982-1985 data, this is also justified by the fact that at about 1 km distance from the spoil area (water liftover in K-I mine) sulphate content was only 20-40 mg/l in groundwater (layer water).

Naturally, it is another question that sulphate solubility in seepage does not really make it possible to have SO_4^{2-} concentrations above 900-1,000 mg/l. This, of course, involves that sulphate content in the water seeping from the spoil area (not in the spoil area pulp) cannot really exceed salvage limit values (700-1,000 mg/l).

In the analysis of the environmental impacts of the material stored in the spoil area, it is also necessary to investigate the extent of heavy metal ion release. In the research, release concentration values of cadmium, lead and zinc have been investigated.

Figures 4, 5 and 6 show the fluctuation in time of cadmium (Cd^{2+}) concentrations in groundwater. Figures show the starting values (1998 verified background concentrations) and pollution limit values. In all the three sampling places, cadmium ion concentrations in groundwater remain below pollution limit values and there are only three peak values in comparison to the 1998 starting state (Figure 5). Basically, cadmium ion concentrations are the same in all the three wells so it can safely be assumed that practically there is no release from the spoil area.

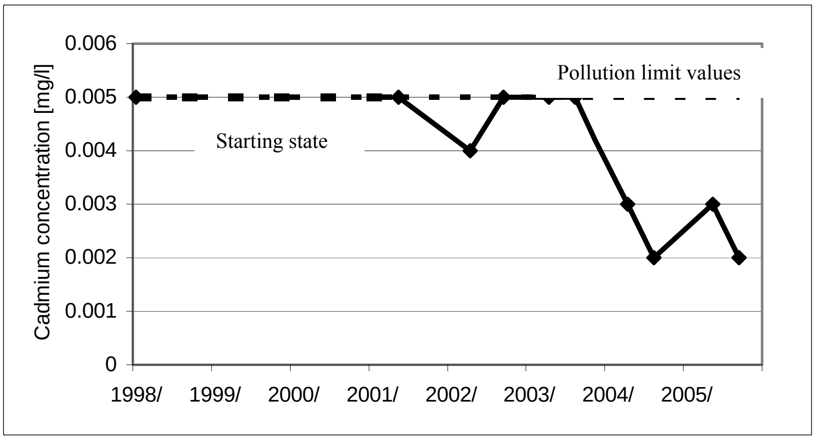

Figure 4
Cadmium concentrations, data from Őzse-1 well

According to the 1984 data, no cadmium was detected in fly-ashes from Visonta power plant. According to the data between 1982-1985, Cd^{2+} concentration was below 0.0002 mg/l in pulp reservoir sludge while it was 0.0002-0.0006 mg/l in pulp reservoir water and lower than 0.0002 mg/l in the water seeping through the pulp and in the remote wells.

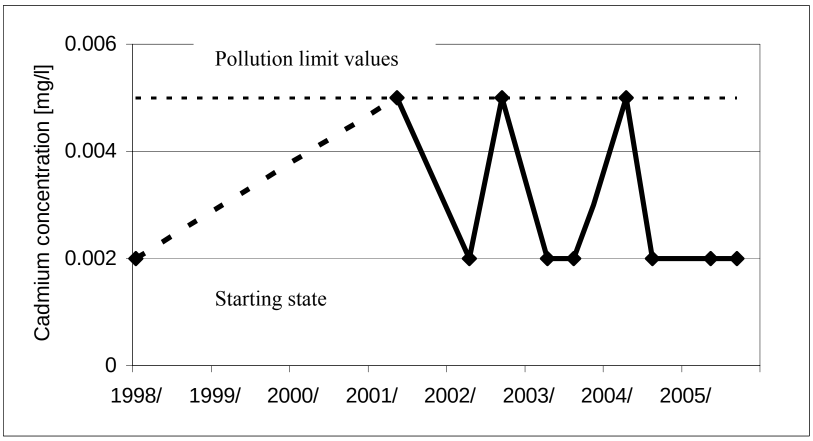

Figure 5
Cadmium concentrations, data from Őzse-2 well

Data analysis indicates that in the spoil area and in its environment there is no change in time in cadmium ion concentrations, it does not increase, does not approach pollution limits and falls far below 0.008-0.010 salvage limit values. The disposal of REA-gypsum and washwater in the spoil area has caused no change in Cd^{2+} concentrations in either the spoil area or its environment.

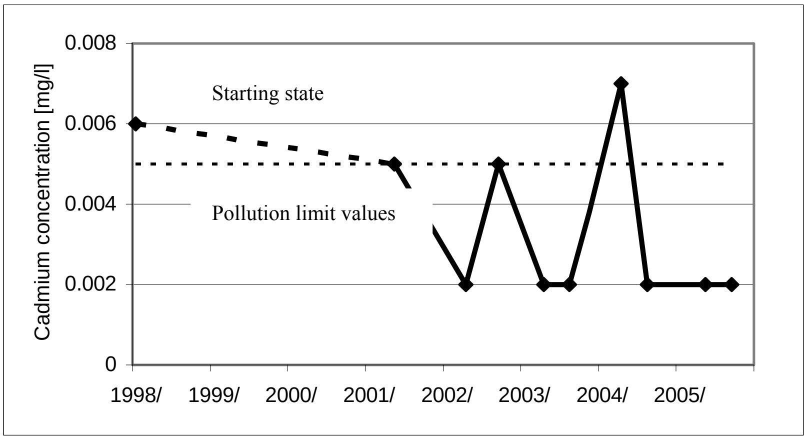

Figure 6
Cadmium concentrations, data from Őzse-3 well

As cadmium content was zero according to the analysis of power plant fly-ashes and the same Cd^{2+} concentrations were measured on the north (in the direction of the Mátra mountains) and south sides of the spoil area, it can be assumed that the appearance of cadmium ions is related to mineralization and wash-out in the Mátra.

The fluctuation in time of lead concentrations between 2001 and 2005 is shown in Figures 7, 8 and 9.

Figures 7 and 8 (Őzse-1 and Őzse-2 wells) show that lead ion concentrations have increased in the last three years exceeding 1998 starting values and, according to several measurements, pollution limit values, as well. In the well on the north side of the spoil area, lead concentration is practically stable, it does not exceed starting values and remains below pollution limit values. The fact that in the groundwater wells 1 and 2 there is higher lead concentration than on the higher side of the spoil area (well 3) seems to prove that there is lead ion release from spoil area material.

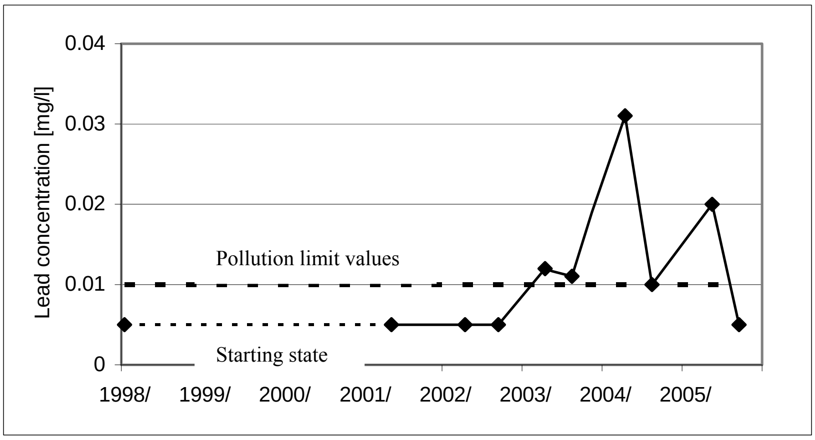

Figure 7
Lead concentrations, data from Őzse-1 well

The possibility of lead release is also confirmed by the fact that the 1984 analysis detected 0.5 mg/kg lead content in power plant fly-ash while the 1985 fly-ash analysis in the pulp reservoir detected a similar lead content (0.5 mg/l). At the same time, no lead pollution was detected in pulp area water, in the water seeping through the pulp or in groundwater wells near or far from the pulp reservoir in the 1982-1985 analyses.

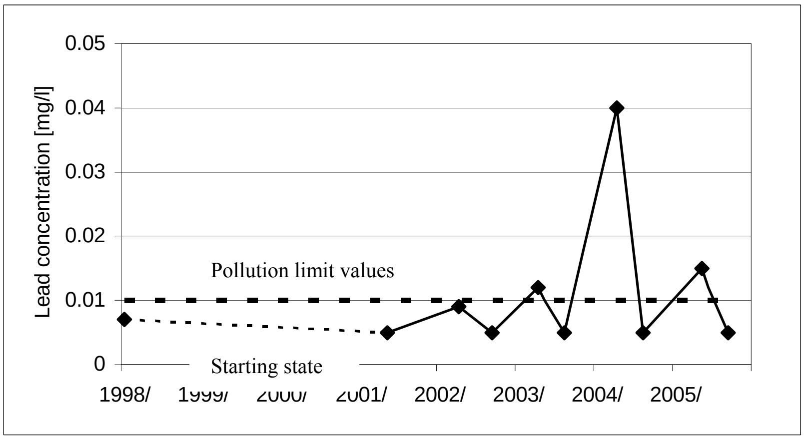

Figure 8
Lead concentrations, data from Őzse-2 well

In recent years, maximum lead ion concentrations measured in wells 1 and 2 were considerably lower (0.020; 0.031 and 0.040 mg/l) than the operational limits prescribed in the regulations, thus calling for no salvage measures.

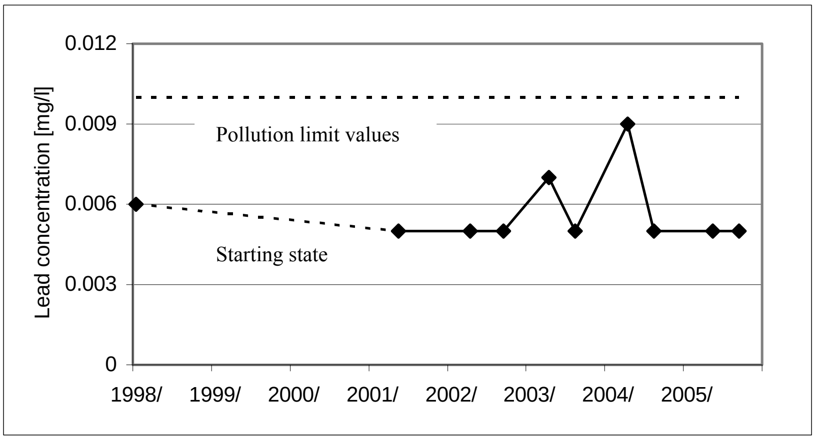

Figure 9
Lead concentrations, data from Őzse-3 well

The appearance of lead may probably be accounted for by mineralisation and perhaps by acid rains in the Mátra (although flue gas purification precisely aims at the exclusion of the possibility of acid rains).

The research has also extended to the investigation of the fluctuation of zinc concentrations. Figures indicate that Zn^{2+} concentrations have not increased in any of the wells in comparison to the 1998 starting values, they have practically been stagnating in the last five years, falling far behind the pollution limit values, practically being around zero.

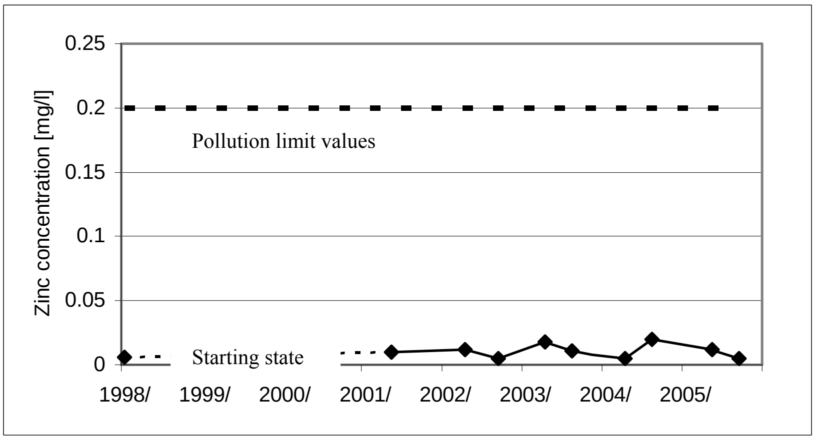

Figure 10
Zinc concentrations, data from Őzse-1 well

Earlier investigations found no zinc content in power plant fly-ash and measured 0.010-0.060 mg/l zinc concentration in the pulp dumped, in pulp reservoir water and in the waters seeping through the pulp, which was evidently caused by some kind of emergency in the life of the well (or its material).

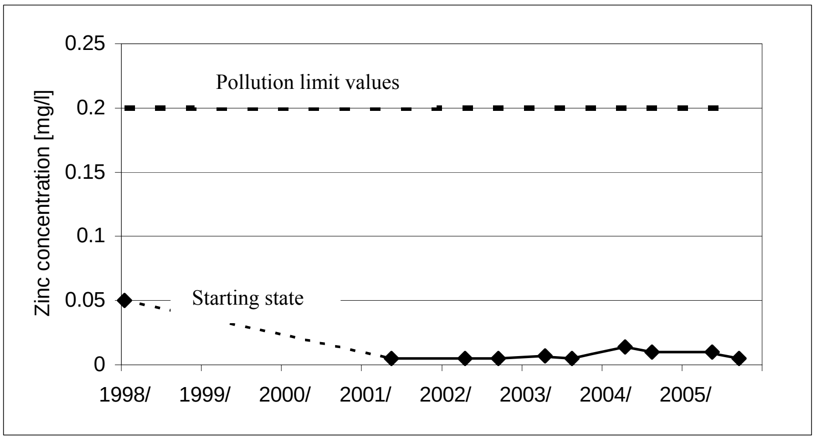

Figure 11
Zinc concentrations, data from Őzse-2 well

In the evaluation of water sample data from groundwater observation wells in the environment of the Őzse valley spoil area in Mátra Power Plant Co, it has been investigated what extent of release (what concentrations) can be detected in spoil area environment after the disposal of residues from flue gas desulphurisation in the lignite-fired power plant (REA-gypsum and washwater).

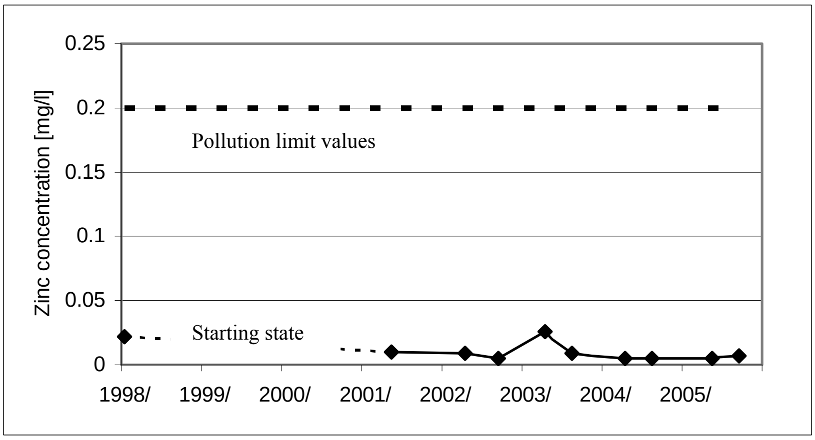

Figure 12
Zinc concentrations, data from Őzse-3 well

Since the 1980s, there has been continuous disposal of power plant slag and fly-ashes in the Őzse-valley reservoir, earlier with thin pulp, more recently with thick pulp transportation technology. Research has concentrated on the analysis of measurement data of recent years with special regard to the fact that flue gas desulphurisation (involving the formation of REA-gypsum and water) started at the end of 2000.

In the research, sample data from three groundwater wells have been evaluated. Őzse-3 well can be found on the northern side of the spoil area, on the opposite side from the waterflow in the spoil area environment. Thus, in theory no material release can occur from the spoil area into this well. Őzse-1 and Őzse-2 wells can be found on the southern side, which means that elements released from the spoil area will surely appear in their water.

In the research, the time series of water sample data from three groundwater observation wells have been analysed, taking into consideration 1998 starting values, pollution limit values prescribed in the regulation concerned and the prescribed salvage limit values.

The investigation has led to the conclusion that the REA-gypsum and water dumped in the spoil area did not increase the sulphate (SO_4^{2-}) concentration of groundwater. The sulphate concentration of groundwater, which is generally 800-1,000 mg/l, exceeds pollution limits (250 mg/l) but does not permanently go beyond salvage limit values (700-1,000 mg/l) so there is no need for taking special salvage measures.

The analysis of groundwater cadmium concentrations in the environment of the spoil area gave the result that Cd^{2+} concentration stagnates in time, it does not increase and does not reach pollution limit values, falling far behind 0.008-0.010 mg/l salvage limit values. The disposal of REA-gypsum and water in the spoil area did not change Cd^{2+} concentrations in the environment.

In the water sample data from Őzse-1 and Őzse-2 wells located south of the spoil area, lead concentrations showed a significant change (rise, then fall) in the period 2002-2005, to some extent they increased periodically exceeding pollution limits but even the maximum values (0.020, 0.031 and 0.040 mg/l), which occurred relatively rarely (altogether three times), were considerably below operational limit values (0.075-0.100 mg/l) as prescribed in the relevant regulation. In the northern Őzse-3 well, Pb^{2+} concentrations did not reach pollution limit values.

Compared with the 1998 state, zinc concentrations have not increased in any of the wells but have practically stagnated in the last 5 years being around zero and falling far behind pollution limits.

To sum up the results, it can be concluded that in the disposal of REA-gypsum and water in a slag-fly-ash spoil area, the concentrations of sulphate and lead ions released from the spoil area into groundwater in the neighbourhood exceed pollution limits but are lower than operational limit values (C_2, C_3).

Cadmium and zinc ion concentrations testify that REA-gypsum and water can be permanently (finally?) stored in a fly-ash spoil area without the danger of polluting groundwater in the environment beyond limits.

REFERENCES

[1] Joint order No. 10/2000. (VI.2.) *KöM-EüM-FVM-KHVM on limit values for the quality protection of groundwater and geological medium*.

[2] Order No. H-2886-27/1998. of the North Hungarian Water Management *Directorate: water law operation license of the water quality monitoring system of Őzse-valley pulp reservoir of Mátra Power Plant Co* (11 June, 1998)

[3] Imre SZABÓ (Gy. FILEP, B. KOVÁCS, J. LAKATOS, T. MADARÁSZ, I. SZABÓ), *Szennyezett területek kármentesítése***.** ['Salvage of polluted areas'] Miskolc University Press, 2002.

DUSTING INVESTIGATION OF DEPOSITED SLAG-SCALE-REA GYPSUM MATERIALS

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BÉLA MANG,**
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Abstract: The Visonta power station of Mátra Power Plants is fired with lignite from Visonta and Bükkábrány as fuel. Besides the traditional residues of coal-firing (slag, ECO-, Ljungström and filter fly-ashes), the REA-gypsum produced in flue gas desulphurisation is also dumped in the pulp reservoir in Őzse valley with thick pulp technology. The objective of the research is to investigate what extent of dusting out occurs after dewatering and drying, and how the disposal of gypsum in the dumping place changes the extent of dusting out. The research performed at the Department of Mining and Geotechnology gave the following results:

- according to the individual investigation of traditional combustion by-products, at an airspeed of 6-12 m/sec, 0.1-6.5% of slag and filter fly-ashes, 0.8-49% of ECO fly-ashes and 10-85% of Ljungström fly-ashes are carried away.
- at an air-speed of 6-21.5 m/sec, 0.4-5.4% of the sample of the spoil area material compacted after the dumping (mixing) of REA-gypsum is carried away. The respective values for the rough fraction of the ground sample are 0.3-9.2% at an air-speed of 6-12 m/sec and 0.6-14% for the fine fraction at the same air-speed.
- at an air-speed of 8-12 m/sec, 50-60% of the 'slag-fly-ash mixture' is carried off, while the spoil area material (surface) formed after the dumping (mixing) shows a 10-14% dusting out.
- it can be concluded that the dumping and storing of REA-gypsum in the spoil area together with combustion residues (slag, fly-ashes) considerably reduce dusting out in the pulp reservoir surface (to about one fifth).

The Visonta power station of Mátra Power Plants is fired with lignite from Visonta and Bükkábrány as fuel.

Flue gases and solid residues are also formed in combustion. In the operation of the flue gas desulphuriser, REA-gypsum and water are formed. The solid grains falling down gravitationally from the combustion area is **slag, fly-ashes** detach themselves on the ECO and Ljungström air heaters, and **filter fly-ashes** can be

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separated electrically from flue gas flow.

In the operation of the flue gas desulphuriser, REA-gypsum is formed.

Slag, ECO- and Ljungström fly-ashes get to the fly-ash tank in the transportation pipeline by washing away with water while filter fly-ashes get there in the fluidisation pipeline. These combustion products get to the pulp reservoir in the form of homogeneous thick pulp (1:1 solid:water ratio) in a pipeline after precipitation, partial dewatering and mixing with dry fly-ashes. In the flue gas desulphuriser opened in 2000, the REA-gypsum ($CaSO_4$) formed after the binding of sulphur dioxide (SO_2) gets to the Őzse valley pulp reservoir together with solid combustion products.

The main research objective is to investigate what extent of dusting out occurs after the solidification of power plant combustion products in the pulp reservoir and to what extent the material detached from the surface is a burden for the pulp reservoir environment. Naturally, the current objective is to investigate how and to what extent the getting into the spoil area of REA-gypsum formed in flue gas desulphurisation influences the dusting out of the materials stored there.

The pulp that gets into the reservoir loses the great majority of the water which acts as transporting medium: water seeps away and mixes with groundwater, residual water evaporates from pulp surface due to atmospheric influences (sunshine, wind) and the pulp gets solidified. From the surface of the dried sludge, grains are removed due to the effect of airflow and other factors. There are three characteristic types of their movement: rolling, bouncing and floating. The primary cause of these three types of removal is the erosion (deflation) caused by airflow (wind). However, for investigation purposes the three movement types cannot be distinguished from one another. While floating is characteristic of smaller grains, rolling and bouncing are typical of the larger ones. As they collide, rougher grains are broken up and the smaller grains that are formed this way are already capable of floating. In this complex process, removal (rolling, bouncing) and dusting out (floating) appear together.

Research investigations were performed in the laboratory of the Department of Mining and Geotechnology of Miskolc University. For it, pulp reservoir sample materials were provided by Mátra Power Plants Co.

The ventillator of the test air tunnel provided adjustable air-speed as the airflow got to the sample tray placed in front of the pipe through a flow regulator. The extent of dusting out was calculated from the amounts of material on the tray weighed before and after blow-in. Measurements done at the different air speeds lasted three minutes each.

