ENVIRONMENTAL IMPACT DUE TO USE OF COAL IN MINTIA THERMAL POWER PLANT

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Abstract

This paper makes reference to issues related to the role and influence of using solid fuels necessary for the operation of Mintia –Deva Thermal Power Plant and the influence of using coal, in the burning process, on the environmental factors.

It is shown the role of the solid fuel (coal) and its availability in the energy field, being made an evaluation of the pollutant emission during 1989-2011, according to the fuel consumption and to the fuel characteristics used in that period of time.

Moreover, it is described the influence of the coal on the environmental factors, through the sulfur oxide, nitrogen and carbon pollution, with coal powder in the coal storehouse, with noise inside the storehouse and through the coal and ash radioactivity resulting from the burning of coal.

Key words: energetic power, environmental factor, impact, pollutant, coal.

1. Introduction

Nature protection, the protection of its natural resources, of biological diversity and of ecological structures that define it, represent a national, economic and human social interest concern, with a decisive role within company sustainable development strategy.

From all human achievements, power plants are, through their very large physical extent, within a close inter-conditioning with the environment. The main priority on many countries list is represented by energetic efficiency improvement.

Energy installations, especially thermal power plants that use coal as a fuel, can influence the environment, sometimes leading even to ecological balance damage within areas where they are located, so that the energy field be considered as the main pollution source.

Mintia Thermal Power Plant showed a broad interest for the issues related to environmental protection, starting from emission and pollutant immissions values knowledge, from the facilities technical state, which – through an improper operation – may cause pollution, and to environment and human factor impact assessment (Mintia Thermal Power Plant staff health and of thermal power plant emplacement area population).Mintia – Deva Thermal Power Plant represents the Romanian third great electrical energy producing unit, and through the installed power size and the high availability degree, safety and operation continuity represent a basic electrical energy source of the National Energy System and of the thermal energy within Deva town.

Mintia Thermal Power Plant is located on the South- East of Transylvania, on the Mures river left shore, at 9 km from Deva town (figure 1). It has an installed power of 1.285 MW, being provided with 5 energy units, 210 MW each (TA 1, 2, 3, 4, 5, 6) and 1 energy unit of 235 MW (TA 3), within block system, each supplied by 2 identical steam boilers, of 330 t/h, 13, 72 MPa, 550^{o} C, each energy unit being an independent unit.

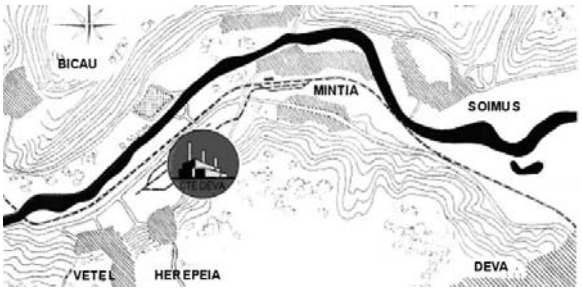

Fig. 1. *Mintia – Deva Thermal Power Plant*

The main fuel is the coal from Valea Jiului basin (energy hard coal), and the auxiliary fuel used are natural gas and black oil.

Since commissioning, Mintia Thermal Power Plant, has produced approx.10% from country electrical energy and approx. 22% from the electrical energy produced by the thermal power plants that use coal as raw material.

2. The role of coal within energy industry

Standard power plants, provided with conventional boilers on fossil fuels were labeled as major emission anthropicstationary sources.

Environment issue within the field of electrical and thermal coal energy production field is emphasized through the following steps:

- mining (coal extraction and preparation);
- coal combustion and electrical and thermal energy production;
- waste management – pollutants removal.

Coal is the fossil fuel the most vulnerable to public opinion reaction, so it tries to reduce the

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emission of the gases that generate the greenhouse effect, especially the carbon dioxide (CO_2). However, coal is still used within many countries.

Coal continues to be the energy main source, because is available and low-priced and is used in large amounts within many countries, and nature protection after its combustion, especially within large energy equipment,is a reality from which no electrical energy producer can deviate.

For a rather large period of time, coal continues to be the main energy source and it will maintain the role of safe fuel, for many countries, being the only economic fuel available to cover the increasing electrical energy demand, that is an essential element for life standard raising.

