Equipment and technology for assessing the safety parameters by the remote control of the mine underground atmosphere

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Abstract: The OH&S standards in force valid for mine closure (i.e. during the conservation and proper closing and for temporary or permanent closing of the mine areas adversely affected during the operating period) state the monitoring of the safety parameters that define the underground atmosphere, mainly temperature and gases.

The idea shown below is part of the group for warning against underground fire hazards and gas and powders hazards. It comprises an early automatic sampling and processing of information related to the history of temperature and gases inside gobs and closed underground areas.

Key words: underground atmosphere, spontaneous combustion, underground fire, coal mine, safety parameters, automatic control, monitoring, evaluation system, voltage converter, receiving catches, process interface.

1. Introduction

At present, most mines in operation and especially the Jiu Valley mines are monitored on permanent basis; there are recorded gas concentrations (especially CH_4), underground temperature. These parameters have to range inside the admissible values stipulated by the currently in force safety norms specific for underground operations.

The intermitent or continous monitoring of the safety parameters is made by portable detectors, automatic apparatus for continous or intermitent measurments with alarming device and electric power breakdown when the presettled concentration is exceded.

Subsequently, each active or inactive working place (temporary closed faces) has sensing heads for gases (CH_4, CO, CO_2), air velocity, temperature, etc. and an encoder to encode and convey information to firedamp measuring station of the mine.

Monitoring gas concentration and temperature inside gobs and temporary or permanent closed areas of the mine is made partially and it is quite a difficult undertake because the current equipment don′t allow the installation of measuring devices in places hard to reach at. Also, the current system used to measure the safety parameters transmit a hazard image whenever a certain alarming threshould when it is necessary to cut down the electric power and complete stop of activities, without a prior warning of risk and possibility for a rapid intervention for preventive purposes.

With the view to evaluating the safety parameters in the difficult accessible areas of a mine, with a tendency to endogenous fires and explosive gases and powders, there folows a presentation of an evaluation method that relies on the remote control of the underground atmosphere.

2. Present stage of the methods used to determine the safety parameters

Before making a classification of the methods used to evaluate the safety parameters, there follows a brief presentation of the occurence and development of endogenous fires-complex incident that derives from the self-ignition of the cooly substance [2], [3], [5], [6], [7], [11], [12], [13], [17].

Subsequently, coal (hard coal for the Jiu Valley mines) crosses several stages before reaching the endogenous fire (fig. 1):

- self-heating;
- humidity evaporation;
- self-ignition;
- proper burning.

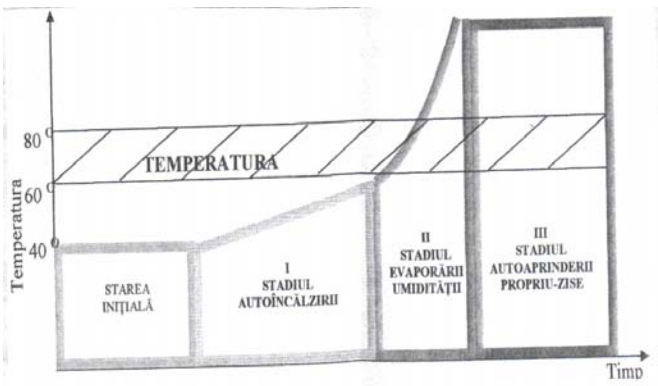

Fig. 1.Stages in the formation of endogenous fires

From the point of view of the evaluation, the first 2 stages (self-heating and humidity evaporation) cover the incubation period (fig. 2); there follows the 3rd stage of self-ignition after the evaporation of humidity when oxidation increases.

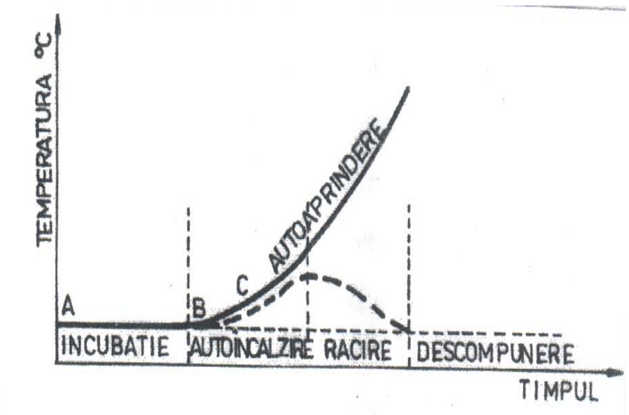

Fig. 2.Evolution of coal self-ignition

On the whole, the time limits of the self-ignition process is relatively large, i.e. between several weeks and several months. Whether no actions are taken to hold oxidation and to coal down coal, the process can go on and reach to the underground fire stage, with all the adverse consequences over the occupational health and safety during coal mining. Subsequently, during the downtime period of the working faces in a coal mine (here, hard coal mine), there increases the self-heating risk that may trigger a fire by virtue of an increasing temperature and oxidation velocity, especially during incidents and accidents when the air ingress flow rate is subject to variation and exposure length to air of the coal left unmined is higher.