DUSTING OUT OF SLAG AND FLY-ASH COMBUSTION PRODUCTS

As the first step of investigations, the extent of the dusting out of traditional solid combustion products was specified individually. Figure 1 shows the slag, ECO fly-ash, Ljungström fly-ash and electrofilter fly-ash placed on the sample tray. With electrofilter fly-ashes, measurements were also done in the way that the surface of the material was grooved and the fly-ash was mixed into a gravel bed of 0-2 mm grain size.

slag, ECO fly-ash, Ljungström fly-ash, filter fly-ash

Figure 1. By-products of Visonta power plant

During the measurements, the side of the sample tray square with the airflow was open, the sample materials were from a location where there is no pipeline transportation yet so there could have been no breakage characteristic of pipeline handling. During pipeline transportation, breakage occurred primarily with slag because slag is of relatively low thickness, it consists of hollow, porous grains and the light particles are surrounded by a jacket of small grains solidified like glass. Initially, the pieces of slag have an amorphous shape like tentacles therefore they are considerably rough and cling to one another. This condition prevents their movement in flowing air. For this reason, there is relatively little removal of slag material in this breakage-free state.

Experiments testify that similarly to slag, the removal of electrofilter fly-ash is also low. Filter fly-ash is the finest combustion product, where the extent of removal is low because the fine grains attach to one another well.

Measurement results are shown in Figure 2.

The adherence of the fine grains of filter fly-ash remains even if the surface of the material on the tray is broken and grooved although during the mechanical breakage of the surface, adherence decreases. If rough material of 0-2 mm grain size is mixed into the filter fly-ash, the extent of removal will be lower. At 12 m/s airspeed, it decreases from 6.13% to 1.24% as the adherence of fine grains remain but the extent of removal is decreased by the sheltering effect of rough grains.

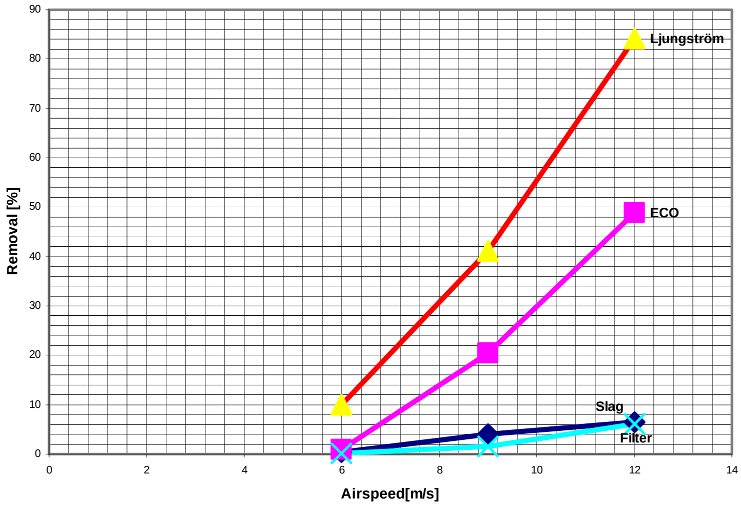


Figure 2. Removal of solid combustion products at different airspeed values

DUSTING OUT IN MATERIAL MIXED WITH REA-GYPSUM

In the spoil area, the mixture of slag, fly-ash and gypsum dumped there as thick pulp gets compact and solidified due to sedimentation (dewatering) and natural drying. As the CaO+MgO content of slag and fly-ash materials from Visonta, which determines their hydraulic characteristics, is relatively low, the strength of the solidified spoil area material is relatively low, as well. The strength of the samples cut out from the in situ material hardened in the spoil area is low; the material breaks easily during working. During sampling, slices were cut out of the compacted material, during which a considerable amount of fine fraction came into being, too. The changes in surface conditions during the testing of samples taken from the compact material are shown in Figure 3.

original sample above 6 m/s airspeed above 9 m/s airspeed

above 12 m/s airspeed above 21.5 m/s airspeed

Figure 3. Gradual removal by increasing the airspeed

The investigation of dusting out revealed that the material has a stratified, laminated structure due to the disposal method, the settlement during dumping. Under the effect of airflow, the sheets get detached and the thinner, lighter parts may be carried away, too. The airflow blows the fine fraction out from the bigger lumps.

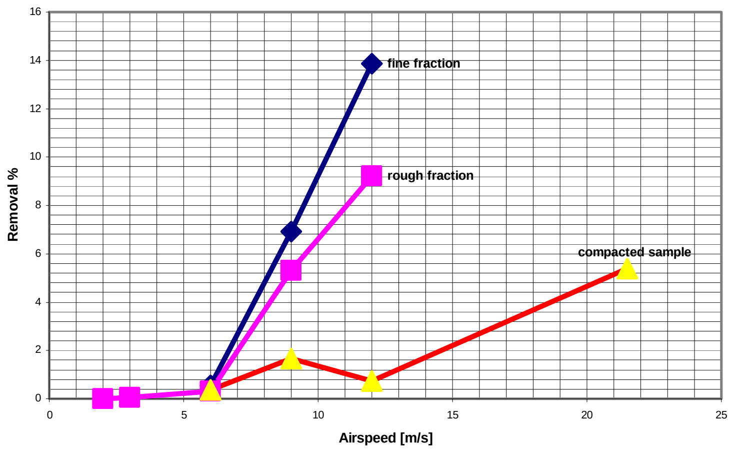


Figure 4. Dusting out values of pulp reservoir samples

A separate measurement was done with the pulp crumbled during sampling. After the drying, it could be seen that the material can be divided into two sets with different characteristics. In one of them, there is more slag (the ‘rough’ sample was taken from it), the other one is finer and this gave the ‘fine’ sample. At first, measurements were done with lower (2-3 m/s) airspeed but there was considerable removal only at 6 m/s.

Figure 4 shows values of removal (dusting out). The data reveal that if the surface of the stored material is broken by different environmental impacts (strong wind, the movement of different animals, traffic) influencing the solidified material on the surface of the spoil area, the extent of dusting out may increase considerably.

For the sake of the specification of the possible decreasing effect of gypsum mixing on dusting out, the respective data of the pulp produced with solid combustion residues (slag and fly-ashes) were also specified. The sample was produced artificially because the spoil area surface of the period before the year 2000 is no longer accessible. In the sample the mass rate of the different materials (slag + 3 kinds of fly-ashes) was the same as earlier in the spoil area material.

DUSTING OUT IN MIXED SAMPLES

The diagram in Figure 5 shows that the dusting out of samples without gypsum has its maximum (50-60%) at 9-10 m/s airspeed. The dusting out value at 9-10 m/s airspeed in Figure 5 is roughly identical with the weighed average of the dusting out values given in Figure 2.

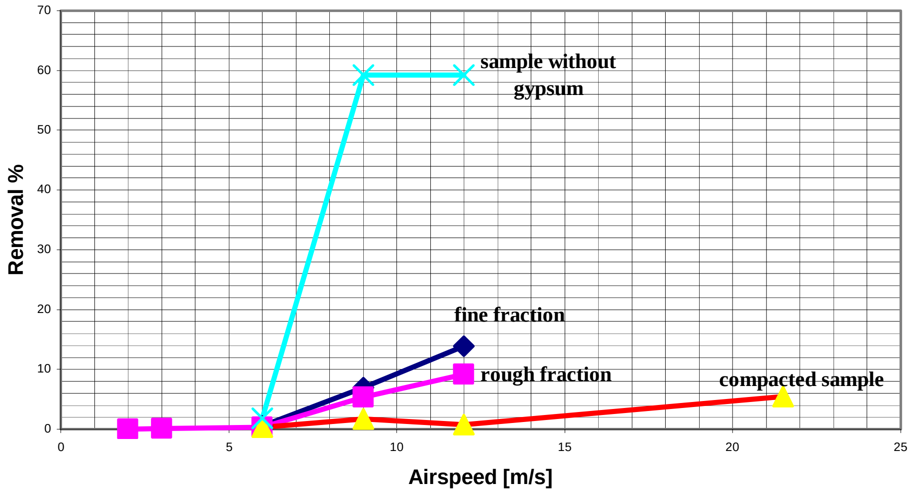


Figure 5. Dusting out values as the function of airspeed

The comparison of the dusting out values in Figures 2, 4 and 5 leads to the conclusion that the dusting out characteristics of the material without gypsum (the maximum values of 50-60% in Figure 5 and the maximum values of 40-80% in Figure 2) considerably exceed the maximum 10-14% values of samples with REA-gypsum in Figure 4.

To sum up, it can be concluded that the **disposal (dumping) of REA-gypsum together with combustion residues considerably (to one fifth) decreases the dusting out factor of the spoil area surface.**

REFERENCES

[1] DOVRTEL, G., *Észak-magyarországi lignitek elégetéséből származó salakpernyék további felhasználását, deponálását megalapozó vizsgálatok.* ('Investigations supporting the further utilisation and dumping of slag fly-ashes from the combustion of North Hungarian lignites'), PhD thesis, Visonta, 2002. 105 p.

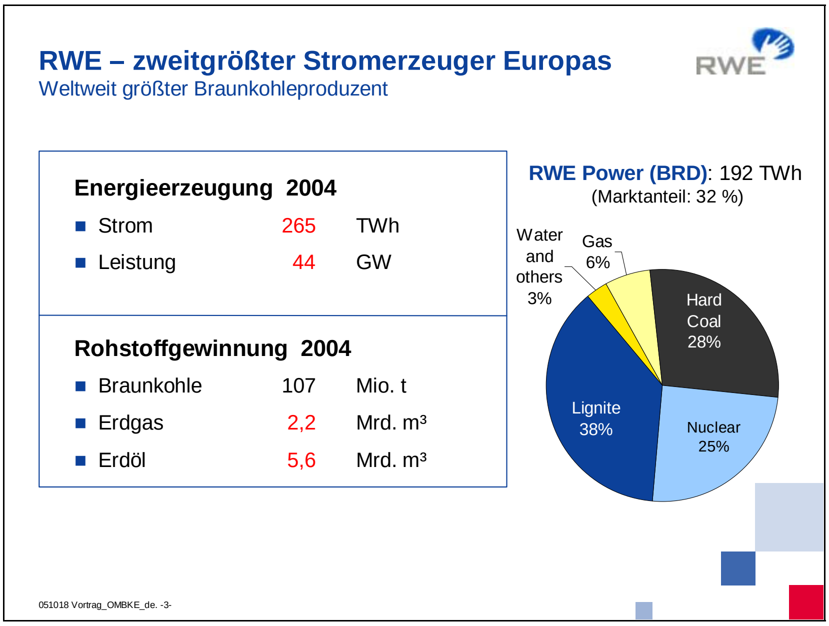
BRAUNKOHLENBERGBAU IM RHEINLAND

MARKUS KOSMA*

EINLEITUNG: Braunkohle ist in Deutschland ein in ausreichendem Maße verfügbarer Energieträger, der ohne Subventionen wettbewerbsfähig ist. Auch als Folge des anstehenden, kontinuierlichen Ausstieges aus der Kernenergie erwächst für die verbleibenden Energieträger - und da besonders auch für die heimische Energiequelle Braunkohle - eine besondere Verpflichtung zur Sicherung der Energieversorgung der deutschen Industrie und Privatwirtschaft. Dies gilt umso mehr, als sich die weltweiten Erdöl- und Erdgasreserven auf politisch und wirtschaftlich wenig stabile Regionen konzentrieren.

Durch stabile Stromverbrauchsprognosen für Deutschland sind mittel- und langfristig gute Perspektiven für die Braunkohlenutzung in Deutschland gegeben. Die aktuelle CO_2-Gesetzgebung schafft in Deutschland zumindest mittelfristig verlässliche Rahmenbedingungen.

Mit der RWE Power AG sind die Gewinnung von Energierohstoffen und die Erzeugung von Strom für Kontinentaleuropa innerhalb des Konzerns der RWE AG zusammengefasst (Bild 1).



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* *Mitglied des Vorstandes der Mátra Kraftwerk AG*

RWE Power ist mit 32% Markanteil einer der führenden Stromanbieter in Deutschland. Dabei stützt sich die RWE Power AG in ihrer Stromerzeugung auf eine breite Palette von Energieträgern: Braunkohle und Kernenergie werden in der Grundlast, Steinkohle und Gas sowie regenerative Energien vorwiegend in der Mittel- und der Spitzenlast eingesetzt. Die Braunkohle ist hierbei eine tragende Säule im Energieerzeugungsportfolio der RWE Power AG. Der Hauptanteil der rheinischen Braunkohleförderung von 90% wird zur Erzeugung in den RWE Power eigenen Braunkohlekraftwerken eingesetzt.

Diese decken mit einer jährlichen Stromerzeugung von rd. 73 TWh netto mehr als 50% des Stromverbrauchs im Bundesland Nord-Rheinwestfahlen bzw. 15% des Stromverbrauches in der gesamten Bundesrepublik Deutschland.

Neben der Nutzung der Braunkohle zur Stromerzeugung wird diese zu rund 10% in den eigenen Veredlungsbetrieben Frechen, Fortuna-Nord und Wille/Bernrath zu festen Brennstoffen in Form von Briketts und Staub, sowie Produkten für den Umweltschutz (Braunkohlekoks) weiterverarbeitet.

Speziell für diese Veredlungsprodukte bestehen aufgrund der hohen Weltmarktpreise für Öl und Steinkohle positive Marktperspektiven.

AUSRICHTUNG DER TAGEBAUE DER RWE POWER AG

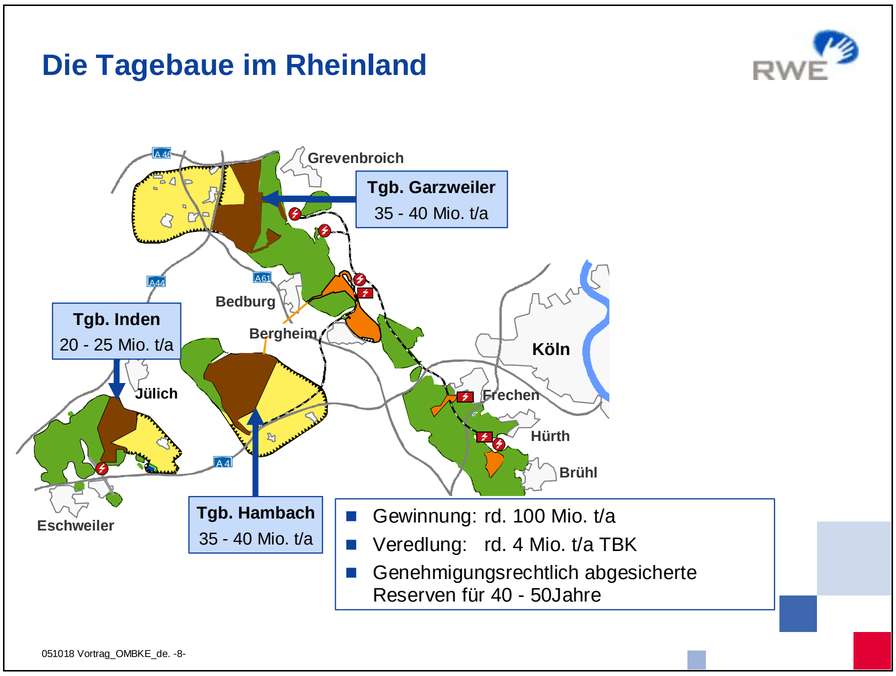
In den drei großen Tagebaubetrieben Hambach, Garzweiler und Inden werden jährlich rd. 100 Mt. Braukohle gewonnen (Bild 2). Diese drei Tagebaue bilden auch langfristig die notwendige Versorgungsbasis für die Kraftwerke und Veredlungsbetriebe von RWE Power. Die in den Tagebaubereichen genehmigungsrechtlich abgesicherten Kohlevorräte betragen fast 4 Mrd. Tonnen. Das entspricht einer Versorgungsreichweite von 40-50 Jahren für den bestehenden, wie für den geplanten Kraftwerkspark und die Veredlung.

Die Kohleförderung fällt zu ca. 20-25 Mt. auf den Tagebau Inden und das zugehörigen Kraftwerk Weißweiler. Die übrige Förderung wird zu etwa gleichen Teilen, d.h. je 35-40 Mt. in den Tagebauen Garzweiler und Hambach gewonnen. Diese Kohle wird über das werkseigene Einsenbahnnetz den Kraftwerken Neurath, Frimmersdorf, Niederaußen und Goldenbergwerk, sowie den Veredlungsbetrieben zugeführt.

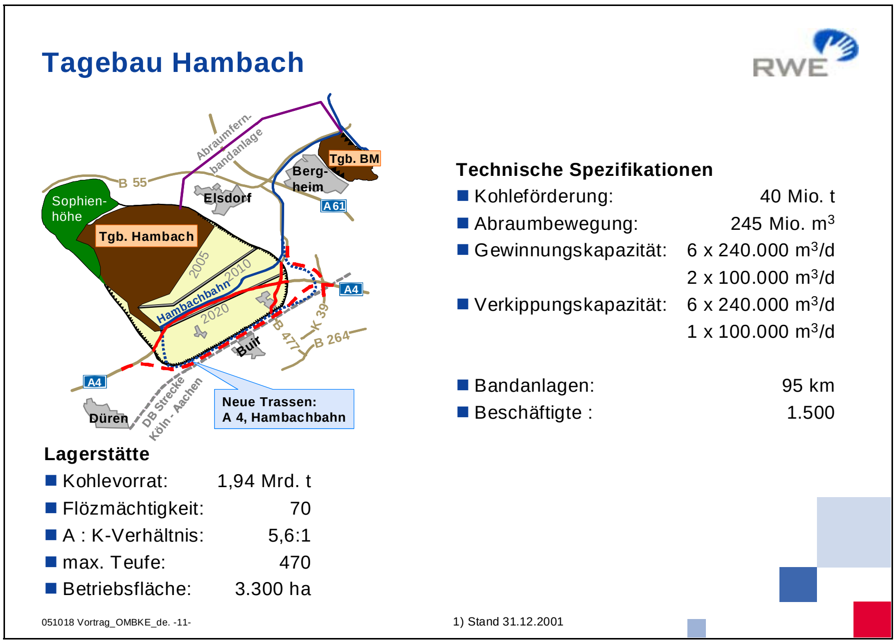
Um am Markt zukünftig sicher bestehen zu können, ist für die Stromerzeugung aus Braunkohle im Rheinland eine kostengünstige und umweltverträgliche Ausrichtung der Kraftwerke und Verendlungebetriebe erforderlich. Gleichermaßen sind hierfür durch die Tagebaue langfristig günstige und im Einklang mit der Umwelt gewonnene Brennstoffe bereitzustellen.

TAGEBAUTECHNIK FÜR DIE BRAUNKOHLEGEWINNUNG IM RHEINLAND

Die Braunkohlegewinnung im Rheinland stellt aufgrund der Dimensionen (Teufe, Massenbewegung, Landinanspruchnahme) heute und zukünftig weltweit einmalige Anforderungen an die Fördertechnik und an ihre Instandhaltung.



Der Tagebau Hambach mit einem ursprünglichen Lagerstätteninhalt von 2,5 Mrd. t eignet sich in besonderer Maße dazu, Leistungsfähigkeit und Entwicklungsstand der Tagebautechnik im rheinischen Revier darzustellen (Bild 3).



Für den Tagebau Hambach mussten neue und leistungsfähigere Geräte und Anlagen entwickelt und gebaut werden. Dabei entstanden die Schaufelradbagger mit

Tagesleistungen bis 240.000 m³/d. Mit der bis dato in den anderen Tagebauen eingesetzten Gewinnungs- und Fördertechnik wäre der Aufschluss bei einem vergleichsweise ungünstigen Abraum/Kohle-Verhältnis von 6,2:1 technisch kaum anders möglich und wirtschaftlich nicht realisierbar gewesen.

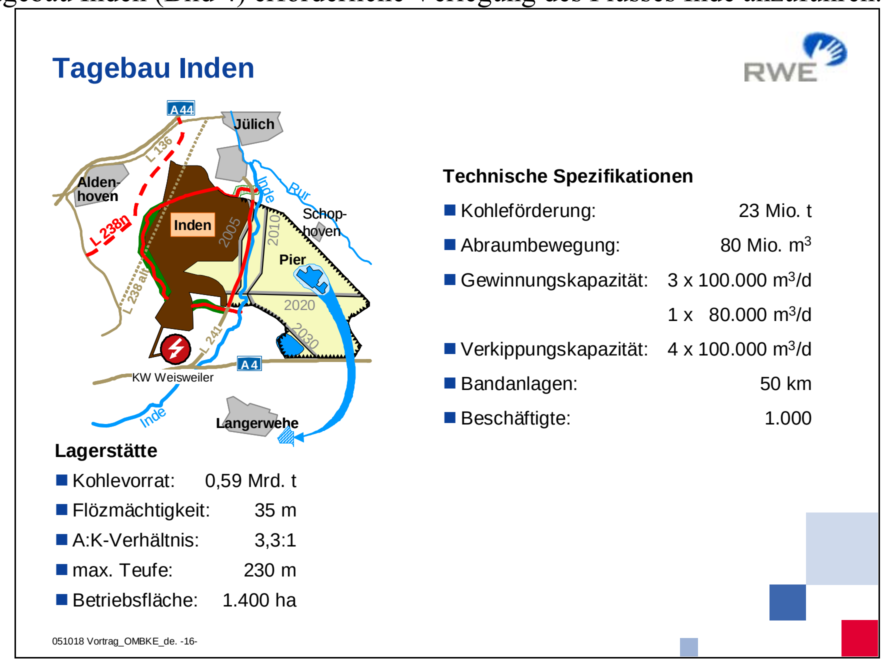
Aktuell sind im rheinischen Braunkohlenrevier 18 große Schaufelradbagger in Betrieb. Das älteste noch laufende Gerät ist der Bagger 255 im Tagebau Inden, ein Gerät mit einer Tagesleistung von 100.000 m³+t/Tag, der 1955 in Betrieb genommen wurde. Abnehmerseitig sind in den Tagebauen 20 Absetzer und weitere 26 Bunkergeräte und Zugbeladeanlagen in Betrieb.

