PROCEDURE FOR THE EVALUATION OF THE SAFETY PARAMETERS WITH THE HELP OF THE AUTOMATIC CONTROL OF UNDERGROUND ATMOSPHERE

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Abstract: *In accordance with the occupational health and safety standards currently in force, the safety parameters that define the underground atmosphere (mainly temperature and gases) will be monitored during the closing of mines, both during the proper closing and the preservation stage, as well during the temporary or permanent closing of the mine areas damaged during the mining period.*

The solution intends to warn against the hazards of undergrounds fires and gas and powders explosions; it consists in the automatic sampling and processing of information on the evolution of temperature and gases inside goofs and closed underground areas.

Key words: monitoring underground atmosphere, security, mining, coal.

1. Introduction

At present, gas concentrations (especially CH_4) and the temperature of the underground atmosphere are permanently monitored as these parameters should meet the permissible provisions required by the existing safety standards in force.

Discontinuous or continuous monitoring of safety parameters is being made with the help of mobile detectors, of automatic devices for continuous or discontinuous measuring, with warning and cutting the power supply when the pre-settled concentrations are overrun.

With a view to meeting this requirement, each active or inactive working place is being equipped with measuring devices (measuring head): they are made of transducers for gas detection (CH_4, CO, CO_2), for measuring wind velocity, temperature, etc. as well as with an encoding device for coding and conveying data to the methane measuring installations found in mines.

Monitoring gas concentration and temperature inside those areas of the mines which have already been mined or even closed (temporarily or on a permanent basis with the help of sealing dams) is only partially performed and is a difficult operation as the existing equipment doesn't allow the location of the measuring devices in areas hard to reach. Also, the current measuring system warns against possible hazards only when a certain warning threshold is reached.

Threshold values are being attained (when it is necessary to cut the power supply and to cease the whole activity) with no other previous warning against risk and possible actions taken to prevent the occurrence of such possible risks.

There follows a presentation of a procedure that relies on the automatic control of the underground atmosphere with a view to evaluating the safety parameters of the mine areas hard to reach, due to the risk of underground fires, gas and powders explosions.

2. Target of monitoring and structure of the system used in the evaluation of the safety parameters

With a view to evaluating the areas and the mine workings that are at risk for underground fires, gas and powders explosions, the following types of underground areas are subject to the monitoring process:

- stopes;
- sublevel-type dams;
- damage-type dams (mine areas closed after the occurrence of fires);
- sealing dams.

Basically, automatic sampling and data processing covers the measurement of underground parameters with the help of a measuring head and the conveyance of these data, through a telemechanical system, to a telemeasuring station with an informational module and then to PCs.

Figures 1 and 2 show the locations of gas and temperature measuring heads in all the above-mentioned workings (stopes, dams).

The system used to monitor gas and temperature comprises the following items:

- the system with the measuring heads;
- the telemechanics for data conveyance;
- the telemeasuring station with informational module;
- the processing PC (processing terminal)

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The system with the measuring heads is made up of the following items:

- methane measuring head;
- oxygen measuring head;
- temperature measuring head for the surrounding atmosphere and rock;
- measuring head for air velocity;
- measuring head for CO_2;
- measuring head for CO.

On the whole, the monitoring system displays a 4-level pyramidal structure (fig. 3): **level 0** covers the measuring with the help of measuring heads, as basic elements to measure the safety parameters in the underground; **level 1** covers the gathering of information for teletransmission; **level 2** covers the monitoring of the whole mine, while **level 3** covers the general monitoring of the company. The connection between the PCs located at each mine and the terminal located at the mine company will be provided by microwaves.