According to the ″oxidation theory″ self-ignition process depends on the coal absorbtion capacity of oxygen from the air, process that occurs with heat emission.

Coal oxidation comprises the reaction between coal and air oxygen, with giving off of CO_2, CO, H_2O and of other gases whose contents depend on the oxidation temperature, coal specific features, as well on the intrusion of other factors in this process. The calorific effect of this exothermal process depends on temperature. During oxidation, the rate of the exothermal process increases 2 up 3 times as coal temperature increases with 10^0C. The temperature increasing rate is governed by heat dissipation rate. As temperature increases, oxidation rate shall increase, thus a higher amount of heat is released and the process is self-accelerated. The conditions that influence the evaluation of an oxidation at low temperature towards heating are the folowing ones:

- A small amount of air gives a diminished oxidation rate and we get the equilibrium condition when heat is dissipated as it is generated. This condition can be found on almost all ventilation ways with high aerodynamic resistance, i.e. gobs at longwalls located in the deposits with tendency to endogenous fires.
- Ahigh amount of air shall lead to such a coaling that a significant temperature increase shall be prevented. Consequently, the oxidation rate shall be limited. This conditions occurs in underground workings with low aerodynamic resistance where the air sweeps coal surface, either through travel ways or through stopes. The systems are quite balanced in these two situations: the first situation (low oxygen intake) sees an oxidation at relatively high temperatures; the second one (cooling due to air flows) sees an oxidation at low temperatures.
- An intermediate situation is when oxygen supply rate and heat driving rate situate in the above-said 2 equilibrium conditions and there is enough coal mass. Consequently, these conditions shall lead to an increased oxidation rate and temperature rise. Whether this process is not halted, there shall come up an endogenous fire.

To summarize the results of the analysis on the occurence and development of endogenous fire, these are the conditions that favour it, i.e. [5], [7], [13], [16], [19], [21]:

- coal with tendency to self-ignition, similar to the Jiu Valley hard coal;
- air flow inside the coal mass so that the process can occur;
- possible heat accumulation.

Subsequently, the factor that favours the initiation of the endogenous fire is heat which, at its turn, is in relation with coal oxidation.

From this point of view, coal tendency to self-ignition and the occurence of underground fire can be determined in relation to the following criteria:

- the criterion of the average temperature rise in an watery environment, i.e. determining the average rise of coal temperature in an watery environment (perhydrol);
- the criterion of the gaseous specific surface that takes into consideration the relation between carbon monoxide, carbon dioxide and oxygen absorbed by coal; as a result as temperature rises, the oxygen absorption increases, with

large releases of CO and CO_2;

- the criterion of the test sample in relation to the oxygen consumption; according to which the physical and chemical changes that take place inside the coal mass occur in relation to temperature;
- the criterion of temperature rise within a time range of a coal sample subjected to pure oxygen flow;
- the criterion of the critical self-ignition temperature;
- the criterion of coal critical temperature;
- the criterion of brittleness ratio – F_x and of mechanical break-up - F_{dm};
- the criterion of coal self-ignition temperature decrease as oxydation proceeds;
- the criterion of oxygen absorption velocity;
- the criterion of coal paramagnetism that relies on the parametric centres inside the coal mass (these centres are the highest reactives areas).

Depending on the above-said criteria, as well on the products that derive from the mine fires, there are a series of methods and means to monitor the safety parameters [1], [3], [4], [5], [10], [13], [15], [16]:

- **Monitoring mine fires by the help of human senses.**
  It is the oldest known method and it relies on the relation between the elements that can be detected by the help of human senses (as smell) and temperature;
- **Automatic monitoring of safety parameters (by electronic and pneumatic means);**
- **Automatic mixed monitoring of safety parameters;**
- **Discontinous monitoring of the evolution of the safety parameters;**
- **Monitoring the evolution of mine fires and of the safety parameters by the help of portable equipment,** that measure gas concentration, temperature, difference in pressure, humidity.