Authorities assessments from coal field and European Community Energy Commission forecasts clearly state that for at least 50 years, coal remains a 'transition' energy source, the current priority being humanity sustainable development.

Is very likely this fuel maintain its share in global main energy requirements, main energy that is converted into electricity through its use within thermal power plants. Electrical energy role on global scale is increasing, and coal will contribute to this every day more.

In order to achieve these, the following are necessary:

- Coal related environment issue solving;
- Exclusion of some artificial barriers within coal markets development;
- Investment increase within mining development, so that coal contribution to national economies reaches the maximum.

Where coal is seen as being important, the immediate problem is the way to be created the possibility of effective installation and as quick as possible of the existing technologies and to reduce the impact on environment and then new technologies development.

Obviously, fuels combustion impact on surrounding environment in general is a special one, being the most important factor of imbalance of terrestrial atmosphere, but 'clean' energy cannot be achieved only with a limited number of means.

It isimportant to understand theimplications ofsubstantialgrowth of coal production and use, forecasted in many countries for worldwide banking system, as well as the need to pay more attention to issues related to the development of some financing possibilities of the projects that apply coal clean technologies.

3. Coal use influence on environmental factors

Environment assessment within an area is given by air, water, ground, population health quality, plants and animals species deficit, characterized by representative quality indicators and for which allowable limits are set.

Main possible pollution agent of the influence area of Mintia Thermal Power Plant is the fly ash (particulate matters) eliminated through chimneys, fine ash dust driven by wind from slag - ash dumps and coal dust derived from coal storehouses or from its transport and preparation.

Pollutant emissions tracking is carried out continuously, through on-line measurements with specialized apparatus and through measurements carried out by third parties or through calculation, according to PE-1001/1994: *"SO_2, NO_x, particulate matters and CO_2 from thermal and thermal electrical power plants operative assessment methodology*" developed by RENEL Environmental Protection Department and approved by M.A.P.P.M.: PE-1001/1994.

According to this methodology, the calculation of quantity of pollution agent discharged into the atmosphere (emission) is carried out depending on fuel quantity consumed during the respective period of time, as well as on the quality and burning process characteristics from boilers furnace.

Because energy coal from Valea Jiului has a high ash content (40 ÷54%) and a sulphur content of (1,0÷1,5%)importedcoal is necessary for combustion process,mixed with import coal, of a higher quality, as well as taking some technical measures appropriate for environmental impact decrease.

Valea Jiului hard coal high ash content, besides environmental impact, also leads to production costs and investment increase due to electric energy high consumption, necessary for burning coal storehouse and preparation, to high commissioning expenses and to coal storehouse, preparation and burning equipment and to slag - ash intake and hydraulic discharge equipment within slag – ash dumps.

Table 1 shows the annual average characteristics of the coal used at Mintia Thermal Power Plant (period between 1989÷2011). Primary chemical analysis were carried out on monthly average samples of consumed coal (inland and inland mixture with import), having the following source:

- Coal (basic fuel): floating hard coal, sorted hard coal, prepared hard coal, mixed hard coal.
- Black oil (carrier fuel): inland, import.
- Natural gas (carrier fuel): inland, import.

Primary data necessary for emissions calculation are represented by the calorific power, humidity, and and the content of: carbon, hydrogen, nitrogen, sulphur and oxygen of the fuelsused, the results

being mass values (quantities) of CO_2, NO_x, SO_2 discharged.

Correlating the electrical and thermal energy value productions for the period between 1989÷2011 with the used fuels characteristics (table 2 and figure 2), there were obtained the following polluting emissions values, presented within tables 3 and figure 3.

Table 1 – *Coal primary chemical analysis*

Characteristics	UM	Value
Low calorific value - Q^i_c	kcal/kg kJ/kg	2.923÷4.257 12.238÷17.824
Ash content - A^i_c	%	35,4÷54,0
Suphur content - S^i_c	%	0,18÷1,46
Humidity content - W^i_c	%	7,30÷9,40
Carbon content - C^i	%	31,11÷46,56
Hydrogen content - H^i	%	2,34÷3,80
Nitrogen content - N^i	%	0,39÷1,19
Oxygen content - O^i	%	5,20÷8,67