Die Tagebaue im rheinischen Revier und speziell der 1978 aufgeschlossene Betrieb Hambach verfügen über eine weltweit einmalige technische Ausstattung. Diese weitgehend aus eigens initiierten Entwicklungen hervorgegangene und auf Basis jahrelanger Betriebserfahrung gereifte Technik, macht den Tagebau Hambach mit einer Jahresförderung von rd. 40 Mio. t Braunkohle - und der Bewegung von 245 Mio. m³ Abraum pro Jahr, auch heute noch zu einem der leistungsfähigsten Lockergesteinstagebaue der Welt.

ÖKOLOGIE UND UMWELTSCHUTZ

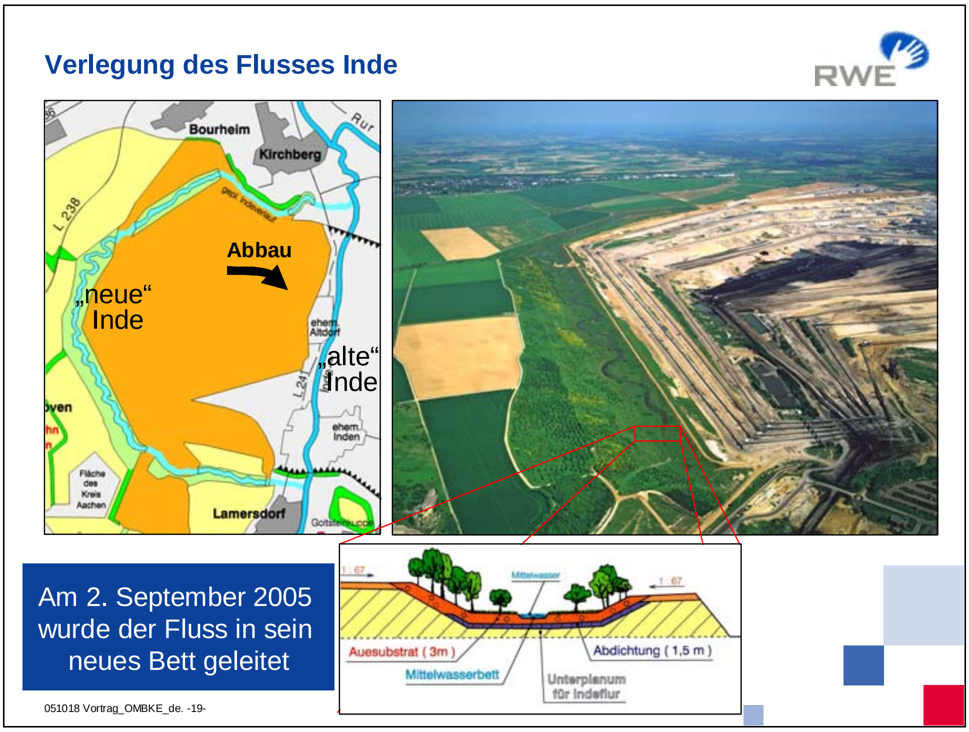
Tagebaue nehmen als offene, ortsveränderliche und flächenintensive Betriebsstätten fortwährend Landschaft in Anspruch. Einen Ausgleich dazu schafft die dem Tagebau direkt folgende Wiedernutzbarmachung durch land- oder fortswirtschaftliche Rekultivierung. Der jährliche Zuwachs entspricht dabei ungefähr der Landinanspruchnahme durch die Tagebauentwicklung.

Als ein herausragendes Beispiel für zeitgemäße Wiedernutzbarmachung ist die im Tagebau Inden (Bild 4) erforderliche Verlegung des Flusses Inde anzuführen.



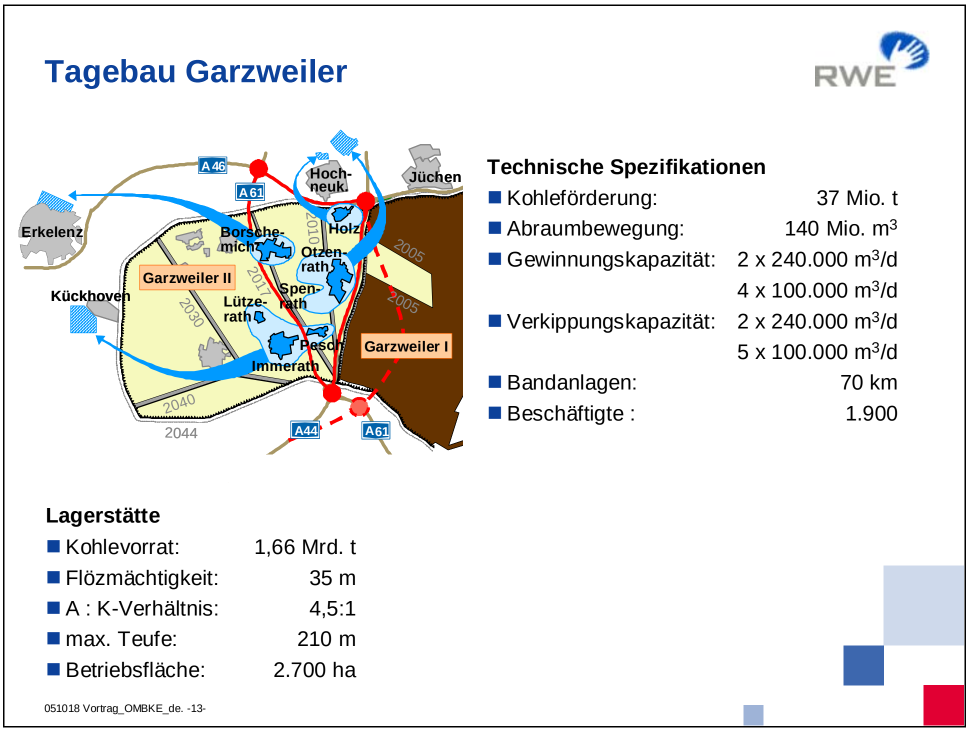
Das Abbaufeld des Tagebaus Inden wird heute auf 4,5 km Länge von der begradigten Inde durchzogen. Ende 2005 wird das alte Flussbett der Inde bergbaulich in Anspruch genommen (Bild 5). Die seit September 2005 fließende „neue“ Inde wird nördlich der Ortschaft Lamarsdorf in einem ca. 12 km langen Bogen, weitestgehend auf rekultiviertem Gelände westlich um den Tagebau geführt. Die mit dem Tagebaufortschritt zwangsläufig erforderliche Verlegung des Flusslaufes wurde genutzt, um dem Fluß eine ökologische Aufwertung zukommen zu lassen. Neben der reinen Verbesserung für Flora und Fauna entstand auch ein wertvolles, heute sehr gut angenommenes Naherholungsgebiet für die Bevölkerung.

Auch die Ausgleichsverfahren für die Eingriffe in den natürlichen Grundwasserhaushalt stellen ein gutes Beispiel für die ökologische Verträglichkeit der Braunkohlengewinnung im Rheinland dar. Da die Wasserhebung des Tagebaus Garzweiler negative Auswirkungen auf die Feuchtgebiete im Nordraum des Tagebaufeldes zu Folge hat, wurden entsprechend umfangreiche Kompensationsmaßnahmen durchgeführt. So wird ein wesentlicher Teil der in den Tagebauen gehobenen Wassermenge von insgesamt etwa 550 Mio. m³/Jahr dem Ökosystem wieder zugeführt.



SOZIALE VERANTWORTUNG

Eine erfolgreiche Gestaltung der Zukunft bedingt ein gutes nachbarschaftliches Verhältnis zwischen Braukohlegewinnung und den umliegenden Gemeinden. Insbesondere gilt dies für die sozialverträgliche Durchführung von Umsiedlungen. In den kommenden 10 Jahren wird dies zu einer besondere Herausforderung für die rheinische Braunkohlegewinnung. So ist durch die Fortführung des Tagebaus Garzweiler (Bild 5) rd. 5000 Menschen eine neue Heimat zu geben.



Um die Einwohner zur Wahrung ihrer Interessen aktiv in die Umsiedlung einzubinden, bedarf es eines großen zeitlichen und planerischen Vorlaufs von ca. 10-15 Jahren. Neben ökonomischen und sozialen Aspekten sind in dieser Phase auch individuelle emotionale Belange zu berücksichtige. Ohne eine Betrachtung dieser, wäre eine langfristige Akzeptanz der unternehmerischen Aktivitäten von RWE Power im Rheinland nicht gegeben. Neben der Berücksichtigung der Belange der direkt im Tagebauvorfeld lebenden und unmittelbar von der Umsiedlung betroffenen Menschen, besteht eine große soziale Verpflichtung gegenüber den sich im Umfeld befindenden Gemeinden. Neben umfangreichen Maßnahmen zum Schutz der angrenzenden ortschaften vor Lärm.- und Staubbelästigungen aus den tagebauen werden beispielsweise auch gemeinsam mit den Kommunen Gewerbegebiete zur Industrieansiedlung entwickelt. So werden aktiv Arbeitsplätze und Wirtschaftskraft in den Gebieten der Bergbaufolgelandschaften erhalten

ZUSAMMENFASSUNG UND AUSBLICK

RWE Power hat mit der Förderung und Nutzung von Braunkohle die Herausforderungen eines dynamischen Versorgungsmarktes in Deutschland angenommen. Der rheinische Braunkohlenbergbau sieht sich technologisch und wirtschaftlich gut positioniert, um mit der Braunkohle heute - und in Zukunft, einen gleichermaßen verlässlichen und wettbewerbsfähigen Energieträger anbieten zu können.

LITERATUR

[1]. Dr. D. Gärtner - *Stand der Tagebautechnik im Rheinischen Braunkohlenrevier*; bergbau 7/2005.

[2]. Dr. L Kulik - Die Rheinische Braunkohle auf ihrem Weg in die Zukunft; bergbau 4/2005.

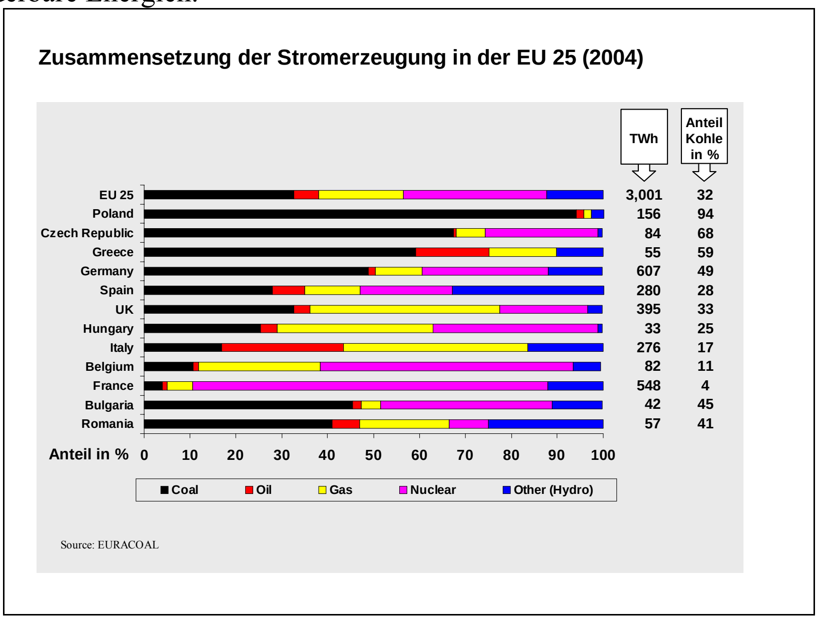
STELLUNG UND HERAUSFORDERUNG DER EUROPÄISCHEN KOHLEINDUSTRIE

MARKUS KOSMA*

Kohle ist ein wichtiger Energieträger für Europa: Im Jahr 2004 beliefen sich die europäischen Steinkohleförderung und -importe auf über 400 Mio. t. Die Braunkohlengewinnung lag bei rd. 600 Mio. t. Damit ist Europa nach China und den USA die drittgrößte Kohleverbrauchsregion der Welt.

Kohle ist preiswert, reichlich verfügbar, kann problemlos gelagert werden und auch beim Transport gibt es kein Risiko. Kohle wird dabei überwiegend in der Verstromung eingesetzt und bildet zusammen mit Kernenergie und großer Wasserkraft eine sichere und ausgewogene Basis für die Stromerzeugung innerhalb der EU.

Kohle ist in der Europäischen Gemeinschaft unverzichtbar, wobei die Bedeutung der Kohle für die Stromerzeugung durch die Erweiterung der Europäischen Gemeinschaft deutlich an Bedeutung zugenommen hat. In den 25 Staaten der EU (EU-25) lag die Brutto Stromerzeugung 2004 bei über 3.000 TWh. (Abbildung 1). Davon entfielen jeweils $^1/_3$ auf Kohle und Kernenergie, 18 % auf Erdgas, 5 % auf Öl und 12 % auf erneuerbare Energien.



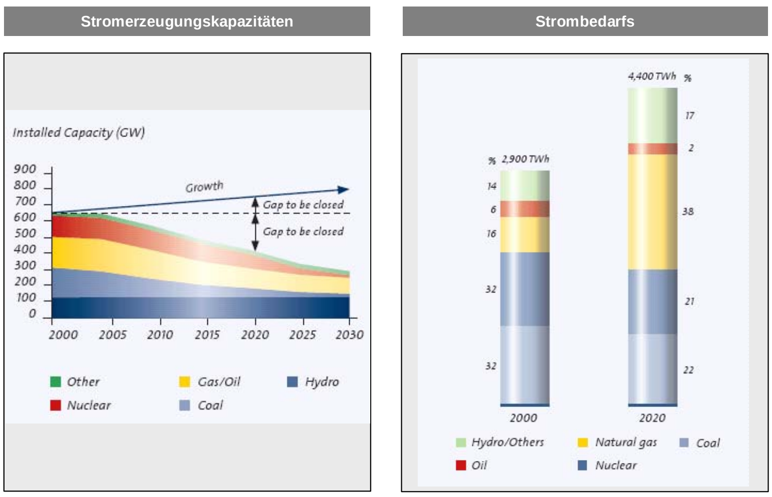
** Mitglied des Vorstandes der Mátra Kraftwerk AG*

Die EU hat bei einer Kraftwerkskapazität von fast 700.000 MW einen Anteil von knapp ¼ am weltweiten Stromverbrauch. Die Anteile der einzelnen Energieträger an der Stromerzeugung weisen in den 25 Mitgliedstaaten erhebliche Bandbreiten auf:

Sie reichen z.B. bei der Kohle von 1% in Lettland bis zu 90% in Polen, beim Erdgas von 1% in Estland bis nahezu 60% in den Niederlanden. Neben ihren weiteren Einsatzbereichen in der Stahl- und Grundstoffindustrie wird die Kohle auch zukünftig eine bedeutende Rolle für eine wettbewerbsfähige, umweltverträgliche und sichere Stromerzeugung in der europäischen Union einnehmen. Die Kohle steht dabei jedoch auch vor großen Herausforderungen die im folgenden kurz aufgezeigt werden sollen.

In der EU-25 müssen aus Altersgründen bis 2020 rd. 200.000 MW Kraftwerksleistung ersetzt und aufgrund des im gleichen Zeitraum um rd. 50% steigernden Strombedarfs weitere 100.000 MW zusätzlich installiert werden (Abbildung 2). Allein für die EU wird der Bedarf an Investitionen in Kraftwerke und Netze für die nächsten 25 Jahre auf rd. 900 Mrd € veranschlagt. Diese Summen lassen sich an den Kapitalmärkten nur mobilisieren, wenn die Rahmenbedingungen den Investoren die notwendige Rendite und Planungssicherheit einräumen. Dazu sind ein marktwirtschaftlicher Rechtsrahmen und ein regulatorisches Umfeld erforderlich, das den Wettbewerb begünstigt und den Unternehmen die notwendigen Marktpreissignale sowie Anreize für ihre Investitionsentscheidungen liefert.

Prognose der Stromerzeugung und des –bedarfs in der EU-25



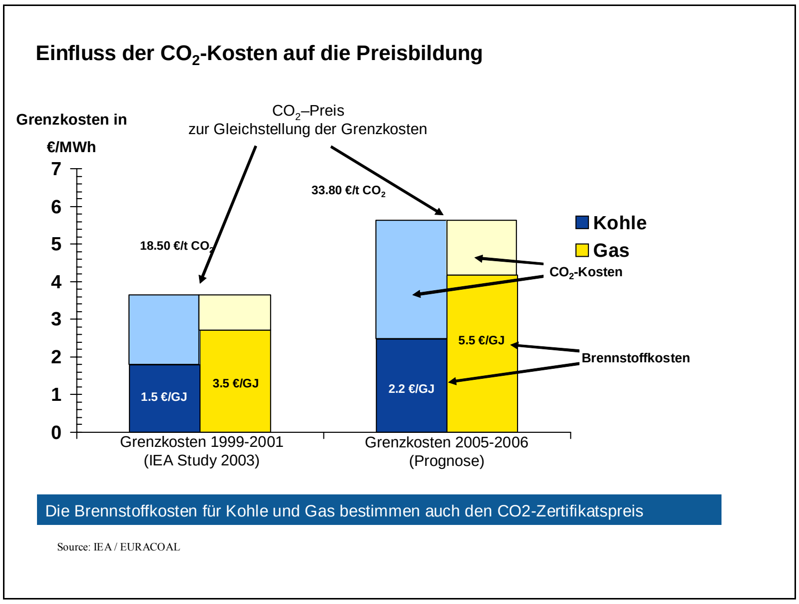
Source: EURACOAL

Es ist ersichtlich, dass trotz eines absolut und relativ zunehmenden Anteils der Kohlenwasserstoffe und Regenerativen in der Stromerzeugung, die Kohleverstromung weiterhin als tragende Säule erforderlich sein wird. In einer langfristig orientierten Energiepolitik müssen daher die Optionen für Kohle offen gehalten werden. Dies gilt insbesondere vor dem Hintergrund der bereits heute bestehenden und zukünftig noch wachsenden hohen Abhängigkeit der EU von Öl-/ Gasimporten aus politisch instabilen Förderländern.

Neben der Versorgungssicherheit sind bei der Wahl möglicher Technologien auch die Randbedingungen des Klimaschutzes und der wirtschaftlichen Bereitstellung von Strom zu berücksichtigen.

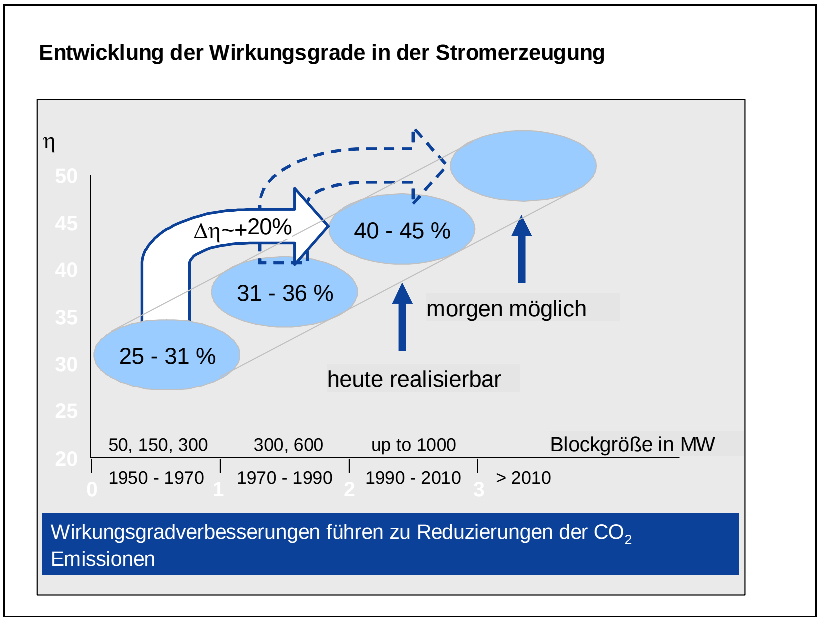
Die EU hat sich verpflichtet, die Emissionen der 6 Kyoto-Gase im Zeitraum von 1990 bis 2008/12 um 6 % zu senken. Angesichts des bisher erreichten Standes (rd. -2 %) scheint dieses Ziel verfehlt zu werden. Daher setzt die EU auf den Emissionshandel. Die entsprechende Richtlichtlinie ist im Oktober 2003 in Kraft getreten und der europaweite Handel mit CO_2-Zertifikaten hat in 2005 begonnen.

Durch die CO_2-Kosten ist es zu einer Änderung der Reihfolge der verschiedenen Energieträger auf der Industriekostenkurve gekommen. So werden je nach Höhe des Zertifikatspreises der Zuteilungsmethode wie der Wettbewerbsverhältnisse die Reihenfolge zwischen Kohle, Gas und Kernenergie verändert. Unter Berücksichtigung der Tatsache, dass bei der Stromerzeugung etwa doppelt so viel CO_2 emittiert wird wie aus Gas, beeinflusst der CO_2-Preis die Stromerzeugungskosten von Kohlekraftwerken in besonderem Maße. Vor dem Beginn des Emissionshandels wurden die Zertifikatspreise mit rd. 5-10 €/t CO_2 prognostiziert. Tatsächlich haben sich mittlerweile Preise von über 20 €/t CO_2 eingestellt. Eine Erklärung hierfür ist in der Entwicklung der Gaspreise zu suchen, da nunmehr die Brennstoffkosten zuzüglich des Marktwertes der dafür benötigten Zertifikate den Wettbewerb zwischen den Energieträgern bestimmen (Abbildung 3). Mit steigenden Gaspreisen nimmt somit auch die Rentabilität der Stromerzeugung aus emissionsintensiveren Kohleanlagen zu. Dies führt zu einer erhöhten Nachfrage an CO_2-Zertifikaten und damit zu ansteigenden Zertifikatspreisen – insbesondere da durch Kürzungen der Allokationspläne u.a. Polens und Tschechiens der Markt bewusst politisch verknappt wurde.



Dies zeigt, dass der Emissionshandel dabei für alle Marktteilnehmer tief greifende Auswirkung hat und bei vernünftiger Ausgestaltung die ökonomischen Anreize zur ökologischen Erneuerung der Stromerzeugung liefert.

Der Neubau von Kohlekraftwerken ist dabei ein kosteneffizienter Weg zur CO_2-Minderung. Moderne Kohlekraftwerke erreichen Wirkungsgrade von mehr als 40%. Dieser Wert ist um rd. 20 % höher als in Kraftwerken, die in den 50er und 60er Jahren errichtet wurden und jetzt ersetzt werden müssen (Abbildung 4).



Geringere Emissionen von Staub, Schwefel und NOX sind damit genauso verbunden, wie deutlich niedrigere CO_2-Emissionen. Und selbst wenn tiefe Einschnitte in CO_2-Emissionen erforderlich sind, können fossile Brennstoffe zur Lösung beitragen. Dieser langfristige Ansatz kann durch Erläuterung der „Clean Coal-Technologie„ illustriert werden.