The pneumatic method used for an automatic monitoring of the safety parameters comprises a replacement of the sensing electronic board with plastic tubes that connect the local control and monitoring station to the central control station. The pumps take air samples from underground and push them towards the detectors located at surface. The results of measurments can be recorded and displayed at the station comprising the detectors or they can be sent to the central control station for recording and displaying purposes.

The pneumatic system can include either:

- A breathe in pump, when the pumps is located at surface; or
- A breathe out pump, when the pump is located in underground for KGK installation.

Mixed methods for an automatic evaluation of the safety parameters comprise both the use of pneumatic tubes and of the electric cables for conveying data to the surface.

Basically, the analyser used to measure the safety parameters is located in underground. The data are conveyed to the surface as electric signals through an electric network. At surface, these data are displayed and recorded .

The method comprises two options:

- locating an analyser at each measuring point;
- locating an analyser at several measurin point.

Observation: There can be used both analysers for one gas and for several gases with the electronic method and the electropneumatic method, providing simultaneously values of the concentrations of several gases.

Method for a discontinous evaluation of the safety parameters comprises sampling with glass or metallic vessels in wet or dry state. The depression necessary to fill in the vessels with gas can be reached by vacuumming (metallic vessels), water means or by the help of a hand pump for glass and rubber vessels. The samples are taken to surface and analyzed in fixed or mobile laboratories. The analysis equipment can include AMKO-3 and ROBERT-MULLER for gases such as O_2, CO_2, CH_4, H_2 and Wosthof for CO, as well normal chromatographs, high accuracy equipment.

Monitoring the safety parameters by portable aparatus

One of the widest used method is monitoring the underground atmosphere and endogenous fires by the help of portable instrumentation. There are measured: gas concentrations (by PFG-GC 1firedamps proof chromatographs, by monogas and multigas individual portable aparatus: MX 2, TX 11, MX 11-OLDHAM, Multivarn II, Mini Pac-CO, Mini Pac O_2-DRAGER or by colorimeter vials through the use of manual or automatic gas pumps), temperature (by electronic and infrared thermometers: INFRATRACE-1000 and HEAT-SPY). There can also be measured other safety parameters such as the difference in pressure (by the help of classic micro-gauges: D 5, D 560, D-562-DOS CH or electronic micro-gauges: MA-200) or humidity (by the help of POLITECTOR-G 700 apparatus).

The values of concentrations can be used under processed or unprocessed form and it is possible to determine the fire indices in the laboratory [12], [17], [18].

Taking into consideration the principles of automatic methods for the evaluation of the safety parameters for those areas in the underground of hard coal mines difficult to reach at, there follows a presentation of an evaluation method that uses the remote control of the underground atmosphere.

3. Structure and operating principles of the system used in the evaluation of the safety parameters

With the view to evaluating the areas and the mine workings with propensity to underground fires and gas and powders explosions, the following types of underground areas are subject to the monitoring process [5], [10], [11] [12], [16], [19], [20], [21], [23], [24], [25]:

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

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

Figs 3 and 4 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;
- processing PC.

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.

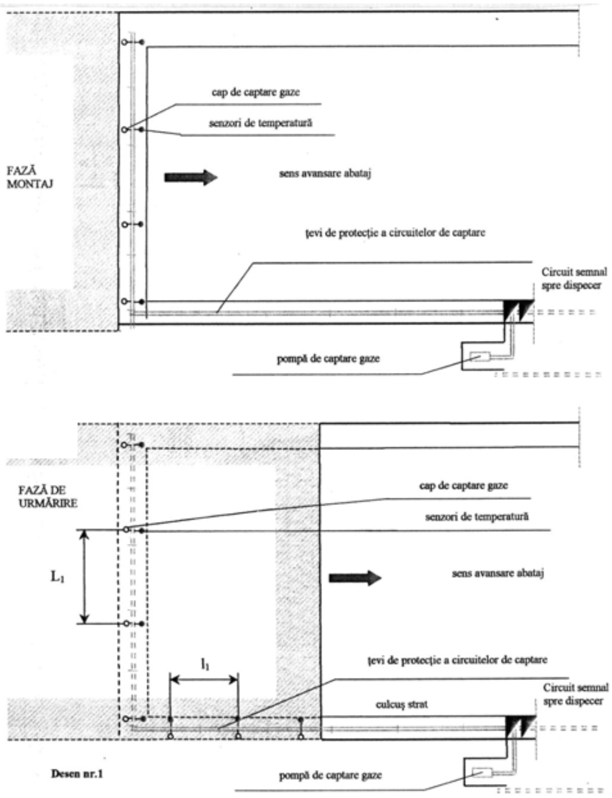

Fig. 3.Basic diagram of the system with measuring heads and for an early pre-warning of the self-heating in the underground atmosphere of the gob(mounting and stages)