Table 2 – *Electrical energy production evolution*

Production capacities		UM	Value
Produced electrical energy	Electrical energy	MWh/ year	1848521÷5477116
	Thermal energy	Gcal/year	176515÷513462
	Coal	t	1227091÷3526950

Table 3 – *Pollution emissions situation*

Pollution agent	UM	Value
SO_2	t	7.968÷124.776
NO_x	t	7.399÷20.732
Particulate matters	t	3.685÷47.595
CO_2	t	1.764.065÷5.529.491

Thermal power plants that use coalas fuel energy, can sometimes have an effect of ecological balance within areas where they are located, presenting a complex impact on all the environmental factors from their neighboring area (atmosphere, water, ground, flora and fauna, food and binnacle).

Flue gas and atmospheric pollution agents discharge is carried out through smoke chimneys, and pollution agents diffusion does not take place immediately they leave the chimney. Through smoke chimneys, thermal power plants emit into the atmosphere flue gas, that contain pollution substances important amounts, as for example: noxious gases (oxides of sulphur –SO_x, oxides of nitrogen – NO_x, carbon monoxide and dioxide – CO and CO_2), as well as fly ash, unburned gases, soot. Other pollution agents due to Mintia power plant operation are fine dust of ashes carried by the wind from slag – ashyard, heavy metals, coal dust, noise and radioactivity.

SO_2, NO_x concentrations and particulate matters for the two large burning installations (IMA) on-line monitored are graphically presented within figure 4.

3.1. Particulate matters (dry ash from within the electrical filter)

Particulate matters are found within flue gas discharged on smoke chimneys and can be found in the sediment form, accumulating on ground or they can be found in suspension.

Particulate matters emissions discharged into the atmosphere through smoke chimneys have been characterized through particulate matters annual considerable quantity, as a consequence to flue gas dedusting installations (electrical filters) rehabilitation programme achievement, programme that was carried out during the period between 1989÷1996.

Nevertheless, particulate matters concentrations exceed the values provided within environmental legislation.