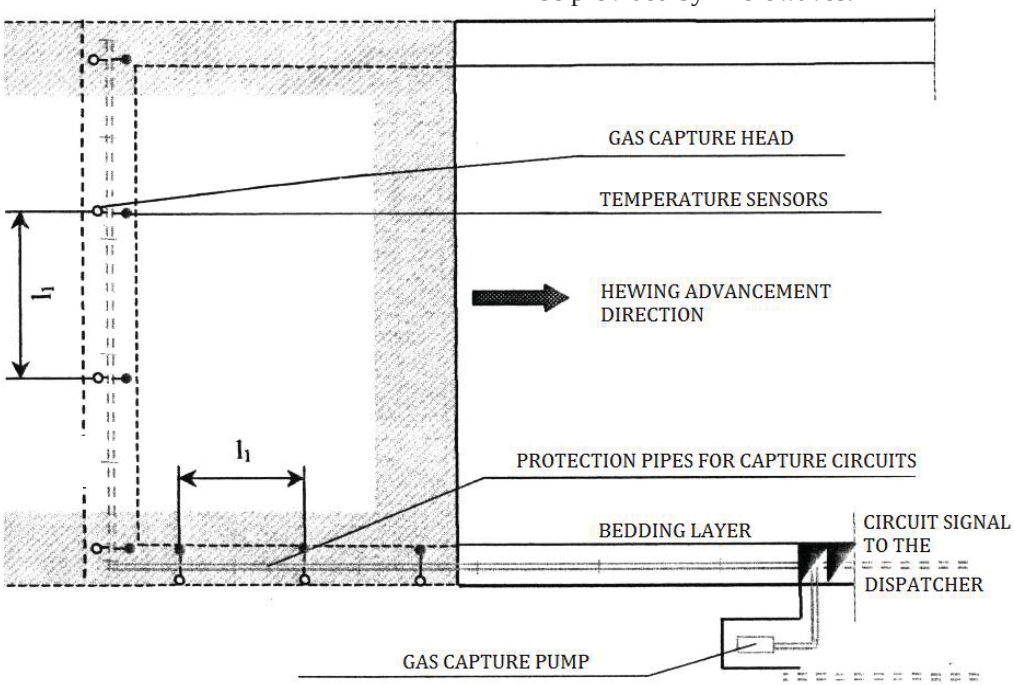

Fig. 1. *Basic diagram of the system with measuring heads and early pre-warning*

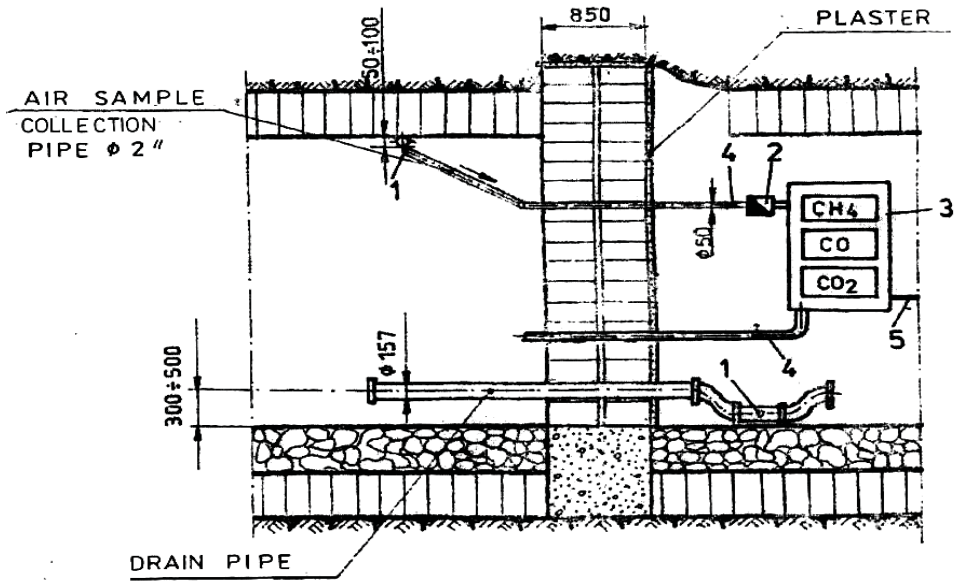

Fig. 2. *Location of heads for gas and temperature measurement during firefighting behind the sealing dams: 1 – temperature sensors; 2 – vacuum pump or vacuuming-type fan; 3 – sealed enclosure for mounting of the measuring heads;4 – valves; 5 – network for conveying the information to the central processing station (dispatching room)*