On the whole, the monitoring system displays a 4-level pyramidal structure (fig. 5): **level 0** covers the measuring with the help of measuring heads, as basic elements to measure the safety parameters in underground; **level 1** covers the gathering of information for teletransmission; **level 2** covers the monitoring of the whole mine; **nivelul 3** covers the general monitoring of the company undertaking. The connection between the PCs located at each mine and the terminal located at the mine company shall be provided by microwaves .

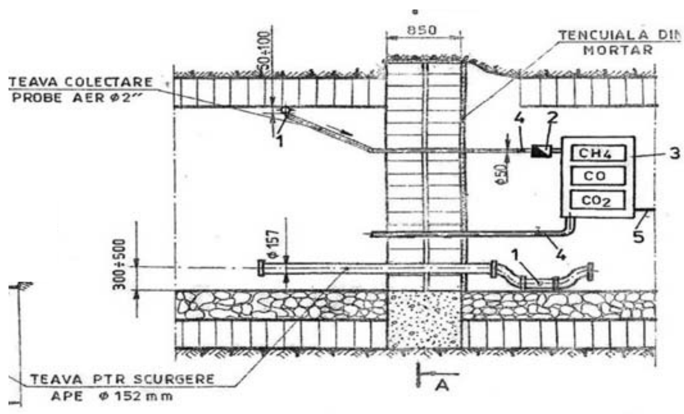

Fig. 4.Location of heads for gas and temperature measurment all through fire fighting behind the sealing

dams: 1 – temperature sensors; 2 – vacuum pump or vacuumming-type fan; 3 – sealed enclosure for mounting of the measuring heads; 4 – valves; 5 – network for conveyance of information to the central processing station (dispatching room)

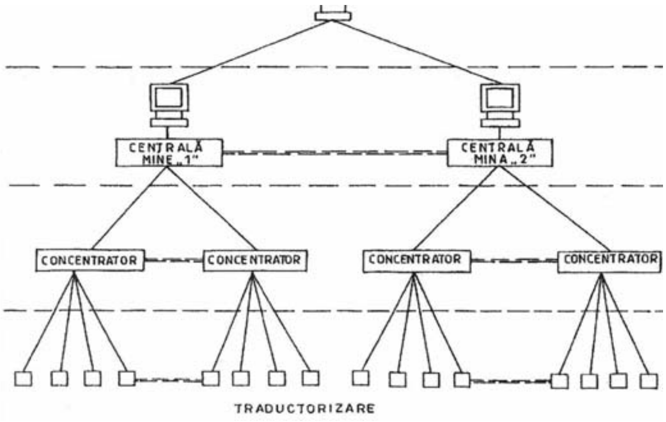

Fig. 5.Diagram of the monitoring system

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

When certain areas of mines in the Jiu Valley are being closed, there should be used the equipment made by OLDHAM, taking into consideration the fact that the mines in operation belonging to CNH Petrosani 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.

The following 3 options are being proposed for implementation in the underground of the mine with the view to monitoring the safety parameters:

a – 1st option, comprises the use of the fire-damp switch gear of CTT2 type whose role is to pick up, galther and record the information conveyed by the heads. The embeded module allows to record information and to send them tan upper information level.

The reciver PC processes the information level that after interpreting the results, there shall be able to take the suitable measures top revent coal self-ignition.

The transducer system comprises OLDHAM transducers especially designed to work with CTT2 switch gear.

b – 2nd option, comprises the use of a bouayage that plays the part of the transducers. It includes sensing devices for CH_4, CO, CO_2, O_2, air, temperature, rock temperature, air velocity. The information gathered by the bouayage are conveyed to the central equipment through the cable network. The central equipment comprises a SIP type interface and a process PC. The PC is being integrated into the PCs network that provide the general monitoring.

c – 3rd option, comprises the use of individual sensing devices for each measured parameter. The information are being sent from underground to surface with the help of output/input analoguous modules. There is being used a MX 62 type central panel.

This panel performs the primary processing and data recording. The panel connects to a process PC that does detailed processing and it is constructed the PCs network for general monitoring.