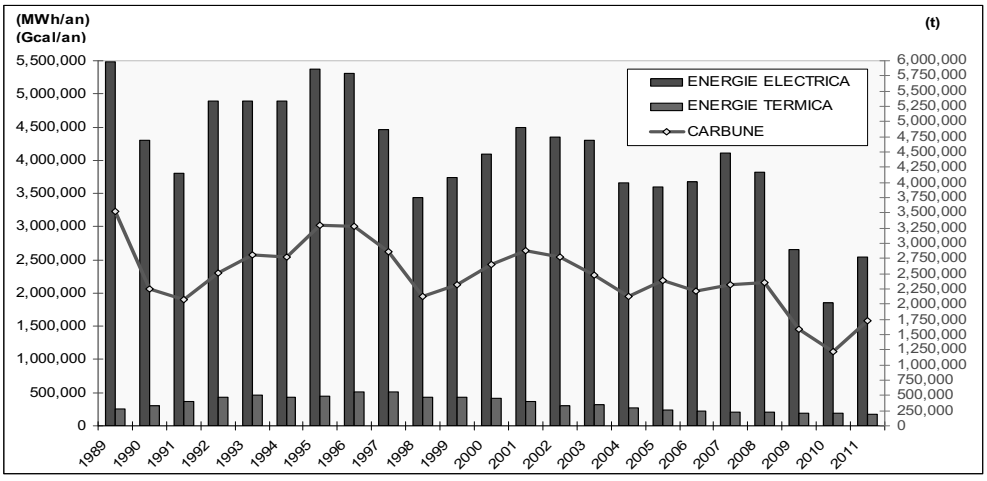

Fig. 2. *Electrical energy production evolution*

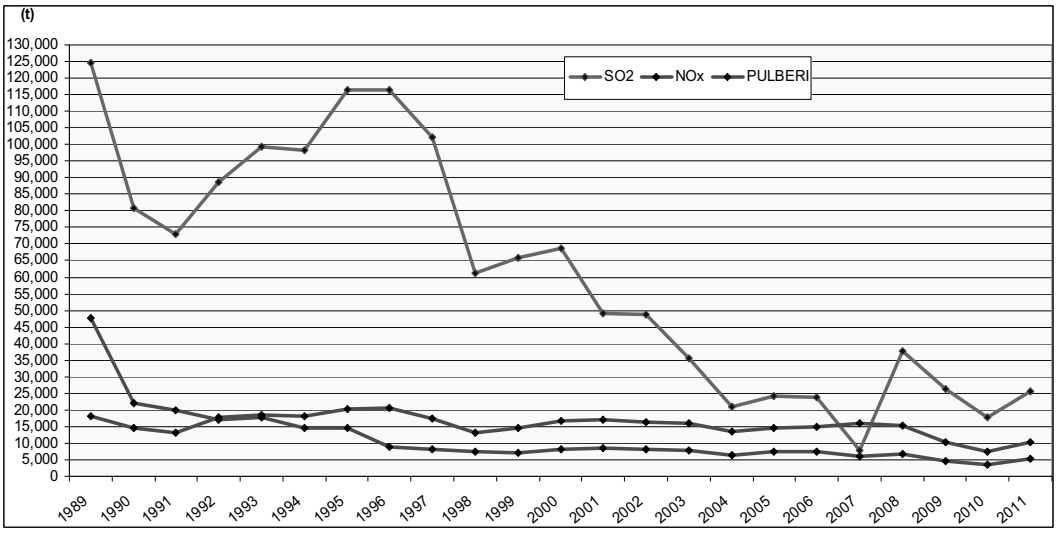

Fig. 3. *Pollution emissions situation*

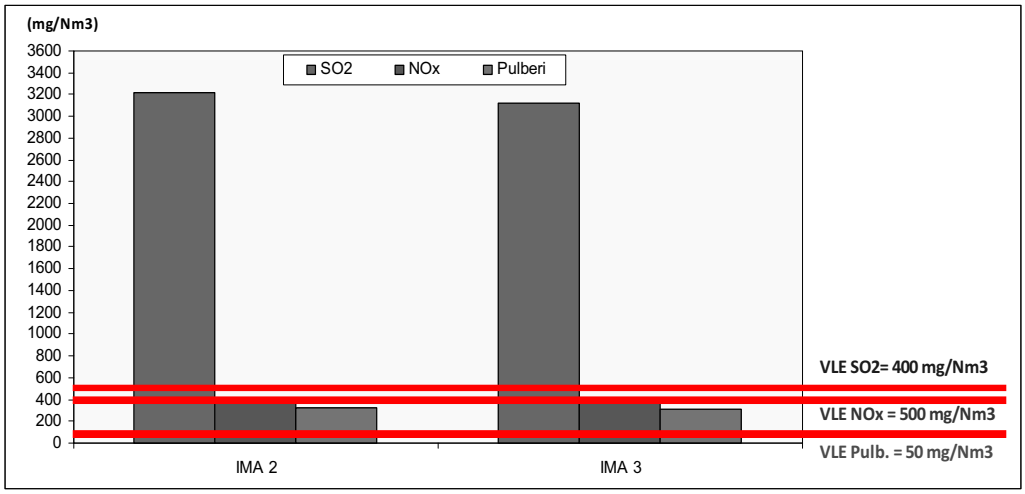

Fig. 4. *SO_2, NO_x concentrations values and particulate matters dischared into the atmosphere*

3.2. Oxides of sulphur - SO_x

Burning of coal which sulphur content is great can have an impact on the surrounding environment, through sulphur oxides pollution – SO_x, represented by SO_2.

These ones have a route and a distance diffusion of up to some hundreds of kilometers, with country crossing borders, thus existing the danger of a transboundary pollution.

SO_2 anthropic emissions that result as emissions within fules burning process can be reduced only with considerable tehnicaland financial efforts, and their reduction is carried out through the purchase of a superior coal, with a low sulphur content, or through mounting of some installations for flue gas desulphurization.

Because SO_2 emissions exceed the values allowed by the environmental legislation, Mintia thermal power plantis within the phase of achievement of flue gas desulphurization installation through wet procedure (WFGD), using limestone as reagent.

3.3. Oxides of nitrogen –NO_x

Even if nitrogen oxides concentration level – NO_x within flue gas does not exceed the maximum allowable value, mainly due to some constructive modifications carried out on energetical units boilers burning system, Mintia thermal power plant has provided NOx content reduction in order to align to future European rules, through achievement of some flue gas de-noxing, through non-catalytic selective reduction procedure (SNCR), using urea as reagent.