Die Vision des CO_2-freien, fossil gefeuerten Kraftwerkes verspricht noch weitergehende Minderungspotentiale. Anders als bei der Primärmaßnahme der Effizientsteigerung in der Kraftwerkstechnik handelt es sich bei der CO_2-Abtrennung und bei der CO_2-Lagerung jedoch um Sekundär-Maßnahmen. Der notwendige zusätzliche Aufwand hierfür ist nach dem heutigen Kenntnisstand enorm. Gegenüber der effizientesten heute verfügbaren Technik

– erhöhen sich die spezifischen Kapitalkosten eines Kraftwerkes um etwa einen Faktor 2,

– steigen die Stromerzeugungskosten um 80-150%,

– steigt der Ressourcenverbrauch aufgrund der Wirkungsgradeinbußen um bis zum 1/3.

Die CO_2-Vermeidungskosten für die CO_2-Abtrennung und –Lagerung werden derzeit auf ca. 40-70 €/t CO_2 geschätzt. Ziel von Forschung und Entwicklung ist es, diese Kosten zu senken. Neben der Wirtschaftlichkeit wird jedoch auch die Akzeptanz in der Gesellschaft eine Rolle spielen. Dies betrifft sowohl den deutlich erhöhten Ressourcenverbrauch für die Stromerzeugung, als auch die langzeitsichere Speicherung von CO_2 in Aquiferen und alten Öl- und Gaslagerstätten.

Bis zur breiten kommerziellen Einsatzfähigkeit der CO_2-freien Kraftwerkstechnik frühesten ca. 2020 ist daher in erster Linie auf den Weg Effizientsteigerung in der Stromerzeugung und damit auch CO_2-arme Kraftwerke zu setzen. Die Entwicklung neuer kommerzieller einsatzfähiger Kraftwerkstechnik erfordert hohe Aufwendungen. Angesichts der engen Märkte ist eine geeignete Forschungsförderung unverzichtbar. Sie sollte ideologiefrei alle Option - insbesondere auch Entwicklung zur Effizientsteigerung wegen ihres hohen Potentials einer nachhaltigen Klimavorsorge - berücksichtigen.

In zahlreichen F&E-Projekten arbeiten Betreiber, Hersteller und Universitäten zusammen, um sowohl weitere Wirkungsgradsteigerungen insbesondere durch Erhöhung der Dampfparameter – Druck und Temperatur – zu ermöglichen als auch die CO_2-Abscheidungs- und Vermeidungstechnologien und somit die Vision des CO_2-freie Kraftwerkes zu einer realistischen Langfristoptionen zu machen.

Als Fazit ist somit festzustellen, dass der primäre Energieträger Kohle auch weiterhin eine entscheidende Position bei der wirtschaftlichen, umweltfreundlichen und sicheren Energieversorgung Europas einnehmen wird. Neue, leistungsfähige Technologien im Kraftwerksbereich und die Potenziale zur weiteren Verbesserung der Energieeffizienz sind gute Voraussetzung, dass sich die Kohle in einem offenen europäischen Markt bewähren kann.

QUELLEN

[1]. EURACOAL: *Coal industry across Europe 2005*, September 2005.

[2]. Dr. Dietrich Böcker: - *Die aktuellen Herausforderungen für die europäische Kohleindustrie*, World of Surface Mining, Februar 2004.

[3]. RWE Power: - *Power: perspektiven 2005 Innovation zur Klimavorsorge in der fossil gefeuerten Kraftwerkstechnik*, RWE Power AG, März 2005.

THE WORKINGS OF CLOSING AND ECOLOGYSATION OF MINING OBJECTIFS - POTENTIAL SOURCES OF POLLUTION OF SURFACE WATERS

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Abstract: Most of the mining objectives in Romania were submitted to the „Closing and Ecologyzation Program". This study refers to an unpleasant aspect of these workings, respectively to the potential sources of pollution of surface waters. There have been studied many mining factories from Caras-Severin, at which the workings of closing and ecologyzation have been started or they have already finished. To the basis, there were performed chemical and physical analyses which were done towards the drawn specimens of mining waters, respectively from the sections of surface receptors. There were drawn up graphics which reflect the fluctuation of the value concentration of chemical and physical indicators in the late 15 years and point out some surprising rises of some of these indicators during the proper period of closing, respectively post-closing.

Keywords: mines, closing workings, pollution, ecologysation.

1. INTRODUCTION

In the 90s, in Romania the mining activity has known a huge decline and the exploitations have suddenly become unprofitable and have set in keeping/ preserving. Thus, at the top-level it has started/ begun a big project of "Closing and Ecologyzation of mining objectives".

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The aim of this project is not just a simple decontamination of the exploitations, but also it shows the importance of ecological reconstructions of them, in order to achieve “the good state of waters”, in order to reconstruct/recover the degraded ecosystems, which are incapable to regenerate themselves into a new association biotope- biocenosis because of the existing polluters.

Mining factories from Caras-Severin followed the same way. They were took over/assumed by the Ministry of Trade and of Finance, The General Board of Mineral Resources, respectively The Mining and Social Reconversion/, which on the base of obtained notifications from the Ministry/ Board of Environment, they elaborate the technical projects of closing the mining objectives. The execution of these workings its then entrusted through public sale/open tendering to the skilful firms. The physical and chemical features of mine waters, which are discharged in the emissary/outlet, are monitorised another two years after finishing the workings of closing. It is very important to grant this period of guarantee as may appear unforeseen situations.

This study precisely points out these problems that may appear, transforming a positive activity into a potential source of polluting the surface waters.

2. MATERIAL AND METHODS

At the basis of this study were the analyses made in SGA Laboratory of Caras-Severin over the water samples which were drawn from many dischargers of mining exploitations in our county. These analyses were made depending on the objective, once a month, once a quarter or once a half-year, and finally there were achieved annual averages. There were worked out graphics which allow the monitorising of the late 15 years fluctuations of the concentration value of some physical and chemical indicators, such as slurries, Cu, Zn.

3. RESULTS AND DISCUSSIONS

In most of the cases, the graphics` flexions register surprising increase or, at least stagnations in the years in which were performed workings of closing and ecologyzation or in the post-closing period. The time in which there are not registered these anomalies, varies from some couple of months to tens of years, depending on the specific features of each exploitation.

During the workings of closing, respectively in the post-closing period, the water seep process continues and also continues the modification of its make-up, a process which is influenced by new type of factors.

The stowage/stowing of winding shafts and implicitly of these „jomp”, who were functioning as „ clarifying tank” , pumping the water from one horizon to another one, finally to its discharging at surface, has been replaced by a gravitational conduction of mine waters towards a unique evacuation. This process has determined an important rise of slurries concentration in discharged mine waters. The most representative graphics are those concerning Varad and Florimunda sectors (IM Moldova Noua) or the Ursoane and Danila sectors (IM Bocsa), where are registered high slurries values during the period of closing workings (2001,2000, 2002, 2002).

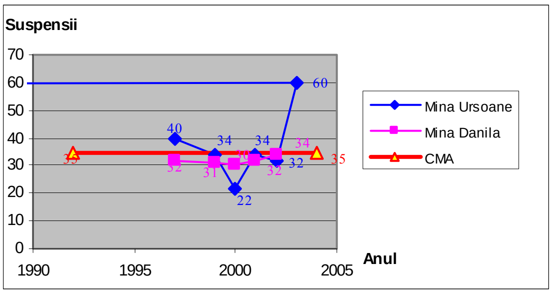

Fig. 1. The concentration variation of slurries in the discharged used waters from I.M. Bocsa exploitation

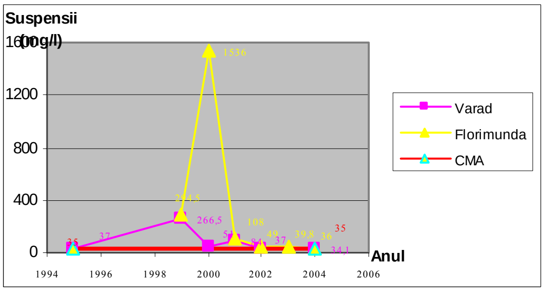

Fig. 2. The concentration variation of slurries in the discharged used waters at SC Moldomin SA Moldova Nouă

A diminution of pH of mine waters, respectively of their sourness, involves a rise of hard metals' solubility. The flooding of the Ocna de Fier – Dognecea (IM Bocsa) deposit has determined the oxidation of metallic sulphide till the sulphuric acid, respectively a diminution of pH and a rise of Cu and Zn concentration in mine waters which are discharged through the Ursoane and Danila gallery.

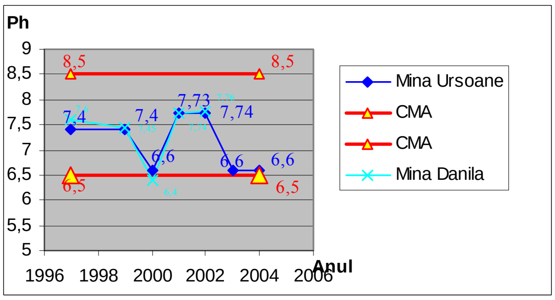

Fig.3. The concentration variation of pH in the discharged used waters from I.M. Bocsa exploitation

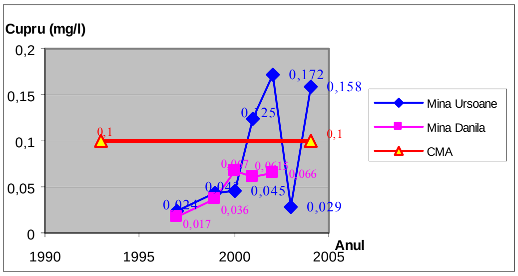

Fig. 4. - The concentration variation of Cu in the discharged used waters from I.M. Bocsa

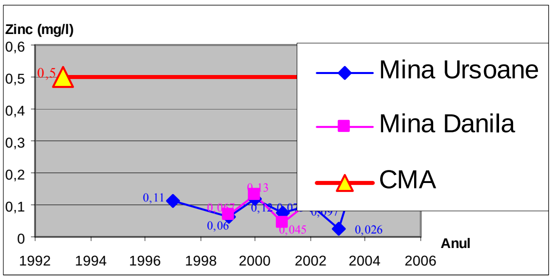

Fig. 5. - The concentration variation of Zn in the discharged used waters from I.M. Bocsa

The flooding of these deposits has, as an effect, the ore lenses washing, which were unexploited, thus, determining rises of Cu, Zn concentrations. This phenomenon was remarked at Florimunda and Varad mines during the post-closing period**.**

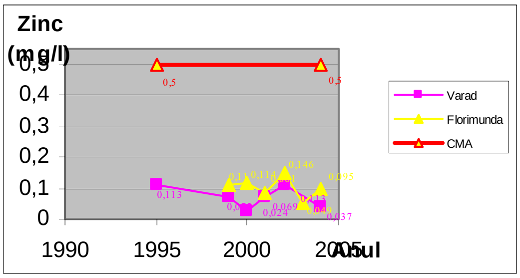

Fig. 6. - The concentration variation of Zn in the discharged used waters at SC Moldomin SA

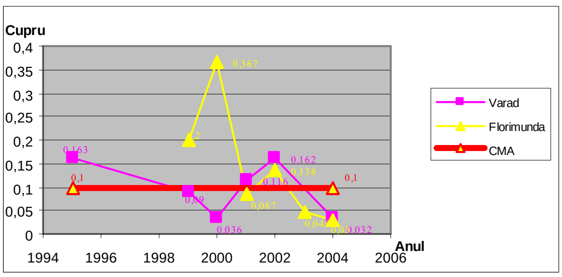

Fig. 7. - The concentration variation of Cu in the discharged used waters at SC Moldomin SA

In Sasca (2001) it is mentioned an important feature of the area where the pH of discharged mine waters has a light basicitiness. This is possible because of the deposit embedding into storage of physical and chemical metamorphosed limestone and which functions as a buffer for acid waters. Thus, it is explainable why the rises of hard metals concentrations are not spectacular, in conditions in which the reaction sulphuric metals- water takes place.

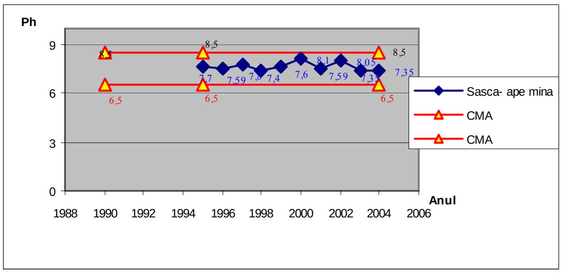

Fig. 8. - The concentration variation of Ph in the discharged used waters from Sasca Montana

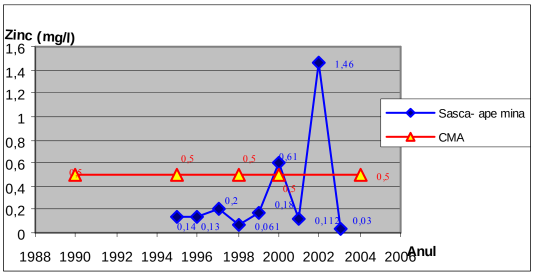

Fig. 9.- The concentration variation of Zn in the discharged used waters from Sasca Montana

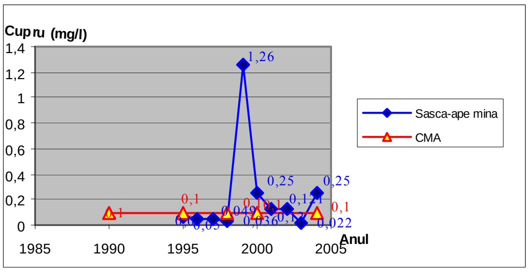

Fig. 10. - The concentration variation of Cu in the discharged used waters from Sasca Montana

Although there are registering some rises of some indicators concentrations, it is remarkable that these concentrations are in C.M.A. limits.

Referring to the Lupac Mine, close to the expiration of the guarantee period (febr.2006) there were registered high acid water exfiltrations, with a pH which has decreased to 3.5-4. These waters affected the river bed in which the mine waters were discharged (the margins have got a strong reddish shade) and also the underground water, the water from neighboring wells has become acid.

4. CONCLUSIONS:

1. The workings of closing and ecologyzation of mine areas are necessary, but it has to analyze very good the variants in order to choose the best solution, which has a minimum impact on the environment and implicitly on the surface waters.
2. There is a period which coincides with the workings of closing, when takes place an important rise of concentrations value of physical and chemical indicators (hard metals, slurries), and after it follows a period of stabilization. The length of this period differs from deposit to deposit, depending on the relation with the hydrographic basin, depending on the chosen variant of closing and on quality of closing.

REFERENCES:

[1]. Ionel I.- *„ Dispersarea noxelor: teorie şi aplicaţii”,* Timişoara, Ed. Politehnică, 2000;

[2]. Lăzărescu I. - *„ Problema reziduurilor din industria extractivă miniera”,* Revista Minelor nr. 9/73, Bucureşti;

[3]. Lăzărescu I. - *„Protecţia mediului înconjurător şi industria minieră*”, Ed Scrisul Românesc, Craiova, 1983;

[4]. Oncia S.- *„ Construcţii şi instalaţii de epurare ”,* Ed. Orizonturi Universitare, Timişoara, 2001;

[5]. Traistă E., Ciocan V.- *„ Tratamentul apelor reziduale ”,* Ed. Universitas, Petroşani, 2000;

[6]. ****Documentaţie pentru lucrări de închidere şi ecologizare - mina Lupac;*

[7]. ****Lucrări de închidere şi reconstrucţie ecologică pentru perimetrul minier Florimunda, Ogaşul Grecilor;*

[8]. ****Proiect tehnic de închidere şi ecologizare a minei Vărad Superior;*

[9]. ****Proiect tehnic de închidere şi ecologizare la EM Sasca Montană- perimetrul minier Sasca Montană”;*

[10]. ****Directiva Cadru 60/2000;*

[11]. ****Baza de date a SGA Caraş-Severin;*

[12]. ****www.cpisc.ro/file/energii_curate/4_decontaminare.pdf.*

NEW WAYS OF BIODEGRADATION OF SELECTED POLLUTANTS

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Abstract: The objective of the project was a laboratory check of biodegradation of soil samples contaminated by PAH/s/, GRO and DRO. For the laboratory check, pure bacterial cultures of Rhodococcus sp. and Pseudomonas putida have been used. It is apparent from the laboratory experiments results that after one-month bacterial leaching, applying the bacterium of Rhodococcus sp. there is a 97 % removal of GRO and DRO, and a 50 % removal of PAH/s/. Applying a pure culture of Pseudomonas putida there is a 86 % removal of GRO and DRO, and a 50 % removal of PAH/s/.

Keywords: contamination, biodegradation, organic and inorganic pollutants.

INTRODUCTION

Human activities lead to the contamination of our planet by organic and inorganic pollutants. The pollution is spreading and it represents a real threat to a healthy development of mankind, animals and plants. One of the most questionable is the group of persistent – exceptionally resistant substances which have been produced by man in significant amounts in the course of last 50 years.

Biodegradation of hazardous harmful substances in the environment embody significant prospective methods, when complex and ecologically unsound pollutants are decomposed into simpler substances (sound ones) by the action of microorganisms. The principle of biodegradation technologies is an optimization of nutrient ratios (to support the growth of selected microorganisms able to degrade the target contaminants) and an application of suitably selected isolated microorganism strains with relevant degradation abilities.

Currently, biodegradation technologies are being improved in an intense way. In the Czech Republic, this trend began to develop after 1989. These are mainly biodegradation technologies designed for the decontamination of soil and water

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contaminated by oil substances and their derivates, for the decontamination of coal tar-phenol pollutions and last but not least for the decontamination of persistent organic pollutants (xenobiotics). Since 2000 a number of companies dealing with this issue have been active in the Czech Republic. [1]

POTENTIAL BIODEGRADATION OF AROMATIC AND POLYAROMATIC HYDROCARBONS

Degradation of organic substances by means of microorganisms makes part of the natural carbon cycle in nature. The process of biodegradation is based on the abilities of microflora to use the present harmful substances as a source of carbon and energy for their own growth. The ability of microorganisms to degrade hydrocarbons has been known since 1895, when growth of yeast fungus on paraffin was described.

More than 200 microorganism species capable of hydrocarbon degradation have been identified. They follow in the order of importance: heterotrophic bacteria, fungi, aerobic bacteria, actinomycetales, phototrophes and oligotrophic bacteria. The most applied bacteria rank in the genera of *Pseudomonas, Arthrobacter, Acinetobacter, Flavobacterium, Alcaligenes, Micrococcus* and *Corynebacterium* [2]. Intense research in this area confirms that besides bacteria, other microorganisms, including fungi and algae, can be used.

THE CHARACTERISTICS OF *PSEUDOMONAS* BACTERIA

Pseudomonas bacteria are gram-negative, chemoorganotrophic, aerobe obligate, with aerobically respiratory metabolisms. Some species are facultative chemolithotrophic. They are straight or curved rods. Their dimensions range between 0.5 and 1.0 μm x 1.5 – 4.0 μm. They move by one or more polar-located flagella. They are arranged mainly individually or in small clusters or chains. They grow under strict aerobic conditions in common culture media, on which they form irregularly large colonies producing water-soluble exopigment (pyocyanine and fluoresceine), which diffuses into the atmosphere and dyes it yellow or blue-green. Older cultures dye dark brown. The temperature range of their growth is 0 – 42 °C; the optimum temperature is 35 °C. The enzymatic activity is dependent on ecological conditions out of which the individual strains were isolated. They make use of some sugars, out of which they form acids, but not gas. Many strains oxidize glucose into gluconic acid, 2-keto-gluconic and other acids. The majority of the studied strains reduce nitrates down to nitrites. They live saprophytically in soil and water. There appears a high affinity with the Vibrio and Xantomonas genera. In total, there are approximately 29 species. [2]

THE CHARACTERISTICS OF *RHODOCOCCUS* BACTERIA

These are gram-negative, chemoorganotrophic, aerobe obligate, with aerobically respiratory metabolisms. The cells are of spherical shapes, the average size of the cells fluctuates between 0.5 and 3.5 μm; they appear individually or two and more cells aggregate into irregular clusters, sometimes tetrads or bundles. They grow under aerobic conditions in common culture media, under the optimum temperature of 25 – 35 °C. On the culture media they form shiny colonies with the dimensions of 2 – 4 μm. Many colonies precipitate pigments of various colours (pink, yellow, orange). In nature, they occur as saprophytes. [2]

THE METHODOLOGY OF EXPERIMENTAL WORK

The experimental biodegradation of the selected harmful substances – PAH/s/, and GRO and DRO – was carried out with a soil sample from Radovesice locality (Czech Republic), namely by means of pure cultures of *Pseudomonas putida* and *Rhodococcus sp.* bacteria. These microorganism cultures were acquired from the Czech collection of microorganisms with the Natural Science Faculty at the Masaryk University in Brno.

In the course of the cultivation works the following media were made use of:

- liquid medium M1 (Beef extract Broth, peptone, NaCl, distilled water, pH 7.2),
- liquid medium M96 (Mineral Medium with Vitamins, Media, Bacteria, pp 123),
- liquid medium M65 (Mineral Medium for Chemolitotrophic Growth H-3, Media, Bacteria, pp 120).

The check of bacteria viability and an approximate determination of their number were done by means of a microscope. For this task we used the Carl Zeiss Jena "Amplival" microscope and Cyrus I, a cell with a raster for reading the number of bacteria. The enlargement ratio of the microscope ranged from 400 (reading the number of bacteria) up to 1000-fold enlargement (observation of bacteria viability).

Post treatment, the mineralogical composition of the sample was determined by an X-ray diffraction analysis in the laboratory of the Institute of Geological Engineering at VŠB – TU Ostrava. The measurement was carried out using a modernized, fully-automated diffractometer URD-6 (Rich. Seifert-FPM, SRN). With the given samples, the following phases were identified: gypsum, jarosite, kaolinite, microcline, muscovite, quartz.

The determination of GRO and DRO, and PAH/s/ was carried out in an accredited laboratory for fuels, waste and water of VÚHU, a.s. Most.

In total, the laboratory experiment lasted four weeks. 100 g of sample, 100 ml of bacterial solution and 500 ml of culture medium were inserted into 1-litre glass vessels which were following closed. Aeration was secured by means of aquarium pumps. The required volume was gradually filled with distilled water. Samples for analyses were taken after one and four weeks.