4. Presentation and description of the monitoring equipment

4.1. CTT 63/40 U telemeasuring station

It is a fully automatized installation that allows the operation and gathering of information received from 40 sensors maximum located at a maximum distance of 10 Km in relation to the main structure of the station.

The main parameters and the remote measuring performances are the following ones:

- automatic or manual exploration of the sensing devices;
- connection between 1 and 40 sensing devices; unlimited extension through the serial connection of switch cabinets;
- self-controlled two-wired remote measuring lines;
- graphic recording of measurments;
- telephone connections integrated to each mesuring point and to the switch cabinet;
- compatibility with MINE – ATMOS - OLDHAM software, especially designed for the mining industry.

From a constructional point of view, the basic equipment of CTT 63/40U comprises the following elements [5], [7], [12], [13]:

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;
- electric switch box with the safety.

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 monitored areas.

One other model (model no. 2) is being produced around 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 state (manual or automatic), the types of measurments, the timing are all being made with the help of the keyboard.

The outputs, the results of measurments different messages are being 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 thereshold for the monitored measuring point, the main structure shall order :

- a trigger of a light warning signal corresponding to the atlained, thereshold 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.

4.2. 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 wich is connected to the measuring heads, on one side, and to the CTT 63/40 U telemeasuring system on the other side.

This encoder:

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

The main technical parameters of the encoder are the following ones:

a) electric parameters

- remote fed assembly, directly connected to the receiver unit CTT 63/40 U;
- input signal come from CMI, CMU or CKA;
- output signal.…...band between 5, and 10 kHz;
- conveyance……...............frequency modulated;
- operating temperature…........…..+5, to + 45^0 C.

b) mechanic parameters

- type of the material:
  - light alloy with less than 6 % magnesium;
  - bronze (optional);
- connection …… with the help of connectors;
- telephone plug …………………………… yes;
- net weight …………………...……… 2,5 kg.

4.3. Voltage – frequency converter

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

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

The main technical parameters are the following ones:

a) electric parameters:

- remote fed assembly, directly connected to the reciver unit (CTT 63/40 U);
- input signal…….........……0 to 2 or 0 to 10 V;
- output signal…..……band between 10-12 kHz;
- conveyance ……............ frequency modulated;
- operating temperature: ....….+5^0 C to +45^0 C.

b) mechanic parameters

- type of the material;
- light alloy with less than 6 % magnesium;
- bronze (optional);
- connection ….....… with the help of connectors;
- telephone plug …………………......………yes;
- net weight ………………………………2,5 kg;
- overall dimensions ………………..380 mm (height); 140 mm (diameter).

The voltage-frequency converter CFF is with intrinsic safety.

4.4. 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.

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

- a COD encoder, comprised by a remote measuring installation, similar to CTT 63/40 station;
- an automatic methane tester, similar to GTM 67A.

The constructive parameters of the sesing head are the following ones:

- housing………polyster reinforced with glass fibres;
- overall dimensions……………13x13x10 cm;
- net weight……………………………….5 kg;
- fastening…………by the help of the connector.

CDO25 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.

The oxygen measuring head comprises basically two subassemblies:

- **the measuring cell**, that includes a self-fed metal/air cell that gives a reading which is not under the influence of pressure and temperature changes and under the influence of the surrounding humidity;
- **the electronic module,** that is directly fed through the remote measuring station found in the control room; in this situation it is no longer necessary a local power supply source.

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

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

CD 025 oxygen measuring head is with intrinsic safety. He meets the requirements stipulated by the legislation in force in several developed countries.

The constructive parameters of the oxygen measuring head are the following ones:

- self-fed assembly directly connected to the remote transmission unit of (CTT 63/40 unit);
- mesuring range …………………...…25 % O_2;
- answer period ……………………........< 10 sec; (90 % of the final value);
- CH_4 influence………….......……...neglectable;
- Maximum storage period per element………+ 1 % CH_4 methane/air cell;
- operating temperature ....…..+5^0 C to +45^0 C;
- sensitivity deviation ….........…< 3 % per week;
- temperature deviation………………...< 4 %/C;
- deviation from zero …………….......……. null;
- housing material …………. light alloy with less than 0,6 % Mg,;
- protection ..…… IP 54 (water and dust sealed);
- sensing element ………… protected by bronze alloy metal;
- connection .....….... with the help of connectors;
- telephone plug…………………….........…………yes;
- net weight……………………...……..2,5 kg;
- overall size…………………280 mm (height) x 140 mm (diameter).