3.4. Carbon dioxide – CO_2

Carbon dioxide emission – CO_2 is inevitable within a burning process where the fuel contains carbon, but can only be decreased only through thermal efficiency increase (energetical efficiency) of energy installations (on the same electrical power, in order that less fuel be consumed), and burning be carried out through a rigorous control process.

The main sources of output increase consist of works with large volume and values, that can be achieved during majour reparations and during energy units rehabilitation.

CO_2 emissions reduction begun to be achieved during ‚Romanian power plants CO_2 emissions reduction' project, which for Mintia thermal power plant meant a reduction of CO_2 emissions with approx.2,5% from energy units current emissions and proposed for each energy unit one programme of measures for performance improvement.

3.5. Slag and ash from

Slag and ash deposited within slag – ash storehouses, that have an annual average consumption of approx. 2,5 mil.tons of coal represent approx.1 mil. tons (figure 5) and be carried out by air currents (deflation phenomenon), having as an effect air and ground pollution with sediment particulate matters, during deposits expansion works, through over-raise or when is being on commissioning, during summer time, within reduced humidity periods and with strong winds. Hard coal ash dissipation is more intense than brown coal ash dissipation, due to much lessgraininess and to specific weight.

In order to avoid these phenomena, there is frequently used the spraying of areas that can be affected or dry surfaces humectation, using the existing water source of slag - ash hydraulic discharge installation, efficient solution and that is carried out with low costs.

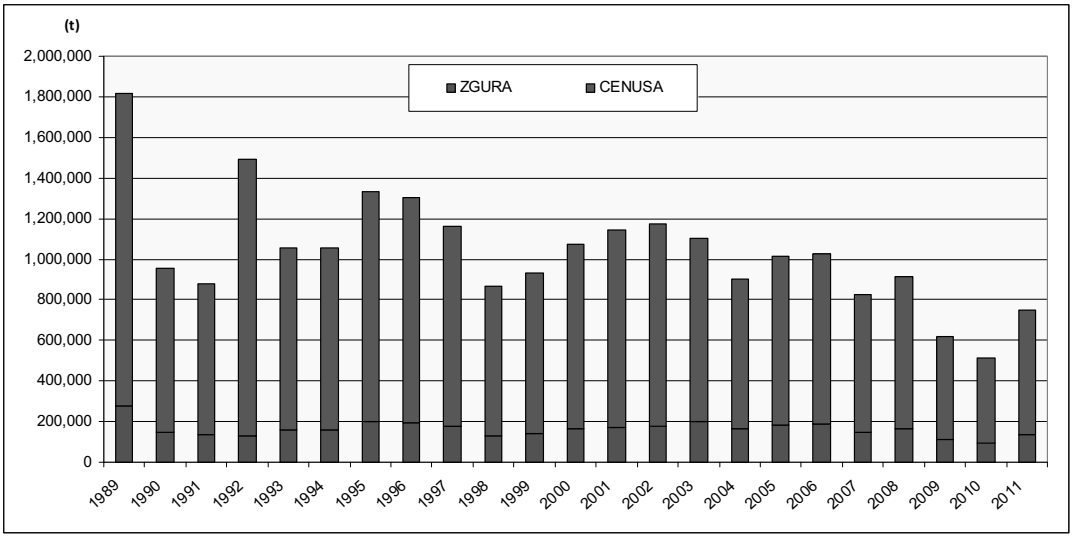

Fig. 5. *Deposit slag and ash annual quantities*

3.6. Coal dust

Coal dust came from coal storehouses or from its transport or preparation also is a solid noxe, that can be found as flying particulate matters (aerosol) or sediment particulate matters.

Solid fuel (coal) handling plant represents one of dust – coal dust pollution sources, that usually has a local action, within inside coal deposit or inside commissioning and fuel maintenance departments. It has a negative action on working personnel health from coal storehouse area.

In order to provide the appropiate working conditions within coal handling plant, coal dust dispersion on discharge (falling) from a belt converyor to other belt conveyor, as well as within coal sorting – crushing plants and sediment dust from boards, walls and energy equipment have to be removed.