RESULTS OF BACTERIAL BIODEGRADATION

The results of bacterial leaching with a pure culture of *Rhodococcus sp.* imply that after one-month leaching it is possible to remove 97 % of GRO and DRO, and 50 % of PAH/s/ from the sample. The results are stated in Table 1. It is apparent from the obtained values that application of this bacterial culture is suitable for the degradation of GRO and DRO. Degradation of PAH/s/ is lower.

Table 1 Course of degradation of selected pollutants by means of *Rhodococcus sp.* bacteria

	GRO + DRO mg/kg solid	**Σ PAH/s/** mg/kg solid
Input	280	4,34
Week	9	2,28
4 weeks	9	2,16

The results of bacterial leaching applying a pure bacterial culture of *Pseudomonas putida* imply that after one-month leaching it is possible to remove 86 % of GRO and DRO, and 50 % of PAH/s/ from the sample. The results are stated in Table 2. On the basis of the acquired values, it is clear that application of this bacterial culture is suitable for the degradation of GRO and DRO. However, degradation of PAH/s/ is lower.

Table 2 Course of degradation of selected pollutants by means of *Pseudomonas putida* bacteria

	GRO + DRO mg/kg solid	**Σ PAH/s/** mg/kg solid
Input	280	4,34
Week	40	2,20
4 weeks	40	2,15

CONCLUSION

The objective of the project was a laboratory checks of biodegradation of PAH/s/, GRO and DRO with a soil sample from Radovesice locality. It is apparent from the acquired results that both bacterial cultures can be used for the given sample. Higher values were obtained in case of *Rhodococcus sp.* bacteria. Better results could be reached by prolonging the period of biodegradation or by more intense biodegradation – adjusting the “magic six” in the bioreactor, or by an application of adapted bacterial cultures.

The project was supported by a contribution from the Grant Agency of the Czech Republic within the Grant Project No. 105/05/0004.

REFERENCES

[1]. Sezima, T. *Biodegradace vybraných škodlivin v půdách a vodách*. Doctoral thesis, VŠB – TU Ostrava, 2003.

[2]. Masák, J. et al. *Speciální mikrobní technologie*. VŠCHT Lecture notes, 1992.

THE NEGATIVE EFFECTS OF THE ANTROPIC ACTIVITY ON THE SOIL IN ROŞIA MONTANA AREA

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Abstract: The nowadays evaluation related to the use of the field, are limited to a general description which reffers to the impact that certain areas suffered, in relation to their productive potential and with to loss of pedological resources. These kind of evaluations do not consider the impact that was done because of the destruction of the soil, upon because of lar incoming of the people that deal with agriculture. The region's survey and geology determins the predominant type of agriculture and use of the forest found. The impact degree upon the use of the field depends on the affected soil's quality and the capacity to diminuate this impact. Because of the reduced thickness of the soil and the abrupt sloaps, there is a small potential to use the field (the IVth class of reliability of the field)

Key words: pollution, impact, soil, tailling dam, sterile, muddled.

1. CAUSES OF THE SOIL'S POLLUTION

After obtaining the ore's concentrate, the sterile is put in the tailling dams. For a first evaluation of the sterile's radioactivity from the Săliştea mining areas, there were analizes 6 samples gamma specometrical.

The collectement of the sterile samples from the tailling dams mentioned before, was realized from 2 layers: one between 0,0 – 2,0 cm, the superficial layer; the second between the limits of 2,0 – 10,0 cm, the depth layer, in order to follow the radionuclids distribution in relation with the depth.

The prelucration of the sterile samples was made by drying and screening, eliminating the particles with a diameter smaller that 1 mm. The measurement of the samples was realized by gamma spectometrical method, the results of the measurements being presented in the table 1.

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Table 1. **The natural radionuclids and Cs-137 in the sterile samples from Sălişte :**

The collecting place of the sample	U.M.	RA – 226	RA – 228	K – 40	CS - 137
Sălişte Valley –ss	Bq/kg	15 +/- 1	18 +/- 3	2432 +/- 33	0,69
Sălişte Valley –sp	Bq/kg	17 +/- 1	11 +/- 2	2248 +/- 23	0,62
Whitness soil	Bq/kg	33 +/- 4	48 +/- 4	639 +/- 5	76 +/- 5

The activity of the prelevated sterile samples from the tailling dams were compared to the whitness sample (Bucharest) p from an area that is situated far from the antropogenical influences. It was seen that in all the analized samples, the concentration of K – 40 is predominant; compared to the average on the country, which is of 540 Bq/kg, the concentrations are 2 – 4 biggers. It was not praised a variation with the depth of this radionuclid.

Another detected radionuclid was Ra – 226, which contribution at the collected dose by the population is highly important. In the meantime, being soluble in water, this radionuclid can reach from the soil into the freatic or the surface water and transported to long distances from the impact place. The concentration of Ra – 226 from the analyzed samples are inferior under the country average, which is of 50 Bq/kg. The small concentrations of Ra – 226 from the sterile samples could appear after the process of ore's concentration. The concentration of Ra – 228 are inferior to those of the whitness sample. The concentration of Cs – 137 are under the detection limit, for all the analysed samples.

The number of efectuated determinations offer a first quality indication upon the radioactive pollution in the tailling dams' area.

After the activity of collecting the gold – silver ore from the Cetate quary, it results, as a waste, the dry sterile, and after the preparation of the ore at Gura Roşiei preparation factory, the so called sterile muddled. Related to the way of careful management of the waste, we will note few issues. The sterile waste dumps, as resulted sterile after the proccess of preparation of the ore, is being repressed as hydroquantity in the tailling dam Sălişte Valley, fig.1, in order to make the mechanical combing out through two wires of transport pipe.

Fig.1. Sălişte tailling dam.

The tailling dam from Sălişte Valley was built during 1980 – 1987, with the purpose of ensuaring the mechanical combing out of the sterile muddless came from the preparation factory Gura Roşiei, following the replacement of the old tailling dams number 1, 2 and 3; nowadays, these 3 tailling dams are being preserved. The intensif use of the aval compartment, associated with the waterproof character of the dam's basin, and also with the unproper realization of the collecting drainage tubes, made the hidrostatic level from the warehouse to grow outcroping in the aval gradient, on the tailling dam.

In order to stop the exfiltrations effect, the growing sloap of the aval gradient of the dam, the deversation period of the muddless in the dam, was reduced, and there was layed a lest of anrocaments, as a filter, at the base of the gradien, to stop the hidro-dinamic trainment, caused by the exfiltration.

After a few years functioning, the 2 compartments were joined, obtaing a gradient angle of 16°, gradient that offers the tailling dam a high stability. The physico – chemical characteristics of the hydroquantity and the physico – chemical composition, of the area sterile layed in the tailling dam, are presented in table 2.

Table 2. **The physico – chemical characteristics of the hydroquantity and the composition of the sterile layed in the dam:**

THE CHARACTERISTIC		U.M.	VALUE
Physico – chemical characteristics of the hydroquantity layed in the tailling dam	rate solid : liquid	-	1 : 5,5
	Specific density	t/m^3	1,12
	pH	-	6 – 7,5
	Iron	mg/l	0,02
	Calcius	mg/l	0,01
	Sodium	mg/l	0,01
Physico – chemical composition of the sterile layed in the place of the tailling dam	Sulfer	%	0,27
	Sulfer byoxid	%	72,35
	Alum Earth	%	11,97
	Iron	%	0,97
	Iron oxid	%	0,09
	Magnesium oxid	%	0,25
	Calcius oxid	%	0,94
	Manganese	%	0,10
	Arsenium	%	0,09
	Sodium oxid	%	0,45
	Potassium oxid	%	9,80
	P_2O_5	%	0,01
	Vanadium	%	0,0012
	Titanus byoxid	%	0,45
	PC	%	2,0
	Gold	%	0,5 – 0,6
	Silver	%	6,3 – 8,8

At the layment of the material in the tailling dams, it appears a separation between the sand layers of few cm and those if few mm, formed of powder and clay, and which are actually hard permeables; generally, the water is being maintained from the profile. The chemical composition of the sterile, related to the analyzement records, is being presented like this:

SiO_2	63,51 %	Pb	0,06 %
Al_2O_3	12,33 %	Cu	0,03 %
Fe	2,15 %	Zn	0,06 %
CaO	2,08 %	V	0,0003 %
MgO	1,49 %	Cr	0,0003 %
S	0,89 %	Ni	0,0003 %
Mn	0,10 %	W	0,03 %
pH-ul	4,5 – 5,2		

The sterile obtained from the activity of extracting the ore is being layed into the active sterile waste dumps Hop and Green Valley. The material layed in waste dumps, is almost all formed of rocks with varied dimensions, from milimetrical particles to blocks, the last ones, being found especially in the inferior side of the gradients, in proportion of 10 – 20 % there is soil, and damaged rock.

The waste dumps are putted in the forest area of pure beech forest and mixed ones. The vegetation coverage of the waste dump is a average of 30 %, but this coverage is not uniform.

2. IMPACT UPON SOIL

Cetate Quary, the sterile waste dumps and the active and preserved tailling dams, affect the soil by occuping some big field surfaces which are in an unproductive area, fig.2 ; the resulted sterile after the proccess of extracting the gold – silver ore from the quary, is layed nowadays in the Green Valley waste dump.


Fig.2. Uncovered areas.

The occupied field, is situated in an unliving area, and does not affect the forest found from the neighborhood.

The waste dumps are formed by laying the sterile resulted from the quary, transported through auto system, tipping on the platform and pushing the material with the bull-dozer on the gradient. The preserved dumps are stable and partially covered with spontan vegetation.

Another source of pollution of the soil is represented by the Sălişte Valley (active) and number 1, 2 and 3 tailling dams preserved. In the active tailling dam the sterile from the preparation factory Gura Roşiei, is being evacuated.

The sterile muddless transported through the hydrotransport pipe is being layed in the dam through the proccess of subacvatic laying. The dam's impact upon the soil is being shown by impurification with dust, because of the phenomen of deflation, contributing at the small development of the plants from the area.

3. CONCLUSIONS

Considering the effects of the extraction and preparation of the gold ore at Roşia Montană area upon the vegetation and the land fauna is obvious that the vegetation from the waste dumps areas and the tailling dams ones is completely destroyed as a following of eliminating the fertil soil layer and because of the sterile materials.

In the tailling dams area, nowadays, there are visibly affected cultures by the dust; the same thing can be told about the fauna in the area, which is habitat is being destroyed. The fact that valuabel species or rare ones, protected by law are not affected is remarcable.

Even though there are preocupations in order to give back in the natural circuit of the fields on which the mining activity is over, the flora which develops by selective cultivation, is usually different from the initial one, and the diversity of preexistant species is being remade hardly during time.

The remaking of the fauna depends on the remaking of the soil's cover, and especially the forest cover of the area.

BIBLIOGRAPHY

[1]. Fodor, D., Baican, G., *Impactul industriei miniere asupra mediului*. Editura Infomin, Deva, 2001.

[2]. Lazăr, M., *Reabilitare ecologică*. Editura Universitas, Petroşani, 2001.

[3]. Nenițescu, C., *Chimie generală*. Editura Tehnică, Bucureşti, 1963.

[**4]. Toderaş, S.**, Impactul activităților miniere asupra mediului înconjurător în zona Roşia Montană, Referat de doctorat, Universitatea din Petroşani, 2005.

[5]. ***, *Evaluarea stării de siguranță a iazului de decantare Valea Săliştei*. Contract S.C. IPROMIN S.A., Beneficiar Filiala ROŞIAMIN S.A. Roşia Montană, 2002.

[6]. ***, *Proiectul Roşia Montană*, S.C. Roşia Montană Gold Corporation S.A., 2002.

QUALITY STATE OF LAND RESOURCES FROM SOUTH-WEST ROMANIA AND THEM PROTECTION AND IMPROVEMENT REQUIRES

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Abstract: In the paper are presented the main aspects referring to the structure of the principal found and to quality state of the soils from the south-northern zone of Romania, in a total surface by 3,2 millions hectares, which 1,9 millions ha agricultural lands.

There are succinctly described the physico-geographical characteristics of the zone and in great detail the organization of edaphic cover, some restrictive characteristics regarding the terrains quality and soils fertility.

Finally, there are presented the measures which must be taken for reducing till optimum values the limitative and restrictive factors of production capacity of the lands from the interest area.

Key words: land resources, protection, improvement measures.

1. INTRODUCTION

Formed in very different natural conditions, soils vary under aspect of their characteristics and fertility state, respectively their capacity to support plants growth and crops formation from a zone to another, because man attached to environment from his first beginnings, cultivating the best lands.

Distinct part of Romanian territory from the viewpoint of geomorphology and soils cover, the studied territory suffered in the course of time hydropedoameliorative interventions, significant for its ulterior evolution, representing a zone by major interest for the modern pedological research, the only capable to substantiate technically and scientifically the most adequate practical measures for producing of vegetal biomass, in a optimized dynamics, rigorously correlated with the increasing exigencies regarding the environment protection.

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Starting from these considerations, the authors try to illustrate in the present paper, basing on dates from personal scientific researches, on impressive volume ofinformation from OSPA archive (Timişoara, Arad, Deva) and on dates offered by the national monitoring system organized by ICPA Bucureşti (correlated with other European systems), some aspects referring to the morphologic, physico-mechanical and hydrophysical characteristics of soils, generated both by the natural conditions, specific to researched zone and by the frequent anthropic interventions.

2. MATERIAL AND METHODS

The approached problematic is referring to a surface by 3.203.331 ha, which 1.961.753 ha (table 1) constitute the territories of Arad, Caraş-Severin, Hunedoara and Timiş Counties.

The characterization of ecopedological conditions specific to the studied space, the defining of soil unities and terrain unities, as well as the analysis of the limitative and restrictive factors were made in conformity with "Methodology for Elaboration of Pedological Studies" (volumes I, II, III) elaborated by ICPA Bucureşti in 1987, completed with elements from Romanian System of Soils Taxonomy (SRTS 2003).

Table 1. **The structure of the main use categories**

County		Arable	Pastures	Hay fields	Vine- -yards	Agric. lands	Orchards	Forests	Others	TOTAL
Arad	ha	348324	128102	25293	3814	511520	5987	212182	51707	775409
	%	44,92	16,52	3,26	0,49	65,96	0,77	27,37	-	100
	%	68,09	25,04	4,95	0,75	100	1,17	-	-	-
Caraş-Severin	ha	127240	182839	75990	1222	399620	12329	409864	42492	851976
	%	14,93	21,46	8,92	0,14	46,90	1,45	48,11	4,99	100
	%	31,48	45,75	19,01	0,31	100	3,01	-	-	-
Hune- -doara	ha	88895	153710	101287	342	348266	4032	312766	45235	706267
	%	12,59	21,76	14,34	0,05	49,31	0,57	44,29	6,4	100
	%	25,52	44,16	29,07	0,10	100	1,15	-	-	-
Timiş	ha	534802	123975	29270	4985	702347	9306	109017	58301	869665
	%	61,50	14,26	3,37	0,57	80,77	1,07	12,54	6,69	100
	%	76,14	17,65	4,17	0,72	100	1,32	-	-	-
TOTAL	ha	1099261	588626	231849	10363	1961753	31654	1043829	197735	3203317
	%	33,49	18,50	7,47	0,31	60,74	0,97	33,08	6,19	100
	%	50,40	33,15	14,30	0,47	100	1,68	-	-	-

3. RESULTS AND DISCUSSIONS

By its geographical position, the studied space presents a big diversity of ecological conditions determined by the large variability of all environment factors and of vegetation conditions which compete to realization of the environment where plants grow and give crops.

The counties Arad, Timiş, Caraş-Severin and Hunedoara include the territory of Banat, the south of Crişana, the south of Apuseni Mountains and the western side of Southern Carpathians.

The large specter of relief formes, characterized by a big diversity of morphologic formes (from water meadow and old deltas, with altitudes by approximately 68-80 m) to semidrained plains (80-100 m), piedmont-plains and piedmonts, high hills, depressions under- and intramountainous, and mountains with altitudes up to 2509 m (Peleaga Peak from Retezat Mountain), generated a large diversity of climatic and edaphic conditions. These conditions are submissive to permanent transformations, both under the influence of natural factors, and anthropic factors which modified the relief more significant then in the other geographic regions from Romania.

The geology and lithology of the surface materials contributed in great measure to the ecopedological complexity of the studied space which are reflected in its very complicate edaphic structures, taking into consideration the genetic and geochemical aspect. Here can be founded eruptive, crystalline or karst formations in the mountainous zone, and clays, loams and grit stones in the piedmonts, or loess formations from plains and fluvial-lacustrian deposits from the water-meadows, all these structures representing the essential elements for defining the environment where the plants grow.

The hydrographic system (the drainage) is represented by rivers, lakes and by the complicated system of canals for draining and irrigation. This hydrographic system and collect its waters almost in exclusivity (excepting Mureş) from the studied space, being connected with the mountain and submountain region by their origin and by the fact that at this level are defined their peculiar characteristics of the liquid flowing.

Climatically, the researched territory is characterized by temperate-continental climate with oceanic and Mediterranean influence, with local nuances generated by the disposing in stages of the relief.

In the western corner of the studied area, the climate is warm-droughty, at Sânnicolaul Mare being registered values of multiannual precipitations by 537 mm and a multiannual medium temperature by 11,9 °C, with a deficit in precipitation by 158 mm (with increasing tendency in the last years).

In the central part of the plain zone from the researched space, the climate is moderate-lukewarm, semi-moist with aridity tendency, characterized by multiannual medium temperatures by 10,03 °C (Arad) and 10,8 °C (Timişoara) and multiannual medium precipitations by 593,5 mm (Arad) and 600,4 mm (Timişoara). The aridity index has medium value about 30, the potential evapotranspiration is approx. 698 mm, and the deficit of precipitation is 60 mm, being a climate with a low deficit in precipitation.

In the eastern side of the territory, in the hilly and mountainous zones have a cool-moist climate, the multiannual medium precipitations reach values over 700 mm (Holod 702,1 mm, Gurahonț 747,4 mm, Budureasa 900,0 mm) and temperatures between 8-10 °C, with an aridity index by 39,0 and a humidity surplus over 125 mm, being a moderate-moist climate. At higher altitudes the climate is intense-moist.

The vegetation of the researched area is strongly influenced by the long anthropic activity archeologically registered from the pre-roman époque. This type of activity led to the fragmentation of the natural vegetation and to its substitution on large spaces with secondary meadow vegetation. As a result, the vegetation, which reflects the natural conditions of the researched area, is reconstituted basing on existing fragments from our days. This vegetation is multi-stage in close connection with the stratification of relief, climate and soil, forming numerous units of vegetation from numerous associations, with local peculiarities, which are exposed from the alpine zone to the plain zone: alpine meadows and bushes, mezofile conifers-forests, mezofile deciduous-forests, and mixed forests (deciduous trees + conifers), mezoxerotherme forest with deciduous species, mezohygrophile everglade-forests, steppe-meadows.

In close correlation with the variety of geomorphological factors (which determine the existence of some relief-units), geolithologic factors (which lead to a large diversity of parental materials and rocks which form he base of soils evolution), hydrological and telluric factors, as well as the anthropic interventions, resulted a numerous population of soils with specific characteristics (related or totally different) in a continuous evolution.

Conform to Romanian System of Soils Taxonomy (SRTS 2003), in the studied space, formed by the Arad, Caraş-Severin, Hunedoara and Timiş Counties, were identified 23 types of soils (table 2) and numerous detailed units, which are distinctly distinguished by their properties, their productive capacity and by the measures taken to maintain and increase their fertility.

Table 2. **The main types and soils associations from south-west of Romania, % from agricultural surface**

Nr. crt.	**SRTS 2000**	**FAO**	**ARAD**	**CARAŞ-SEVERIN**	**HUNEDOARA**	**TIMIŞ**
1	Litosol	Leptosoil	1,30	6,89	12,82	1,40
2	Regosol	Regosoil	4,61	3,50	11,51	3,20
3	Psamosol	Arenosoil	0,46	0,05	-	0,03
4	Aluviosol	Fluviosoil	8,54	7,15	10,02	4,15
5	Cernoziom	Chernozem	23,82	0,88	0,85	26,65
6	Faeoziom	Phaeozem	6,63	5,60	0,88	3,52
7	Rendzină	Rendzinic Leptosol	0,08	1,69	2,78	0,02
8	Nigrosol	Humic cambisol	0,32	0,20	-	-
9	Humosiosol	Dystric Humic Cambisol	0,04	6,52	1,03	-
10	Eutricambosol	Eutric Cambisol	5,32	12,06	10,21	12,67
11	Districambosol	Dystric Cambisol	1,48	10,04	16,94	-
12	Preluvosol	Haplic Luvisol	10,48	10,47	3,13	12,12
13	Luvosol	Luvisol	13,38	22,78	18,00	10,90
14	Planosol	Planosol	1,25	0,14	-	0,60
15	Prepodzol	Cambic Podzol	0,03	0,08	5,07	-
16	Podzol	Haplic Podzol	0,04	0,20	1,16	-
17	Vertosol	Vertisol	11,82	2,39	0,97	10,14
18	Gleiosol	Gleysol	2,41	0,73	2,29	6,14
19	Stagnosol	Stagnic Luvisol	0,79	1,10	2,34	1,05
20	Soloneț	Solonetz	4,58	-	-	6,05
21	Turbosol	Histosol	0,04	0,06	-	-
22	Erodosol	-	2,07	6,79	-	0,80
23	Anthroposol	Anthrosol	0,51	0,68	-	0,56
T O T A L			100	100	100	100

Taking into account the characteristics of relief and the main chemical and physico-mechanical parameters of the soils, generated by the pedogenetic processes, by operations of evaluation and monitoring of the quality state, were distinguished a series of limitative factors which act on production capacity of the lands, being determined from the agricultural surface of the researched space the following degraded surfaces:

- erosion, land sliding: 396.200 ha, 20,20 %;
- acidification:858.800 ha, 43,80 %;
- saltness: 139.400 ha, 7,10 %;
- deficiency in nutritive elements: 1.002.460 ha, 51,00 %;
- primary and secondary compactness: 990.800 ha, 50,50 %;
- excess of underground and surface water: 620.800 ha, 31,60 %;
- inundations (the surfaces affected in 2005 were not included): 429.625 ha, 21,90 %;
- edaphic volume reduced: 703.905 ha, 28,60 %;
- reduced carrying capacity: 634.990, 25,80 %.