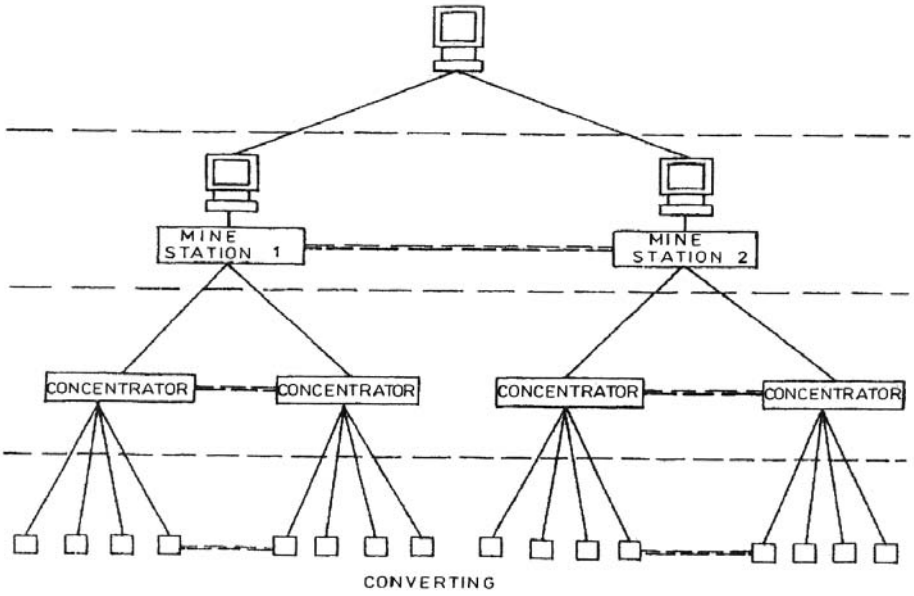

Fig. 3. *Diagram of the monitoring system*

This structure allows the company operator to access the information from each measuring head and each mine.

When certain areas of the mines in the Jiu Valley are going to be closed, they should use the equipment made by OLDHAM, taking into consideration the fact that the mines in operation belonging to CEH still use methane measuring installations made by the same company. The measuring heads and the sensors necessary for the monitoring purpose are also made by OLDHAM. The telemechanics and the telemeasuring station can be reused, since they already exist inside the methane measuring installations found at the coal mines still in operation.

3. Presentation and description of the monitoring equipment

3.1. CTT63/40U telemeasuring station

It is a fully automatic installation that allows the operation and gathering of information received from maximum 40 sensors located at 10 Km from the main structure of the station, which are required for the general functioning. From a constructional point of view, the basic equipment of CTT63/40U comprises the following elements:

A – The equipment located at surface:

- the main structure, i.e. the brain of the installation. It is located outside the hazardous area and provides the voltages and currents necessary for a good general operation;
- an electric switch box with the safety that provides the intrinsic protection of the circuits located in the potentially explosive environment

B – The equipment located in underground:

- a network of cables for telemeasuring purposes with bifilar lines made of even numbers, equal with the number of measuring points in operation;
- measuring heads located inside the monitored areas.

Another model (model no. 2) is produced relying on the Z80 microprocessor that carries out the cyclic exploration of measuring heads through static switching. It manages the warnings and recordings. The selection of operative inputs, of warning levels, the working condition (manual or automatic), the types of measurements, the timing are all being carried out with the help of the keyboard.

The outputs, the results of the measurements, different messages are displayed on LC8. CTT63/40U, model 2 station displays 80 warning levels, totally independent one from another, adjustable in any moment. It is also possible to program one or two threshold values at each point (pre-warning). When the value exceeds the pre-settled warning threshold for the monitored measuring point, the main structure will order:

- a trigger of a light warning signal corresponding to the attained threshold value and to the measuring head that provided the information;
- decoupling of the inverse relay for the remote control of an optical and sound external warning;
- the operation of the selective decoupling devices (TDV1 or TDV2) that can be delivered with the equipment.

3.2. Telemechanics of the monitoring system

The conveyance of data from the measuring heads (made by OLDHAM) is performed through a parasite full atmosphere. The use of a COD-type teletransmission system protects the conveyed information.

The COD-type encoder is an electronic system which is connected to the measuring heads, on one side, and to the CTT63/40U telemeasuring system, on the other side.