This problem solving can be made through dedusting installation achievement for discharge hoppers and of one intake installation for coal dust, that will be installed within sorting – crushing plants (the most polluted area from coal handling plant), coal bunkers ares from end tower, as well as on mixed machines and deposit taking-over machines.

It is very important that coal dust pollution reducing measures from within solid fuel handling plant have as a premier effect professional exposure risks reduction, through some particulate matters removal or reduction advanced technology insertion (especially nanoparticles), in order to improve health and safety conditions within workplaces („nanohealth").

3.7. Heavy metals

Heavy metals (Cr, Ni, Cd, As, Pb) from ash resulted from coal combustion have a low content, so that formed aerosol are nontoxic. As a harmful aspect, these ones are important only in large quantities.

3.8. Noise

Noise, in all discomfort factors, occupy a special place. Installation and equipment that are serving coal storehouse, that produce noise pollution are the sorting – crushing plants, belt conveyors and bucket wheels machines.

Noise level reduction only solution within coal storehouse area is vibrations insulators implementation, that are elastic elements and that are mounted between vibration source and foundation.

3.9. Radioactivity

Solid fuels and especially energy coal, as raw material or through combustion can present a certain degree of **radioactivity**.

Radioactivity problem due to coal used within combustion process and implicitly of slag – ash resulted and discharged into slag –ash storehouses and of ashes discharged into the atmosphere through smoke chimneys from Mintia thermal power plant has been an issue much addressed within area mass-media.

As a consequence, management board within thermal power plant shows a special interest for periodic establishment of the radioactivity degree within enclosure and from thermal power plant neighbouring area, by taking radioactivity measures and through specialized medical studies carried out on thermal power plant working personnel and on area residents.

Researches and measurements carried out within this field show that:

- Naturalγ intensity measured values were smoothly rated within the acceptable levels and without presenting any danger for population, working personnel, area flora and fauna;
- Global β radionuclides specific activity measured values and γ on Valea Jiului domestic and import coal were smoothly rated within the acceptable levels, being very close of area natural background leveland without presenting any danger for population, working personnel, area flora and fauna;

It can be said, with full responsability, that coal measured samples radioactivity, electrical filter ashand slag and ash from slag – ash storehouses do not present a radiological danger for commissioning personnel within thermal power plant, nor for neighbouring area population.

4. Conclusions

By its well-defined industrial specificity, with many and large mining, siderurgical, energetical, cement production and construction materials unities, Hunedoara departement has been and stillis one of the most polluted departments from our country, with all social and health consequences this phenomena determines.

Mintia – Deva thermal power plantis part of exception from these, one of the greatest industrial objectives from Hunedoara department, that until 1989, has been part of a large modernization programme of air decontamination installations (electrical filters) represents one of the most polluting objectives within this area.

Mintia – Deva thermal power plant performance have as an objective, under environmental aspect, integration within sustainable development requests. Mintia thermal power plant presented a large interest for all the aspects related to environment protection, starting from polluting emissions and immissions values knowledge, from installations technical state, which – through an improper operation – can determine pollution and until environmental impact evaluation and on human factor (health of personnel employed within Mintia thermal power plant and of the population within thermal power plant emplacement area).

Thermal power plants operation using energy coal as fuel will also require a maximum future attention from the part of electrical energy producers, as well as authorities competent for surrounding environment protection, knowing pollution irreversible effect.

In order to achieve a sustainable development international cooperation is necessary and also technological transfer that lead to the generalization of some energy efficiency increase and of gas noxes and particulate matters reduction, thus preventing regional pollution increase, as well as global climate change.

REFERENCES

1. **Ciomaga, C.**
SO_2, NO_x and CO_2 emission reduction through fuel choice optimization. RELASIN programme, Bucharest, 2002

2. ***** ECOTERM ENG.Bucharest**
Study, technical project and DDE for dust concentrations reduction within coal handling plant of Deva Thermal Power Plant.

3. ***** ICEMENRG Bucharest**
Chemical analysis of the fuels used within Mintia - Deva thermal power plant. Bucharest, 1998 ÷2012

4. **Vaida, V., Beres, F.**
Romanian energy history pages. Mirton Publishing House, Timisoara, 2003.

5. **Vasiu, T.**
Doctorate thesis: „Mintia –Deva Thermal Power Plant ecological integration solutions, with reference to atmosphere pollution", Petrosani, 2004.