Referring to these nutritive elements which affect the production potential of soil cover, it is necessary to take pedohydroameliorative or cultural measures, that depending on case to case:

- correction of acid reaction of soil by periodical calcic amendation or alkaline reaction by gyps application;
- improvement of nutrition conditions of the plants by ameliorative fertilizations;
- assurance of an optimum aero-hydric regime by workings of prevention and fighting (control) of humidity excess (canals, ditch, gutters, drains etc.) or, depending on case, the control of aridization tendencies (irrigations, protective forest belts, adequate plant cultures etc.);
- prevention and control of soils sliding and erosion (earthen walls, coast canals, furrows, antierozional belts, afforestrations etc.);
- application of technologies for soil workings which avoid their destructuration and compaction (no-till, minim tillage etc.) and biodiversity protection by introducing of agro-ambiental schemes.

4. CONCLUSIONS

The pysico-geographical conditions of the researched area delimited by the areal of Arad, Caraş-Severin, Hunedoara and Timiş Counties, determined a big diversity of ecopedological conditions.

As effect of the interactions of pedogenetic factors resulted a numerous population of soils with extremely diverse characteristics: from those arenaceous (psamosoils and some alluviosoils) to those extremely argillaceous (pedosoils and vertosoils), from those alkaline (salsodisoils) to those strongly acid (podzols, luvosoils, districambosoils etc.), from those meager in humus and other nutritive elements (lithosoils, psamosoils etc.) to soils well balanced from all aspects (chernozems).

Or, the knowledge in detail of the factors which compete to the increase or decrease of production capacity of each portion of territory (according to “Methodology for Elaboration of Pedological Studies”, 1987), can assure for the organisms capable to take decisions an efficient instrument in choosing of those working proceedings which favor an efficient utilization of land resources, in the interest of man, for improvement of his living conditions and in the interest of entire community and next generations.

REFERENCES

[1]. Borza, I., Țărău, D., Irina Țărău – *Soils degradation process and restoring measures in south-west Romania,* „Orizonturi Universitare" Publishing House, Timişoara, 2001;

[2]. **Borza, I., Țărău, D., Țărău, Irina, Mădălina Iordache, Jurcuț, T**. – *Determination of plots favorability and the agrochemical systematic control of soils as definitive elements of some agricultural sustainable technologies in west zone of Romania,* Scientifical Papers of International Symposium "Cultivation technologies for wheat and maize in the conditions of sustainable agriculture system", SCDA Oradea – World Bank, 2005;

[3]. **Dumitru, M. et al.** – *The monitoring of quality state of the soils from Romania,* GNP Publishing House, Bucharest, 2000;

[4]. **Munteanu, I.** – *On aspects regarding the relations between drought, pedogenese and land degradation,* „Știința Solului" Revue, no. 2, vol. XXXIV, 2000;

[5]. **Otiman, I. P.** – *Dezvoltarea rurală în România,* Ed. Agroprint, Timişoara, 1997;

[6]. **Teaci, D.** – *Transformarea peisajului natural al României,* Ed. Ştiință şi Enciclopedie, Bucureşti, 1983;

[7]. **Țărău, D., Borza, I., Irina Țărău, Ramona Jaraba** - *The monitoring of quality state of vegetation factors from Mureş Plain and its role in fondation of agricultural sustainable tehnologies,* Scientifical Papers of International Symposium "Cultivation technologies for wheat and maize in the conditions of sustainable agriculture system", SCDA Oradea – World Bank, 2005.

AIR POLLUTION IN JIU VALLEY

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Abstract: Jiu Valley is one of the most important coal mining area in Romania. Also in Jiu Valley are developed other industries including a[1] power station. This development of area made that this area to be much polluted. One of the most polluted environmental compounds is air. Jiu valley is bounded by high mountains that made very difficult air refresh. By this reason is very important to mitigate the air pollution especially by dust. Because the companies are concentrated in a small area is very difficult to identify and prosecute the pollutant one. This research aim to identify the sources of air pollutants, especially among mining companies because the power station is considered the most important pollutant in this area.

Key words: climate, air quality, coal mining, sedimentable particles, suspension particles

1. INTRODUCTION

In Romania, in Meridional Carphatian Mountain, in the upper basin of river Jiu there is the most important coal field that produce coke coal named Jiu Valley.

Coal field is placed in a intermountain depression surrounding by four mountain massifs, two of them with high over 2,500 m and one of them was declared Biosphere Reservation. This geographical placement made that in this field air circulation to be disturbed by the relief forms. For this reason the air pollution in area is a very sensitive issue.

2. CLIMATIC CONDITION IN JIU VALLEY

In same characterisation Jiu Valley is considered to be an southern extension of Hateg depression. If in a way this think is true, taking into account the relief feature, the

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another features makes it very particularly. The Jiu Valley is characterised to be the most specific discontinuity geographic area from Meridional Charpatian mountain. The oblong form of this field, surrounding by mountains, has a great importance for climatic feature, because air circulation is made easier along the Jiu Cerna corridor, following the longitudinal splitting of Meridional Charpatian Mountain and less from north to south through transversal broken of mountain, Banita-Merisor and Surduc Lainici. The mountains are weir against air circulation, hampering its moving. The mountain protection hampers the air refresh in the depression.

In the huge trough between mountains there is one more interesting phenomena: the stagnation and cooling of air slide from hills to the depression ground, named thermal inversion, well-known in all Carpathian depression. Under thermal inversion influence, the lowest temperature are under minus 30°C while at Parang meteorological station the lowest temperature is not exceed minus 24°C. Consequently, the most severe cold but no longer was in the bottom part of depression and no on the hills that are under the weather air circulation influence. Even if the severe cold there is not on the hills, the number of cold days, with temperature under minus 10°C is greater then bottom of depression. The frosty weather from Petrosani is due to air cooling by radiation (air that is stationed between mountains). By this reason days with white frost or hard frost are even in the may. Even if by geographical position and altitude the climate should be a submountain one, taking into account the average temperature oh the most hot month (July with an average by 16.7°C) and the year average temperature (6.8°C) the climate may be considered a low altitude mountain one. The submountain climate, characteristic for Sub-Charpatian area, have the July month average temperature greater with 3 ÷ 4°C and the year average greater with 2 ÷ 3°C.

The number of hot days with an average temperature over 10°C is more reduced at Petrosani then in other places that are considered colder, and the summer days , with the temperature over 25°C is about 50 in the central part of Jiu Valley. Through western part, simultaneously with the altitude the number of summer days decreased. The climate character results obviously from thermal amplitudes that is greater than 64°C. The tropical days are in number of 4 ÷ 5 on years, while at north (Deva) and south (Targu Jiu) they are almost 35. Generally, the climatic data show that it is an excessive feature climate due to great thermal oscillation that in the winter months are over 20°C. This fact proves the same influence of thermal inversion climate due to relief features. The monthly average temperature evolution in Jiu Valley in comparison with surrounded areas in shown in Figure 1.

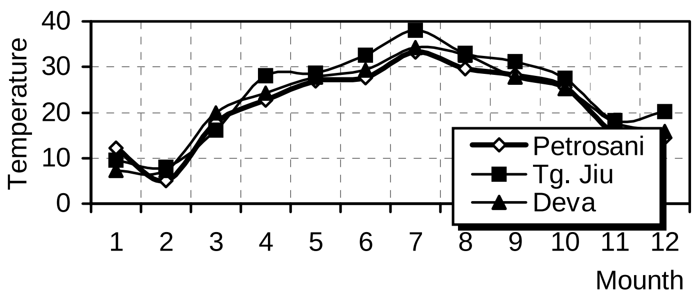

Figure 1. Evolution of maximal temperature in Jiu Valley

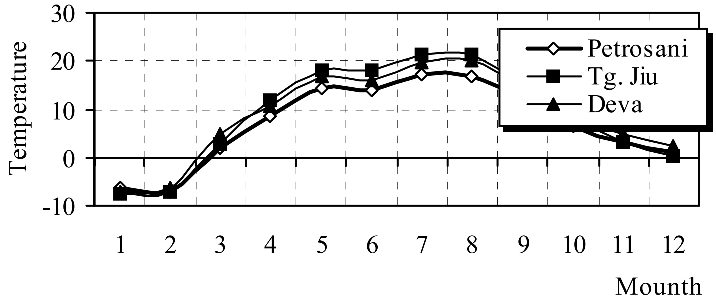

Figure 2. Average temperature evolution in Jiu Valley

Figures 2 and 3 show the evolution of minimal and maximal temperature in Jiu Valley in comparison with the surrounded areas, Deva at north and Targu Jiu at south. Orographycal conditions influence feels the effects of air current

The western part of Romania in under western and north-western air circulation influence. However, in Jiu Valley there is a north-south air circulation due to obstacle effect of Retezat and Godeanu Mountain that are hampered the air circulation. Even if the western direction of wind is not common, these winds are the most strongly. The mountain cover make that cold air to be deposited on the bottom of depression and then there are long period of calmness, especially in January and February (when are 82 ÷ 83% calmly days)

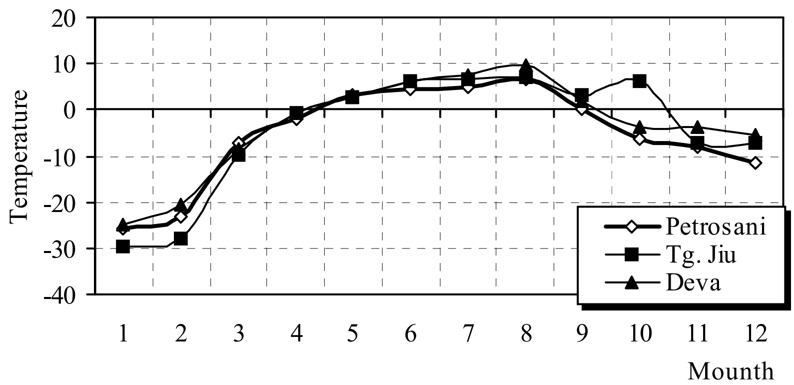

Figure 3. Minimal temperature evolution in Jiu Valley

A local feature is the wind that blew from Jiu canyon that is a strong and cold wind especially in spring and autumn time. In the summer are north-western winds that bring humidity. Southern winds are not wished because they produced cool in spring and winter and drought in summer.

Flowing the air current along the main valley is a frequent phenomenon, but local. Along of all valleys may be felt the cool mountain breeze. The wind distribution on the main direction is shown in Figure 4.

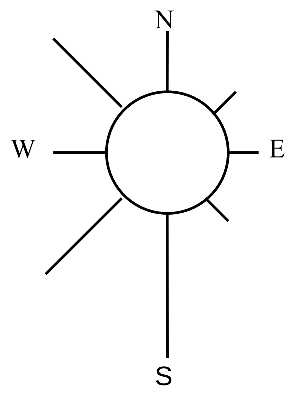

Figure 4. Wind direction distribution

The sheltering and the isolation of area are reflected in the rain year average quantities. In the depression the rainfall are among 700 ÷ 800 mm in comparison with the mountain area where are 1000 ÷ 1500 mm. The monthly average of rainfall is shown in Figure 5.

The number of cloudily days is over 200 per year. In the central part of depression, where the industrial activity is more developed and atmosphere is more polluted, the rain are more frequently due to dust and smog particles which are condensation centres. By this reason, in autumn the smog and drizzling rains are more frequently. Many days, even weeks in every morning fog cover all this area. Even if the wind blows the fog, a translucent fog remains almost all year. Only in climatic changes period this fog disappears (March - April) when the air turbulence is maximal.

In conclusion can say that Petrosani area has long winters, but not very cold, short and cool summers with fog and rainfalls, with cool and long autumns.

3. AIR POLLUTION ASSESSMENT

Air is polluted by a power station and by mining and coal processing activity with dust. Another pollutants are between legal limits can see in table no. 1.

Table 1. ***Air pollutants***

No.	*Pollutant*	*U.M.*	*Legal*	*Value*
1	HCl	mg/m3	0.100	0.000
2	NO2	mg/m3	0.100	0.023
3	SO2	mg/m3	0.250	0.018
4	Suspension particles	mg/m3	0.150	0.101

Air quality is monitoring in some point that are placed in the most sensitive area. The main issue is to identify the pollutant sources correctly. In this chapter are presented the issues that appear in air pollutants sources identification process.

Sedimentable particles in are presented in Figure 6 from an area placed at Paroseni power station and in the surrounding area. Figure 6 shows that air pollution depend on power station dust emission.

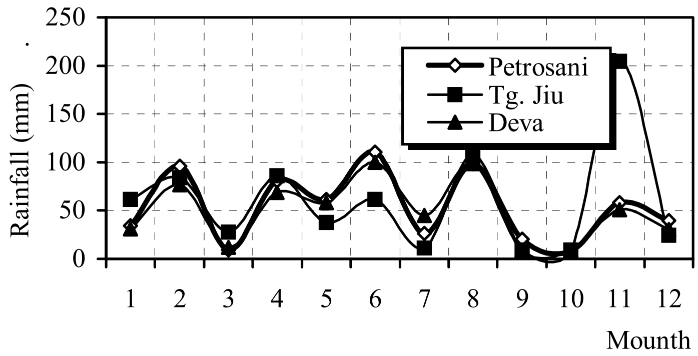

Figure 5. Rainfall evolution.

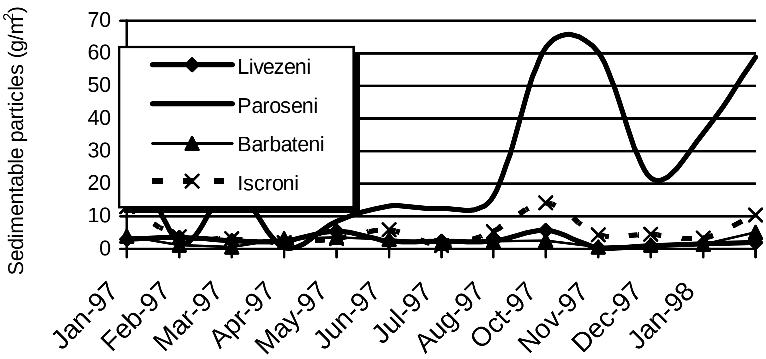

Figure 6. Sedimentable particles in air near Paroseni power station and in surrounding areas.

To assess what are the pollution sources with dust is interesting to show the daily evolution of suspension particles in air (Fig. 7.).

In mining companies Saturday and Sunday are free days so that it was expected that suspension particles in air to be reduced in these days. The fact that suspension particles have not a weekly variation show that air is polluted in a large measure by other companies like power station.

In Figure 8. is shown a comparison between air content in suspension particles in 1997 winter and 1998 winter This figure show that air quality decrease in the last year.

To assess what are exactly the polluting sources is necessarily to increase the number of places in which air quality is analysed.

Because is very expensive to monitories air quality in a great number of points, is better to use a monitoring method like gas tubes that are very cheap, but it can not to registered the picks that appear. This method is representative just like an average method, for a longer period of time.

For example in table 2 is shown the suspension particles content in air in an area surrounding one chimney. The results show that the chimney is pollution sources that cannot be assess using actually air quality monitoring method.

Table 2. ***Suspension particles in air in area surrounding a chimney from a coal processing plant***

No	Sample place	Suspension particles µg/m^3
1.	10 m to chimney	1.15
2.	50 m to chimney	3.10
3.	100 m to chimney	2.45

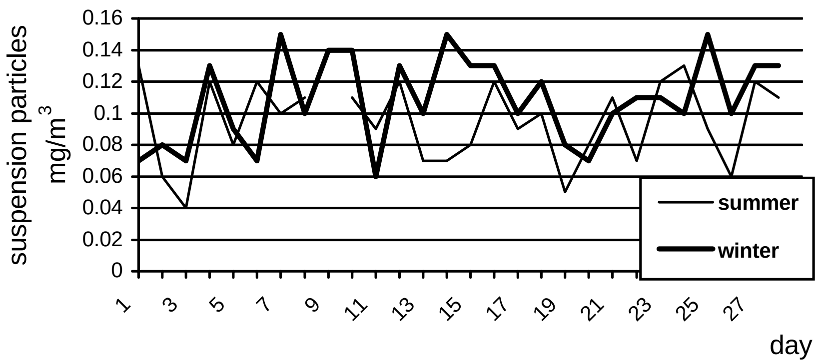

Figure 7. Daily evolution of suspension particles content.

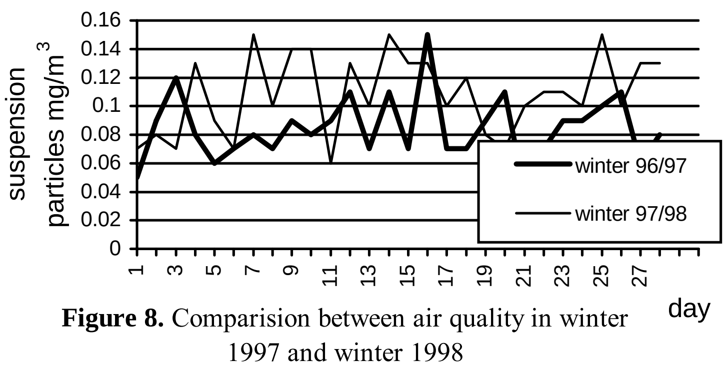

Figure 8. Comparision between air quality in winter 1997 and winter 1998

CONCLUSION

Mining activity have a strongly negative air impact because due to dust emissions.

Mining activity air impacts cannot be assessing due to another polluting source that superpose their impact over mining impacts.

In order to assess every polluting sources impact is necessarily to increase very much the samples drawing points. Is very difficult to assess small polluting sources when a strongly polluting source, like a power station superposes its impact over other impacts.

REFERENCES

[1] Sarbu R., Georgescu M., Ciocan V., Badulescu C., Traista E., *Polluting sources and their impact on the environment in the Jiu Valley coal field,* A.A.Balkema/Rotterdam/Brookfield/1997, p 957;

[2] Glasson J., Therivel R., *Introduction in environmental impact assessment*, Oxford University Press, 1995;

[3] Morris P., Therivel R., *Method of environmental impact assessment*, Oxford University Press, 1995;

[4] Traista E., *Improvement of waste water provide from coal mining activity cleaning*, PhD. Thesis, Petrosani, 1998.

PROPOSITION DE TRAITEMENT EVENTUEL ET DE REHABILITATION POUR UN SITE POTENTIELLEMENT POLLUEE OU POLLUEE

EMILIA DUNCA *,
IOAN DUMITRESCU **

Résume: Le site de l'ancienne "Lagune du Triangle de Marienau" a fait l'objet d'études environnementalistes réalisées conformément à la méthodologie "Gestion des sites (potentiellement) pollués", diffusée par le Ministère de l'aménagement du territoire et de l'environnement. Etant donné son niveau de pollution et en gage de sécurité pour son futur (zone industrielle légère et/ou commerciale), il est souhaitable de pérenniser ce site par la mise en place, le cas échéant.

Les mots clé: site pollue, réhabilitation, biotraitement,

1. INTRODUCTION

La dégradation, la dilution, le transport et la solubilisation de la pollution, présentées dans les phases d'air, d'eau et de sol, constituent la base de cette problématique environnementale.

L'inventaire d'un site industriel se fait en fonction du cas rencontré : (Cf. Figure n°: 6.1)

- constat d'une pollution d'un site ancien ou en activité, ou lors d'un accident ou de découvertes fortuites;
- étude des sites en activité;
- études historiques des sites anciens sur lesquels une activité aurait pu produire une pollution.

Dans notre cas on a fait une étude historique de l'ancien site du ″Triangle de Marienau″ pour lequel on suppose qu'il y a la possibilité d'existence d'une pollution.

Après qu'on ait fait un examen préliminaire de la situation du site (l'étape initiale de la procédure) permettant une identification des dangers réels on peut envisager les mesures d'urgence à mettre en place afin de limiter, voire éliminer les risques immédiats identifiés sur un site potentiellement pollué (SPP).

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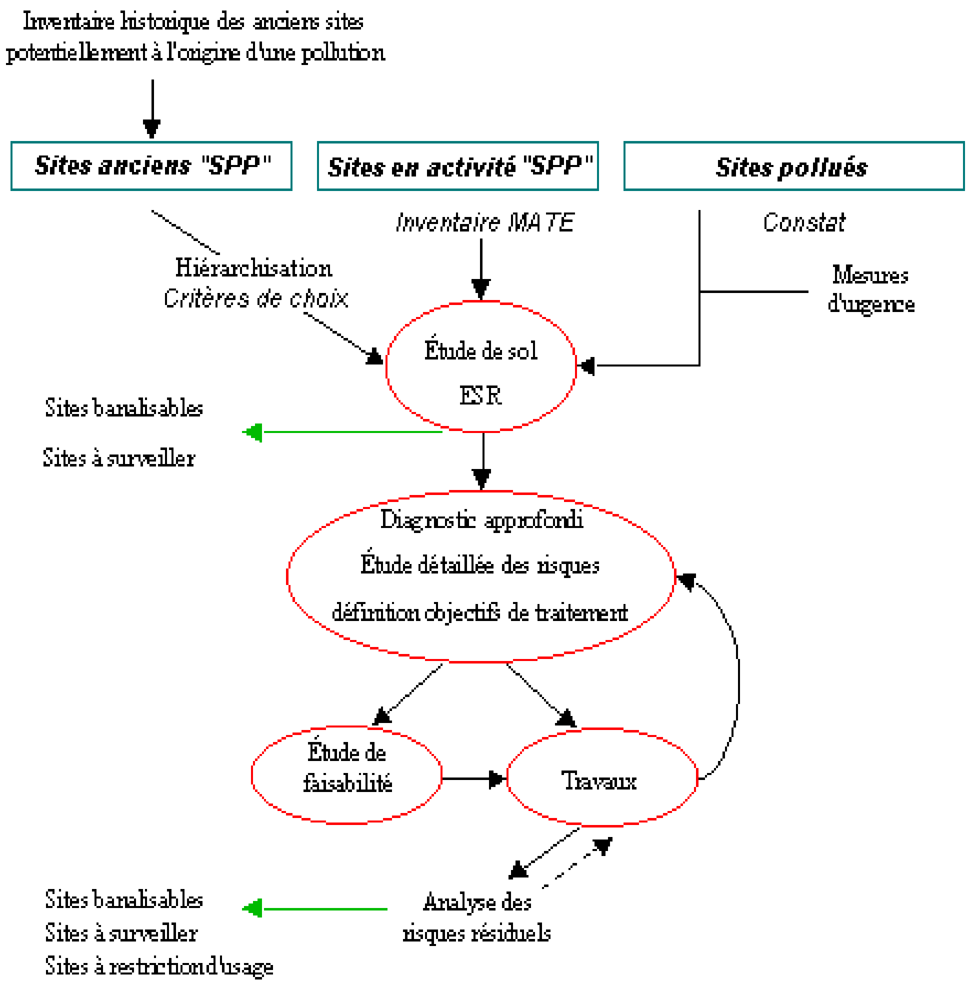

Fig.1. Méthodologie d'inventaire pour un site potentiellement pollué ou pollué

2. ETUDE DES SOLS ET DE LA NAPPE PHREATIQUE

Les objectifs sont de réaliser une première caractérisation d'un site pollué et de son impact ainsi que de fournir l'information nécessaire pour réaliser l'étude simplifiée des risques.