This encoder provides:

- the recharging of the internal battery intended to provide the electric power to the measuring head during the measuring period;
- the electric feeding of the same measuring head;
- the conversion of the analogical signal into frequency through the measuring element;
- the teletransmission of information;
- the telephone connection with the main CTT structure.

3.3. Voltage – frequency converter

The conveyance of analogical data collected from the underground atmospheres needs reliable and less costly methods for the implementation of the required operations.

Accordingly, CFF frequency converter is an electric system with intrinsic protection that allows the teletransmission of information under frequency. The main uses involve the remote surveillance of physical units changed into analogical values.

3.4. Receiving measuring heads

In relation to the designation of the remote measuring system, its structure comprises the following types of measuring heads:

- methane measuring head;
- oxygen measuring head;
- temperature measuring head for the surrounding atmosphere and rock;
- measuring head for air velocity;
- measuring head for CO_2;
- measuring head for CO.

Methane measuring head is intended for an accurate air measurement of methane concentrations ranging between 0 and 5 % CH_4, fire damps or natural gas. Whether installed in atmospheres with 100 % CH_4 maximum, it shall not deteriorate or provide errors of measurement. It is connected to an interrogator that provides the supply of current and analyses the results of measurement.

CD025 oxygen measuring head connected to the remote measuring station located at surface measures the volume of oxygen in the atmosphere of a mine. When it is used with a CRA-type warning device, then the user is warned immediately.

Once converted into voltage, the electric value of the oxygen concentration is being amplified and converted into frequency in the middle of the specific circuitry.

The transmission wideband is between 10 and 12 kHz. Complex voltage and current regulators are added to this operating system.

CD025 oxygen measuring head is with intrinsic safety. It meets the requirements stipulated by the legislation in force in several developed countries.

CTS792 oxygen measuring head is equipped with two types of probes for temperature measurements: one probe that measures the temperature inside the massif and one probe that shows the temperature of the mine atmosphere.

This head that is used to measure temperature comprises two subassemblies:

- the box with the electronics intended to connect the probe (including a phone connection);
- the measuring elements, i.e. the measuring probe.

The group of elements is provided with intrinsic protection.

The head for measuring the air flows inside a gallery or pipe, with the possibility to convey the captured information to a remote point, i.e. the CTT63/40U measuring station located at surface.

It displays a solid structure and can be used in underground atmospheres.

The circuitry of the head for measuring the air flows – CAT797 is provided with intrinsic safety.

The measuring head for CO (abridged CCO), detects CO in the air or in the underground atmosphere with CH_4.

The measuring scale (100 ppm), the intrinsic safety protection and the remote measuring system allow the prevention and detection of fires in firedamp mines.

CCO is connected to the CTT63/40U, which provides the electric power necessary for proper operations.

3.5. TMP process interface

The panel of the process interface is made of the following items: the display, the reset button, the light signal on two distinct line levels; warning light signal, sound warning device; control block of the battery.

On the lower part (behind the panel), there are:

- the part of the lines (TLN) connected to the measuring points;
- graphical recorders (TEN);

▪ the contact plugs of the warning and alarming relays;
▪ The MINE ATMOS informational system, from ex. (output V24).

4. Presentation of the programming system

The functions of the program are the following ones:
▪ measurement of the measuring;
▪ gathering a database;
▪ data processing based on the mathematical model;
▪ the drawing up of protocols with the gained data;

The CTT63/40U station gathers the information from the measuring heads. The creation of the database and the processing of the database are made on a PC connected of the TMP.

5. Conclusions

Occupational health and safety standards require that the parameters defining the underground atmosphere should be monitored all along the preservation and closing period, as well as during a temporary or permanent closing of those underground areas that have been previously damaged during the mining process.

This type of evaluation is part of the group that includes the warning-type solutions against hazards of underground fires and explosive dusts and gases. It includes the sampling and automatic processing of information on the evolution of temperature and gases from inside goofs and closed areas.

Mainly, monitoring the safety parameters of the underground atmosphere covers the measuring of the safety parameters with the help of measuring heads and their conveyance to a remote station with information module and then to PCs for further processing.

In relation to the results gained after analysing the data, it will be possible to get the best decision and take the suitable measures to prevent the occurrence of potential hazards which may come up during mine closure.

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