Cette étude comporte deux étapes:

- *Etape A*, qui consiste en une évaluation fondée sur l'analyse de l'information existante concernant le site (ses activités et les pollutions potentielles en résultant) et son environnement : analyse historique, étude de la vulnérabilité de l'environnement à la pollution, visite technique sur le site.
- *Etape B*, qui regroupe des compléments d'information notamment ceux réalisés à partir de quelques investigations de terrains.

Après les études sur le site, on propose un réseau des sondages qui va permettre de connaître la qualité des sols et de déterminer le potentiel d'atténuation naturelle de la contamination de site. La connaissance de ce potentiel est nécessaire dans le choix des technologies de traitements.

Dans ce cas, il faut étudier la possibilité de mettre sur le site des piézomètres pour surveiller la qualité d'eau de la nappe en proximité de trois bassins de dépotage.

On propose d'analyser la qualité de l'eau de la rivière Rosselle en amont du premier bassin et en aval de la deuxième lagune. Dans ce cas, on peut avoir un indice sur une éventuelle migration de polluants ou non.

3. POSSIBILITE DE TRAITEMENT BIOLOGIQUE

Si une pollution existe nous proposons de réhabiliter ce site par un biotraitement. A l'avenir, pour les sites contaminés à réhabiliter, nous préconisons l'utilisation d'un logiciel (comme par exemple SITE I et II).

3.1. Description de la technologie

On propose un procédé biologique conçu pour traiter les matières solides qui se trouvent dans les trois bassins. Ce procédé permet une destruction des hydrocarbures réfractaires, tels que les hydrocarbures aromatiques polycycliques (HAP) à poids moléculaire élevé qui sont des composés insolubles dans l'eau et donc peu accessibles biologiquement.

Ce type de traitement convient également aux boues semi liquides et aux sédiments, ainsi qu'à certains sols ou résidus industriels. Le traitement peut être réalisé en lot, directement du site d'origine de la contamination (in situ), ou en continu à l'aide de réacteurs (ex situ). D'un diamètre de 3 m et d'une hauteur de 8 m, les réacteurs sont transportables et conçus pour permettre une excellente agitation des matières en suspension.

Selon les caractéristiques du matériel à traiter, le procédé Biolyse permet une destruction de 65 % à 98 % des hydrocarbures lourds. Le traitement en réacteurs nécessite un temps de résidence moyen de trois semaines. La capacité de traitement globale des trois réacteurs est de l'ordre de 4 m^3/j.

Le traitement in situ s'effectue en lagune et nécessite un temps de résidence de cinq à dix semaines. Le volume traité peut être plus élevé que dans le cas du procédé en réacteurs, et correspond à la taille de la lagune. Le traitement in situ est recommandé pour les interventions ponctuelles, lorsqu'une quantité minimale de 1 000 tonnes de matières doit être traitée.

La dégradation des hydrocarbures s'effectue en phase semi liquide et le système Biolyse est en mesure d'effectuer une fluidisation efficace lorsque la proportion de solides ne dépasse pas 45 % en poids. Le système ne peut pas être utilisé pour le traitement des matières contenant des contaminants très volatils en raison des contrôles additionnels alors requis. Enfin, la présence de métaux dans la matière à traiter limite l'application de la technologie puisqu'une fois traitée, la matière serait débarrassée des hydrocarbures mais resterait chargée en métaux.

3.2. Installation et fonctionnement

Il y a trois étapes de transformation successives qui permettent de détruire les hydrocarbures.

Dans la première étape, sous l'effet d'enzymes et de surfactants, les hydrocarbures subissent une première décomposition qui est aussi favorisée par l'action mécanique du mélange. Cette étape permet d'accroître la biodisponibilité des hydrocarbures qui peuvent alors traverser la membrane cellulaire des microorganismes les utilisant comme source de carbone. L'ingestion des polluants par les microorganismes et la dégradation endocellulaire constitue les 2ème et 3ème étapes de transformation. Ces trois étapes sont les mêmes pour les deux types de traitement. Elles s'effectueront de façon simultanée pour le traitement en réacteurs et de façon séquentielle pour le traitement in situ.

L'originalité de la technologie de Sanexen repose sur une réaction en chaîne qui se produit lorsqu'une masse critique d'enzymes spécialisées est dépassée. Cette réaction entraîne un mécanisme de rétroaction positive qui permet d'accélérer la biodégradation et rend le procédé fortement exothermique. La chaleur dégagée favorise l'évaporation de l'eau contenue dans les boues et, conséquemment, une réduction de volume de l'ordre de 40 % à 60 %. Elle permet aussi au procédé d'être applicable 12 mois par année.

Le système Biolyse peut être automatisé ou non, et nécessitera un employé à temps partiel ou à temps plein selon l'application. En fonction de la nature des contaminants présents, des mesures de sécurité peuvent être requises lors de la manipulation de la matière à traiter. Le procédé ne génère normalement aucun effluent liquide, l'eau étant recirculée à l'intérieur du procédé.

Le coût de traitement avec le procédé Biolyse varie en fonction du volume à traiter et des performances recherchées.

4. LES INSTRUMENTS INFORMATIQUES

La réhabilitation des sites repose de plus en plus sur l'utilisation du concept d'analyse et de gestion des risques toxicologiques et écotoxicologiques.

Le logiciel **SITE**, permet de cartographier les sites contaminés montrant les types d'interventions possibles et les risques environnementaux.

Les différents modules du logiciel **SITE**, sont principalement conçus pour aider les gestionnaires dans l'application d'un traitement biologique actif ou d'une approche de réhabilitation basée sur l'atténuation naturelle des contaminants.

Le logiciel **SITE I** permet d'identifier les zones d'applicabilité de l'atténuation naturelle des contaminants pour les eaux souterraines. Il tient compte des caractéristiques géologiques et hydrogéologiques du site ainsi que des facteurs environnementaux permettant au processus de biodégradation de se produire. Le logiciel considère la vulnérabilité des eaux souterraines à la contamination et tient compte du risque écotoxicologique. La flexibilité de SITE I permet également d'estimer l'étendue des nappes d'eaux contaminées nécessitant une intervention de réhabilitation (ex: le pompage).

Le logiciel **SITE II,** permet d'évaluer le potentiel d'atténuation naturelle des polluants dans les sols de la zone non saturée. Ce modèle, plus simple, est dérivé du modèle SITE I et s'applique aux sols de surface (moins de 1,5 m), c'est à dire à ceux qui présentent un risque pour la santé humaine et aux sols excavés qui sont entreposés en dépôt. Le modèle tient compte des processus abiotiques impliqués dans le transport des polluants, des processus de biodégradation, et prend en compte l'évaluation des risques à laisser les sols en place.

5. PROPOSITIONS ET CONCLUSIONS

Dans ce cas pour du "Triangle de Marienau" on propose de:

- mettre sur le site un piézomètre de surveillance de la qualité de l'eau souterraine et un autre en aval du site;
- mettre sur le site un réseau de sondage pour voir si il y a d'éventuelles pollutions dans ce site pour choisir le scénario de réhabilitation;
- effectuer des analyses d'eau de la Rosselle en amont et aval du "Triangle de Marienau" pour voir si il y a une influence sur la qualité de l'eau de surface dans le tronçon où se trouvent les trois bassins et les deux lagunes;
- d'étudier en laboratoire des prélèvements de sol du "Triangle de Marienau" par la méthode de lixiviation pour les polluants éventuels;
- d'effectuer, le cas échéant, un biotraitement sur le site du "Triangle de Marienau.

Conclusion:

- la surface du site est entièrement végétalisée;
- lors de la construction des bassins du "Triangle de Marienau" aucun dispositif de protection des sols et de la nappe phréatique n'a été mis en place;
- une partie du goudron extrait de ces bassins, a été acheminée vers la cokerie de Carling;
- les travaux de réhabilitation ont été réalisés sur le site après que des essais de mélange de cendre et goudron aient été effectués en laboratoire;
- le fond des décanteurs n'a pas été bétonné et non pas été nettoyée avant l'opération de remblayage avec des schistes;
- les fonds de la lagune n'ont pas été nettoyés avant d'être remblayés avec des schistes;

Actuellement on ne dispose ni de diagnostic des sols ni d'analyses des eaux ni d'aucun autre de nous permettre d'établir un constat d'impact sur l'environnement.

6. BIBLIOGRAPHIE

[1]. J. Bernot, R. Chantereau. - *Traitement biologique des eaux de cokerie.* ATS 1968.

[2]. J. Bebin. - *Le lagunage aéré.* TSM L'eau novembre 1973.

[3]. S. Hains, K. e.a. - *Etude du potentiel d'atténuation naturelle d'un site à pollutions mixtes résultant des activités d'une ancienne cokerie.* Ecole Polytechnique de Montréal. CRSNG en assainissement et gestion des sites. 2001.

LOCAL PUBLIC ADMINISTRATION UNDER THE CIRCUMSTANCES OF RE-STRUCTURING MINING INDUSTRY IN THE JIU VALLEY

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Abstract: The paper intends to focus upon the economic, social, and administrative evolutions that took place in the Jiu Valley during the period 1996 – 2005 under the circumstances of re-structuring mining activities within this area.

1.RE-STRUCTURING MINING ACTIVITY IN THE JIU VALLEY

The industrial exploitation of the largest pit-coal deposit in Romania began in 1852, in the Jiu Valley. At present, the National Pit-Coal Company S.A. in Petrosani (N.P.C. -S.A.) continues the activity of extracting, preparing and processing pit-coal with a view to producing electricity in power-stations as well as thermal energy for population and other institutions. The industrial reserve is of about 323 million tones and is able to assure the continuity of exploitation for a period of over 80 years.

The economic and political changes that have taken place at a national level, after 1989 determined a deep decline of the mono-industrial region of the Jiu Valley and materialized in various results among which, in order to accomplish the goal of this paper, only the below ones are going to be considered.

The production of raw coal extracted in the Jiu Valley decreased from 11.2 million tones in 1989 to 5.9 million tones in 1990 in order to subsequently increase to 7.17 million tones in 1996. Afterwards an almost continuous decrease of the production has occurred so that in 2005 only 3 million tones were extracted. The limitation of coal mining extraction in the Jiu Valley that materialized in the preserving or shutting down of certain mining units, quarries and preparation units, in re-organizing and employment terminating part of the personnel has been determined by the decrease of pit-coal demand as a result of diminishing the consumption within re-structured Romanian economy. Accordingly, until now, the following mining units have undergone preservation works and/or have been shut down: Campu lui Neag, Valea de Brazi, lupeni Sud, Aninoasa, Iscroni, Dalja, Petrila Sud and Lonea Pilier as well as the preparation units of Uricani, Lupeni, Liveyeni, and Petrila.

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The number of N.P.C. - S.A. employees continuously diminished from 54,493 in 1990, to 44,920 in 1996 and to only 18,114 in 2000 as a result of the massive employment terminations during the period 1996 – 1998; afterwards, the descendent trend maintained so that, at present, there are about 13,000 employees.

On the other hand, the expenses reported to 1,000 lei commodity production have had a variable evolution with values between 2600 and 1600 lei reported to 1000 lei commodity production; such an evolution has been the result of both the changes of the volume of raw extracted production, of the total production expenses, and of the maintaining of the selling price under governmental control and of non-up-dating it according to the market value. Such values of the expenses reported to 1,000 lei commodity production, on de one hand, and the continuous decrease of the resources provided by the state budget as subsidies and budget transfers, during the period 1996 – 2002, on the other hand, determined the company's incapacity of paying its debts towards the state's consolidated budget, and implicitly towards the local public administrations of the Jiu Valley.

Consequently, on June 30, 2005, N.P.C. – S.A. exhibited historical debts of 8,880 billion lei (contributions and penalties) out of which debts towards the state budget of 5,734.7 billion lei, and debts towards the local budgets of 30.4 billion lei.

2. THE LOCAL PUBLIC ADMINISTRATIONS OF THE JIU VALLEY

Administration represents one of the most useful human activities applied to the entire complex environment of social life.

The concept of administration has three main meanings:

a) administration as a human activity within the process of administration;

b) administration as structure or organization indispensable for the accomplishment of the process of administration;

c) administration as an institution, comprising its activity and structure in order to accomplish the responsibilities given by political power and to satisfy general interests observing people's legitimate rights and interests.

This paper has in view exactly the third meaning of administration and focuses on the process of management within administrative institutions at a local and district level. Public administration must serve general interest or the interest of a local collectivity. When it serves the interest of a local collectivity and is represented by the autonomous local forums (district council, local council and mayor) or by the budget institutions, autonomous administrations and/or the companies that are subordinated, from the point of view of their organization, or of their functions, to the district or local councils, we deal with local public administration.

The content of local public administration is given by the activities that take place as a result and fulfillment of the country's laws and of the decisions of the district and local councils. Consequently, local public administration is a continuous process and a permanent activity, adaptable to the dynamic conditions of the social environment of the local collectivity. Social environment exerts an important influence upon the structures, phenomena, and content of the administration's activities, as well as upon the psychology and the behavior, both individual and collective, of the administration's staff. On the other hand, administration communicates with social environment according to certain relations of co-operation, subordination and even constraint, and accordingly, it exerts its influence upon the evolution of local collectivity. Local public administration provides a democratic governing at a local level. The improvement of this local governing implies the superior turning to good account of local resources owing to a performing management at a local level.

3.LOCAL AUTONOMY AND THE MECHANISMS OF FINANCIAL TRANSFER.

Local autonomy gives the right to local public authorities to solve and administrate, according to the law, public goods, in the name and interest of local collectivities they represent. Local autonomy is only administrative and financial and regards organization, functioning, competences, and abilities as well as the administration of those resources that, according to the law, belong to the territory and administrative unit.

Among the authorities of the local, district and central public administration there are relations established by legislation; nevertheless, "the authorities of central public administration cannot impose responsibilities to the authorities of local administration without providing the financial means necessary in order to accomplish such responsibilities".

In order to provide financial means at a local, district, and national level a legislative system has been elaborated and applied with a view to regulate both the financing resources of the local, district, and state budgets, and the mechanisms of financial transfers among these budgets.

The mechanisms of inter-budgetary transfers, regulated by G.E.O. no. 45/2003, modified, stipulate that the companies' income tax should be divided according to certain percent "shares" that represent incomes of the state, district, and local budgets. Accordingly, at present, 18 % of the collected income taxes belong to the state budget, 35 % to the district budget, out of which 13 % are used at the district level and 22 % are used in order to balance local budgets, and 47 % belong to the local budget of the public administration within whose territory these companies deploy their activity.

Meanwhile, the most important deviations from the legal stipulations that regulate the functioning of financial inter-budgetary mechanisms, although the shares have had other values, have been displayed by the units subordinated to N. P. C. – S.A. Petrosani as they did not have financial resources to pay the income tax to the state budget; consequently neither the district budget nor the local budgets have had a benefit from the corresponding divided shares. The situation determined a financial obstruction of the Jiu Valley public administrations and, subsequently, an inefficient financial management of such administrations.

The size of this financial obstruction generated, at a large extent, by the re-structuring of the Jiu Valley mining activity, is further exhibited.

4.FINANCIAL BALANCE AT A LOCAL LEVEL.

The re-structuring of the Jiu Valley mining activities significantly influenced the management of the local public administrations authorities, both from the point of view of social implications and from the point of view of available financial resources and of their use.

The significant diminution of the number of employees of the mining units (about 50 %) during the period 1996 – 1998, owing to employment terminations determined by the re-structuring process, generated during the period of time that followed such terminations, contradictory social effects and manifestations. Accordingly, during the period that immediately followed the “waves” of terminations, the new social category, that of the persons whose employment terminated, in its majority, spent compensation money in order to better live and to buy long term consumer goods. After they spent the money obtained as compensation for their employment termination and after the periods when they benefited from unemployment support and support indemnification, not being able to find a new job, a part of them associated and initiated street claiming protests.

As a consequence, during the period 2000 – 2001 the authorities of the Jiu Valley public administration worked under “street pressure” and provided significant financial resources as social support for the families of those who couldn’t find a new job after their employment termination.

Subsequently, due to the adoption and implementation of the law that stipulated and provided the minimum guaranteed income, the social protests of the Jiu Valley mining employees whose employment terminated diminished and social tensions ceased to determine the same pressure on the local public administrations.

The above data try to briefly describe the evolution, from a social perspective, of the objective conditions that marked the process of management of the Jiu Valley public administrations, without approaching the psychological and social aspects at the level on the individual, family, and social group.

Further, in order to reflect financial resources and the way they are used by the Jiu Valley local public administrations, we are going to analyze the evolution of planned incomes as well as of those collected at the level of the entire Jiu Valley region, both as a whole and according to the element that depends on mining re-structuring, that is according to the incomes collected owing to the divided shares of income taxes.

The evolution of the incomes planned by the incomes and expenses budgets emphasizes medium increases of the incomes planned for the period 1996 – 1999, from 26,354 million lei, in 1996, to 107,015 million lei in 1999 as well as spectacular increases of the incomes planned for the period 2000 – 2004, from 170,417 million lei, in 2000, to 1,540,112 million lei in 2004. Such spectacular increases of planned incomes are explained by the stipulations of the budget law that required that the incomes planned and not collected in the previous year should be included in the incomes planned for the next year. The evolution of the incomes collected within the Jiu Valley as a whole, according to the budget execution accounts, resembles, from the point of view of their tendency, with the evolution of planned incomes; nevertheless, from the point of view of their values, collected incomes are significantly inferior as compared to planned incomes.

The percent level of achieving planned incomes within the Jiu Valley as a whole, during the period 1996 – 2005 shows that during the analyzed period two sub-periods having opposed tendencies set forth, namely, the sub-period 1996 – 1999 when the percent of collecting planned incomes increases from 83.93 % to 91.30 %, for the entire Jiu Valley (a situation resembling that of the rest of the country), and the sub-period 2000 – 2004 when the percent of collecting planned incomes continuously decreases from 78.14 %, in 2000, to 56.54 %, in 2004 (a situation that is not similar to that of the rest of the country).

These diminished levels of collecting total planned incomes are due to the fact that within total incomes the component of the divided shares of the income tax has a significant size and its level of accomplishment was significantly lower. In order to support this allegation, we have analyzed the share of the incomes provided by the divided shares of the income tax within the total amount of the incomes planned and collected and the degree of collecting planned incomes of the component of divided shares of the income tax within the entire Jiu Valley.

The level of the planned incomes of the divided shares of the income tax within the total amount of planned incomes shows an almost continuous increase, from 27.5 %, in 1996, to 52.0 %, in 2002; afterwards, it decreases and maintains its value of about 40 %. The significant increase of the level of the planned incomes of this source is explained by the accumulation of the incomes that were not collected in the previous year.

As regards the level of collected incomes of the divided shares of the income tax within the total amount of achieved incomes two completely different sub-periods set forth, namely, the sub-period 1996 – 1999 when the level of the achieved incomes corresponding to this source increases from 32.6 % to 43.6 %, superior to the planned level, and the sub-period 2000 – 2003 when the level of the achieved incomes corresponding to this source decreases from 22 %, in 2000, to only 6.5 %, in 2003 and is quite inferior to the planned level. Between 2004 and 2005, we witness an increase of the level of the incomes corresponding to this source from 16.5 % to 21.0 %, that is about half of what had been planned.

The level of achievement of the planned incomes of the divided shares of the income tax also has a similar evolution during the two sub-periods of the up-dated period. Accordingly, during the period 1996 – 1999, the planned incomes corresponding to this source are completely achieved (100 %); during the period 2000 – 2003, the level of achievement, within the Jiu Valley, decreases from 40.2 %, in 2000, to only 9.7 %, in 2003. During 2004 and 2005, we witness an improvement regarding the level of achievement of the planned incomes corresponding to this source.

5.THE MANAGEMENT OF LOCAL PUBLIC ADMINISTRATIONS UNDER THE CIRCUMSTANCES OF RE-STRUCTURING

All the evolutions previously exhibited emphasize the fact that the re-structuring of mining activities in the Jiu Valley significantly influenced the management of local public administrations both from a social point of view, during the period 1999 – 2001, and from an economic and financial point of view, during the period 2000 – 2004.

Consequently, the changes that have taken place within the social environment, on the one hand, and the financial limitations determined by the impossibility of collecting the incomes owed to the local budgets, according to the legal stipulations, on the other hand, generated a shift of the focus of the local public administration management, from prevision activities and identification of strategic solutions meant to solve the problems of the local communities, to current activities and identification of so-called "survival" solutions.

Consequently, the lack of alternative jobs and the somewhat forced constraint of the necessity of creating and financing jobs towards the District Employment Agency and local administrations determined momentary solutions set forth in temporary employment programs (6 months) for the persons who terminated employment and not in a substantial solution of the jobs problem.

The fact that planned incomes of the local budgets have not been achieved mainly determined negative effects upon the management of the local, public administrations, although certain positive effects could have also been noticed. Among the negative effects the most important are the following:

- the delay of achieving investment works under execution, among which gas works are of major importance, as well as the impossibility of initiating new investments in the local communities;
- the poor financing of maintaining and modernizing the works of local infra-structure with negative effects upon their state and functionality;
- the poor financing of the companies subordinated to the local councils and, consequently, inferior services of communal administration and providing of thermal agent and house-keeping warm water;
- the impossibility of financing the building of dwelling-places although the demand has been and still is quite high;
- the impossibility of financing feasibility studies and projects meant for tourist objectives, although everybody agrees that tourism is one of the viable alternatives provided by re-structuring mining activities in the Jiu Valley.

As a main positive effect of the lack of financial resources at a local level in the Jiu Valley, we should mention the access to non-repayable funds. Accordingly, at the level of each local public administration specialized departments have been organized, elaborating the documentations necessary to access to non-repayable funds. Thus, during the period 2001-2004, the local public administrations of the Jiu Valley acceded, within the PHARE – MARR program, 2.3 million Euro, and within the PHARE 2001 RO 108 program, the "Small Infra-structure" component, 1,814,532 Euro.

At present, theses departments have the necessary experience in order to access such non-repayable funds and, under the circumstances of January the 1st 2007 integration, they are going to turn to good account post-integration structural funds.

6. CONCLUSIONS

The re-structuring of the mining activity of the Jiu Valley significantly influenced the social and economic evolutions at a local and regional level. Such evolutions have been and still are partly different from those witnessed at a regional and national level.

As a consequence, the local public administrations of the Jiu Valley confronted with complex social and economic problems, among which: high unemployment, severe poverty, poor financial resources, the lack of interest of investors and the governors' indifference.

Under such special circumstances, the management of the local public administrations succeeded in maintaining a certain balance at the local level and in identifying solutions that, during the next period, may re-vitalize the economic and social life of the region.

BIBLIOGRAPHY

[1]. Hodor, P. – *Particularities of the Management of Local Collectivities under the Circumstances of Re-structuring the Mining Activity within the Jiu Valley*. Scientific works of the International Symposium "Universitaria ROPET 2001", Focus Publishing House, Petrosani, 2001.

[2]. Hodor, P. – *Financial Aspects of the Management of the Jiu Valley Local Collectivities*. The Review of Management and Economic Engineering, vol. I/no.3, 2002.

[3]. x ^{x} **x** – *N.P.C. – S.A. Petrosani. The Situation of Technical and Economic Indicators*.

[4]. x ^{x} **x** – *The Jiu Valley Town-halls. Incomes and Expenses Budgets*; Budget Execution Accounts.

ASPECTS OF THE ANALYSIS OF THE MINING INDUSTRY PRODUCTION PROCESS

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Abstract: In order to solve management and engineering problems, beginning with the simplest ones, such as the movements of a worker during the working process, and ending with the most complex ones, such as the management of the various economic activities specific to large companies, analyses of the production process are drawn out.

Keywords: resources, mining industry, management, complex of operation, production process, movement.

In order to solve management and engineering problems, beginning with the simplest ones, such as the movements of a worker during the working process, and ending with the most complex ones, such as the management of the various economic activities specific to large companies, analyses of the production process are drawn out.

Nowadays, there is no unitary approach of such analyses or a unitary consideration of the problems they arise; each problem category according to their level of complexity still employs its own notional system of principles and criteria.

A single category of problems, namely the one regarding work quoting, is approached owing to a standard analysis system. This analysis system, in the case of the mining industry had as a basis the already existent standard analysis system of the machine building industry. Within the extractive industry such a standard is extremely difficult to be used; there are even instances when it cannot be employed for certain production processes.

Consequently, a few decades ago, that is between 1955 and 1960, they set forth and published a conception of analysis of the mining industry production processes according to a proper system of notions and principles.

This system has been proposed by Professor M. Al. Luca and set forth by a scientific work at Prague in 1962.

The basic idea of the production process analysis model proposed by Professor Luca is the passage from simple to complex, passage that is underlined by qualitative

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leaps of the work object that undergoes the changes. Accordingly, everything starts from the simplest work acts of a worker finally reaching processes of a great complexity at the branch level.

Three levels of complexity can accordingly be established:

- Inferior work and technological stages;
- Medium work and technological stages;
- Superior work and technological stages.

There are certain criteria according to which the integration within certain levels can be done, such as:

- The time during which the work act develops;
- The space within which the work act develops;
- Integration is done from simple to complex.

1. Inferior work and technological stages

These stages begin with the simplest work acts of the worker, namely the movements of parts of the human body, and end at the moment when the first changes of the work object can be identified and, even quantified.

According to their complexity, the inferior stages are the following:

- Movement (m);
- The complex of movements (cm);
- Handling (H);
- The complex of handlings (CH).

These stages are also similar to the standard specifications of the machine building industry.

1.1. Movement

The defining marks are the human body and its condition at a certain moment of the working process.

A movement is the change of the position of a part of the human body as compared to the previous condition. A movement is the simplest work act of a worker.

1.2. The complex of movements

The defining mark for a complex of movements is, this time, a material object of the production process (e.g. materials, tools, machines, a place within space) and human body.

A complex of movements is a group of movements specifically combined (overlapped or successive) that finally lead from a certain position of the human body as compared to the material mark to another position as compared to the same material mark.

The complexes of movements can be complexes of movements of changing the place (changing the place towards the pick-hammer), complexes of movements of engaging (seizing the hammer), complexes of movements of disengaging (setting free the hammer) and complexes of movements of relaxation in order to recover owing to a micro-break. The complexes of movements determine several types of movements.

1.3. Handling

In order to define handling we introduce as a mark a first position change of one of the material elements of the working process.

Handling is a technological group of complex movements or of movements only that finally change the position of the material elements taken into consideration. An example of handling is the switching on of a bulb from the switch.

1.4. The complex of handlings

The complex of handlings has as a defining mark either a single material object that successively moves through several positions in order to reach a qualitative different position as compared to the intermediary positions or several material objects that undergo handlings (simultaneously or successively) in order to determine a different configuration from the previous position.

As examples we can notice the complex of handlings of loading wood on a truck or the complex of handlings of starting a drill rig.

The identification of these work stages within the production process and their correct definition is necessary in order to explicitly set forth beginning and ending marks mainly with a view of measuring time. Such analyses of production processes are drawn out for planning studies of working methods as well as for time study and its measurement.

2. Medium work and technological stages

The qualitative leap from the inferior stages to the medium ones is marked by the elementary changes (the first change of the work object), and the ending of medium stages is marked by reaching the final form of the changes of work objects when they are already taken or given either to other workers or in order to be received and paid (even if they are taken by the same worker in order to be changed again). The medium stages are the following:

- The operation (o);
- The complex of operations (co);
- The phase of simple process (psp);
- The simple process (sp).

As regards the medium stages there is no equivalence between the standard terminology and the terminology proposed for the mining industry due to the complexity of the mining production processes.

2.1. Operation

An operation can be defined when its technological elements are well established, that is the changes of work objects that take place during the operation, when the work object is correctly defined (especially those changes for which a worker is quantified and paid).

An operation is a group of complexes of handlings and/or handlings and passages and, possibly, machine phases that have as a result a first (elementary) change of the work object already defined, a change that can be quantified and for which a worker having a certain qualification is quoted and paid.

The defining elements of an operation require maintaining unchanged its material elements (tool, machine, material) as well as of those of the worker. The change of these material elements specifies another operation. Examples of operations: preparing a drill for drilling, drilling, elevation of the beams on the console, ripping the sections, loading the resulted material with the loading machine, trucks maneuver at ramification.

2.2. The complex of operations

There is a work object at the level of the complex of operations that is usually the result of one of the operations that are part of the complex of operations or of several operations that are considered to be the main ones of the complex of operations. The change of the work object is superior to any operation having a higher degree of finishing. At the same time, beside the operations that are considered to be the main ones there are other secondary operations that only help the well performing of the main operations.

Some of the secondary operations have, as a rule, a beginning or a ending character with no time connection with the duration of the whole complex of operations or with the volume of change achieved within the complex of operations.

As a result, within a complex of operations, both repeatable operations can appear considering the proportionality of work consumption to the volume of changes to be achieved, and unrepeatable operations that consume work that does not depend upon the quantity of changes of the work object.

The complex of operations is a group of main and secondary operations, repeatable and unrepeatable connecting each other and overlapping according to certain technological rules having as a result changes of work objects superior to any of the component operations. As an example, the drilling of a mining with a view of achieving a leap is a complex of operations due to the fact that starting with the moment the drilling begins until the moment the mining can be taken in order to load the holes several operations should be done in the sense previously defined. Accordingly, the following operations may take place:

- Proper drilling – main and unrepeatable;
- Passage from one hole to another – secondary and repeatable;
- Cleaning the hole – secondary and repeatable;
- Preparing the drill – secondary and unrepeatable;

- Fixing the holes – secondary and unrepeatable;
- Removing the drill – secondary and unrepeatable.

2.3. The phase of simple process

The works of Professor M. Al. C. Luca contain certain ambiguities regarding the way a simple process is defined, a fact that determines the necessity of including another stage between the complex of operations and the simple process. This contribution to the analysis of the mining work processes has been done by Professor Aurelian Simionescu, D.E. who noticed that several simple production processes are, in fact, made of several process phases. As an example, in order to build a drift the following process phases are to be considered:

- Digging and sustain;
- Enlarging and concrete filling;
- Railway building.

Process phases may be assigned to different working teams. Such process phases are quoted and paid differently even though they are achieved by the same working team. Process phases are done during different periods of time and, consequently, different agreement contracts are to be concluded, the phases being received and paid separately.

A process phase has as a result only a part of the entire work; yet, it is a finite one from the point of view of those who execute it. There are simple processes that have a single process phase, but there are also simple processes that have several process phases.

2.4. The simple process

A simple process is a group of complex operations and/or process phases within a defined technology but different from the one of the complex of operations and only owing to the combining of such complexes of operations and/or process phases that result in a work, a product or a service that, from the point of view of their destination, are already finite.

A simple process may be the execution of a mining work (drift, shaft, ladder shaft, incline) or the extraction from the mining of useful ore. A simple process, as we have already seen, may include several process phases.

The simple process has been defined as resulting in a finite work (drifts, inclines, shafts, ladder shafts) or finite products (extracted coal or ore).

3. Superior work and technological stages

3.1. The complex process

Complex processes are organized at the sector or unit (quarry) level and include all the simple processes of the main and auxiliary activities of the unit.

At the level of the complex process only exchanges of delivering and receiving between independent workers take place.

The analysis of the complex process according to the component simple processes and their process phases is the object of the engineering of production processes at sector and unit level. Currently, they materialize under the nomination of production programming, production organizing, and production supervising being accomplished by the programming, organizing, quoting, and remuneration department specific to each mining unit.

3.2. The integrated process

The integrated process structures the complex processes of various units having a mining profile (mines, quarries) with other units that deploy complex processes of preparation or even processing auxiliary products, general services, that is activities having a different character from the mining one.

Integrated processes are to be encountered at the level of autonomous administrations or mining branch.

REFERENCES:

[1]. Simionescu A., *Organizing and Administrating Mining Activities*, Technical Publishing House, Bucharest, 1985.

[2]. Tiuzbaian I. N.,*Researches with a View of Elaborating a New System of Quoting the Work within the Mines of the Jiu Valley Having as a Basis the Engineerig of Working Methods*, doctorate thesis, Petrosani, 2002.

INFLUENCE THE OF „LABOR" PRODUCTION FACTOR UPON WORK QUOTING AND PRODUCTIVITY IN MECHANIZED MINING

IOAN NICOLAE TIUZBAIAN*

Abstract: Every mining work of opening or preparing in execution, respectively every mining front, represents a well-established production system, characterized by its own production function. This function determines the quantitative link among the input factors, specific to the individual production system, and the results obtained due to its functioning, results represented by meters of drift or tons of coal.

Keywords: resources, coal, mining industry, management, production process, improve

Every mining work of opening or preparing in execution, respectively every mining front, represents a well-established production system, characterized by its own production function. This function determines the quantitative link among the input factors, specific to the individual production system, and the results obtained due to its functioning, results represented by meters of drift or tons of coal.

Coal production extracted from a mining depends both on the resources allocated and consumed within the mining and on the natural conditions characteristic to the mining. The production level achieved is a direct result of the mining technology applied as well as of the number of humans that work in the mining. A great influence upon the mining production has the way maintenance and supplies of the mining are provided.

A review of the input factors characteristic to the mining regarded as an individual production system, emphasizes the existence of certain essential distinguishing features among them.

Accordingly, there are:

1.Input factors independent of certain managerial decisions not being influenced by such decisions. Theses factors are represented by natural, geo - mining conditions such as: the type of rocks, the physical and mechanical properties,

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2. especially the firmness and the cutting strength, the existence of certain tectonic accidents, hydro and dynamic conditions, gas and dynamic conditions, the main characteristics of the deposit, such as thickness, inclination or depth.

When the mining is going to function, these input factors will be known only partly; they will be completely known only after having extracted the whole deposit of the mining field.

3. Management decisions regarding the exploitation method and the technology to be employed.

The technologies of executing mining works as well as the parameters they are characterized by (section, sustain, fitting out) also represent managerial decisions taken according to the first category of factors, but taking into account the particularities of the exploitation method that is going to be used. Strictly connected to the exploitation method, but taking into account natural conditions a certain mining technology is going to be chosen. As a rule, once chosen, this technology constitutes an input factor that doesn't change during its functioning. Only under special circumstances, when natural conditions impose such a fact, this technology will be modified, but the new technology will also be the result of a managerial decision.

Having chosen the mining technology, one can state that the "capital" input factor has already been established as an essential production factor; accordingly, the quantity of coal that is going to be extracted from that mining directly depends on it.

After adopting the technological solution, the management preoccupations are going to regard the organization of the activities in the mining, respectively the adoption of the most suitable model of organization and determination of the number of workers necessary in the mining. Once this stage has ended the production factor "labor" has been determined too.

4. The basic and auxiliary materials that will be consumed at the work place. The demanded level of these input factors is determined by the mining technology employed as well as by the intensity this technology is used.

5. Auxiliary staff that is going to be employed in order to maintain and supply the work place.

The mining production will be influenced by each of these categories of input elements. Nevertheless, those influences, their mechanisms of initiation, the way they are transmitted will be different, specific to each category of input elements and even to each element.

Below we are going to analyze the way the results of the mining are influenced, that is production, by the number of workers employed in order to do mining works.

After choosing the mining technology, according to a organizational model selected by the management according to the characteristics of the mining technology chosen, the number of mining workers is going to be established, that is the force of the mining face. The calculus of the number of workers necessary for the mining faces is generally done without taking into account a fundamental production law – the law of reducing the coming backs to a single production factor – which shows that when a production factor is increasingly employed, the other production factors remaining unchanged, production increases are smaller and smaller; at a certain moment they become null, the whole production manifesting a tendency to diminish.

The Nortier model of organizing the mining activities analyses dependencies such as the "number of workers within a certain mining – mining productivity", confirming the validity of the coming backs to a production factor. Such dependencies are emphasized only within a mining equipped with a plow or within which coal cutting is done by a combine.

The input factor called "mining staff" belongs to the category of input elements regarded as solutions adopted by the management that remain unchanged as long as the mining exists. This means that the mentioned production factor has the character of a fixed, constant behavior characteristic that is once having established its level it remains unchanged as long as the mining exists. Yet, in reality, this production factor, determined for the mining achievements, has a variable character.

Every leader of a work group and every specialist of the mining field know the fact that the number of workers within a mine cannot be done according to a programmed level all the time. Consequently, if the theory specifies a fixed character behavior of this production factor, founding all considerations and efficiency calculus it develops on such a behavior, practice shows the variable character of the number of persons that work within a mining. Nevertheless, this variable character also has a special characteristic: the variability of the number of human beings that work in a mining is not a natural, arbitrary variability, but a controlled variability.

Frequently, those at the beginning of the shift organize the work faces find themselves in a position of taking decisions regarding the way available forces are distributed, respectively regarding the number of human beings necessary for underground faces. Generally, the way of distributing people according to faces is the result of certain previous decisions improved according to current needs that reveal at shifts level. Yet, production theory shows that such a distribution of the staff according to faces should be done taking into account the fundamental law of diminishing the coming backs to a production factor.

The variable and controllable character of the input factor called the "number of people within a face" is emphasized by those situations regarding the face staff distribution at Lupeni mining unit.

In order to demonstrate the above theory we are going to analyze the situation of six frontal faces equipped with mechanized complexes. These faces and certain characteristics are shown in the following table 1:

According to the data exhibited in the table one can notice the fixed character given to the input factor called "face staff" by the model according to which they organize the face activity and the system of norms and rules employed. Yet, in fact, the number of workers employed in the face has a variable character controllable by the managers of the mining activities. This allegation is supported by the daily face distributions and the productions obtained according to such distributions

Tabel 1

Frontal face The 3rd layer No.	Length (m)	Height (m)	Daily programmed production (t/day)	Quoted jobs (jobs/day)	Daily programmed advancing (m/day)
1	60	3.4	182	33	0.5
2	78	3.3	273	39	0.6
3	118	3.3	427	61	0.6
4	90	3.3	223	52	0.5
5	85	3.3	444	61	1.0
6	94	3.3	279	41	0.5

The following table (table 2), for the six faces taken into consideration, exhibits the daily distributions and the daily productions obtained during a certain month.

In case we are going to analyze the table we grasp the variable character of the number of workers distributed in frontal faces.

Accordingly, there are over-distributed faces (1, 2, and 5). Yet, such an over-distribution does not suppose the obtainment of significant production growths; moreover, not even the daily programmed production is achieved.

Analyzing such a situation according to the elements of the production theory, the evident conclusion is that the optimal level of employing the production factor called "face staff" has been over-passed, production increases being smaller and smaller in the case of the persons employed over a certain number, over a certain limit (the optimal level). At the same time, within the frontal faces of the other fields, faces are under-distributed.

Such data also point out an aspect having important implications upon the efficiency of the activity deployed as a whole, the different manner of distributing faces from a production field to another (the faces belonging to different fields), without taking into consideration the fundamental economic principle represented by the rule of decreasing the coming backs to a single production factorMining.

Such under-distributions determine the significant diminution of daily production that, in certain cases, is much smaller than the programmed one. This situation can also be explained according to the elements of production theory. When face distribution drops under the optimal level, production losses will grow with every person that should have been distributed in that face.

The distribution of mining faces according to the principle of diminishing the coming backs to the production factor called "face staff" finds itself in contradiction with the present way of establishing face distribution owing to the system of work norms and rules. Although it may seem paradoxical, face production is not a lineal function of the number of workers distributed in a face. The present system of quoting the work considers that, within certain limits, such a relation exists.

This function has a more complex form, according to which the optimal level of employing the production factor called "face staff" being established.

Mining	***Front mining1***		***Front mining 2***		***Front mining 3***		***Front mining 4***		***Front mining 5***		***Front mining 6***	
	jobs	Prod t	jobs	Prod t	jobs	Prod t	jobs	Prod t	jobs	Prod t	jobs	Prod t
1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	40	76	37	253	42	98	-	-	48	354	40	244
4	38	177	45	-	53	-	50	115	48	499	54	170
5	37	174	45	63	53	-	49	298	48	599	54	198
6	-	-	43	132	53	128	45	206	47	655	-	-
7	37	236	-	-	53	148	45	144	45	305	52	337
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	37	121	49	-	54	-	45	183	51	386	51	195
11	37	62	54	302	45	157	48	181	51	380	51	578
12	37	101	54	118	45	184	46	129	51	407	51	206
13	35	124	53	181	46	251	46	255	49	529	-	-
14	34	217	50	134	-	-	46	142	40	300	50	336
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-
17	26	205	-	-	48	229	42	227	40	478	56	204
18	31	111	40	80	50	147	43	115	42	362	52	269
19	29	117	40	170	50	207	39	-	42	333	48	333
20	31	155	54	210	41	113	39	147	43	623	52	301
21	30	91	42	206	43	146	43	356	42	323	52	161
22	-	-	-	-	-	-	-	-	-	-	-	-
23	10	90	12	102	-	-	-	-	13	162	-	-
24	38	99	-	-	-	-	41	-	45	569	42	116
25	37	65	55	374	48	101	45	-	46	564	48	135
26	37	126	48	147	56	-	43	352	46	745	40	-
27	37	103	58	222	46	159	46	304	50	510	41	190
28	26	96	47	217	56	128	45	288	50	612	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
31	34	262	42	212	28	132	40	212	50	235	-	-
Total	698	2808	868	3123	910	2328	886	3654	987	9930	834	3973

Yet, we should mention the fact that this optimal level is not regarded as a certain number of workers who, in case they are distributed in a certain face, characterized by certain conditions and by a certain manner of supply and maintaining all necessary utilities , are going to achieve the maximum possible production of that face, bur rather as a certain interval during which, compulsorily, the number of workers distributed in the face should enter, in case one wishes to obtain the best results, taking into account the fact that, at the beginning of each shift, the problem of distributing the workers according to work faces should be solved.

Even the necessity of accomplishing a certain distribution, according to specific criteria, of the forces per work faces determines the variable and controllable character of the production factor called "face staff".

The data contained by the above table and the graphics at the end of the chapter (in the thesis), represented by the combinations of values called "face jobs – achieved production", seem to provide the informational basis necessary in order to establish some dependences of a functional type between the dependent variable called "daily production of the face" and the independent variable called "the number of jobs daily performed in the face", dependencies owing to which, the optimal level of employing the production factor entitled "face staff" might be established further.

The processing of such data with a view of obtaining certain explicit mathematical forms of the existent dependencies is not going to be undertaken as the authenticity of the data regarding the productions obtained is not so rigorous due to the continual transport fluxes that accomplish the transport of face production up to the main collecting points; it is consequently difficult to exactly establish the daily production a each face.

Production is daily reported, but such a fact rather represents the result of a subjective manner of appreciation rather than rigorous calculus. In order to support such allegations we should mention the values calculated in the case of the productions achieved within each face when, on each decade, face topographical measurements are done. At the same time, at the end of the month, when on the basis of such measurements the production achieved during that month is established within each face, one notices the fact that between this value and the value obtained by cumulating the daily reported productions there are significant differences.

The research and the establishing of the optimal level of employing the production factor called "face staff" should have as a basis data that are most specific to practical reality so that the conclusions obtained are affected by a smaller margin of error and found a new basis, rational from the economic point of view in order to distribute according to each shift the forces of work faces.

The above data determine two conclusions regarding the manner workers distributions according to faces is done:

1. The production factor called 'Face staff" has a character of managerial solution that does not keep a constant, unchanged character during the functioning of the face, representing a variable input factor that, at a same time, is, to a certain extent, controllable by managers;

2. The under-distribution of workers within the faces represents a reality that determines significant losses of production and productivity.

As regards the forces distributed to each face and, in the case of advance faces, as well as in the case of a mining, the forces distributed within a face are not fixed; they have a variable character in time (the limits of variation are smaller than in the case of a face), controllable, to a certain extent, by the front line managers of the mining underground activities.

REFERENCES

[1]. Simionescu A., *Organizing and Administrating Mining Activities*, Technical Publishing House, Bucharest, 1985.

[2]. Tiuzbaian I. N.,*Researches with a View of Elaborating a New System of Quoting the Work within the Mines of the Jiu Valley Having as a Basis the Engineerig of Working Methods*, doctorate thesis, Petrosani, 2002.

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