CTS 792 temperature measuring head is equipped with two types of probes for temperature measurments: one probe that measures the temperature inside the massif and one probe that shows the temperature of the mine atmosphere.

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

- the box with the electronics intended to connect the probe (including to connect a telephone);
- the measuring elements, i.e. the measuring probe, that can be found under two forms that can be used on the ground and for atmosphere:

- the version for the rock (the sensing element is embedded in a tube of 20 mm in diameter and 100 mm in length;

- the version for gaseous atmosphere (the sensing element is located outside a box 148 x 173 mm).

The constructive parameters of temperature sensing head are the following ones:

- measuring type……………………...electronic;
- measuring range…………..…80^0 C (10 to 90^0 C);
- accuracy………………...…...bigger than 1^o C;
- remote power supply………. (no local source);
- tremote transmission….frequency modulation;
- widthband…………………………10-12 kHz;
- probe for the rock………100 mm x 20 mm (diameter).

The assembly of elements is with intrinsic protection.

The head for measuring for CO (abridged CCO) inside a gallery or pipe, with the possibility to convey the captured information to a remote point, i.e. the CTT 63/40 U measuring station located at surface.

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

It comprises:

- a cylindrical sensing head that recloses the CTN measuring cell exposed to the air flow at the desired measuring point; it is protected by paper filters of large catching surface against dust penetration;
- easiliy interchangeable filters with a life span of

several months; when the filters are changed, the plates of the perforated drums protect the measuring cell when the equipment is opened;

- a box that comprises the electronic part for power supply of the driving operations and of the remote conveyance of the measurment results;
- a connection box that allows a rapid connection of the remote conveyance of the measurment results; a special plug allows the connection of a telephone for communication purposes between the underground and surface.

Constructive features:

- measuring range…….between 1 and 25 m/s (accuracy ± 8%);
- measuring method.................by manual or automatic means;
- output…………………signal modullated in frequency (10 – 12 KHz);
- electric supply…………...through a stabilized current;
- temperature range……..............+ 5 to + 45°C;
- protection level of the electronic ....…IP 55;
- mounting …………… with the help of fastners;
- overall dimensions……...16x25x8 cm (L, H, e);
- net weight…………………...…………..2,7 kg.

The circuitry of the head for measuring the air flows CAT 797 is 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 mm), the intrinsic safety protection and the remote measuring system help in the prevention and detection of fires in firedamp mines.

CCO is connected to the CTT 63/40 U which provides the electric power necessary for proper operation.

The main technical features of this sensing device are the following ones:

a) cell

- measuring type…………………...................….electrolytic;
- scale…………………....between o and 100 ppm;
- accuracy……………..……………….± 3 ppm;
- deviation……..…...< 3% per month (baseline);
- CH_4 interference….……± 1 ppm with 3% CH_4;
- answer time from the final value.........< 1 mm at 90%;
- temperature………..…...between 10 and45°C;
- humidity……………between 10 and 95% RH;
- pressure……..……between 800 and 1200 bari;
- air velocity……………..…………...< 6 m/s;
- known interfering gas………..H_2 – 502 – H_{25} – Alcohol.

b) CCO sensing device

- remote power.. supply;
- remote conveyance of information.............by frequency modulation;
- bandwidth....................................10 – 60 KHz;
- telephone...........possible by remote conveyance lines;
- adjustment.................zero and sensitivity reachable from outside.

c) mechanic features

- cylindrical box.................................ϕ 122 mm;
- net weight..4 kg;

The elements that form the sensing device CCO are in accordance with the requirements stipulated by CENELECT T6 regulations.

4.5. TMP process interface

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

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

- the part of the lines (TLN) connected to the measuring points;
- graphical recorders (TEN);
- the contact plugs of the warning and alarming relays;
- MINE ATMOS informational system, from ex. (output V 24).

The main features of the process interface are the following ones:

- operation…………….scan of the microprocessor, with the relocation of TAS, TPA, MAT, TOO at the interface and CTT 1 interface;
- Z80(Zilog)…………..………. microprocessor;
- memory of the program…..………...8 K RAM;
- given memory..……………………..1 K RAM;
- CTT 1 compatibility……………...……….full;
- input…..……….with the help of the keyboard;
- alphanumeric 32 character …...…type display;
- type of the display................. in plasma orange;
- number of alarms per line …………………..2;
- total number of alarms…………………..….80;
- digital output……………………..V 24 CCITT.

4.6. Presentation of the programming system

The functions of the program are the following ones:

- measurment of the measuring;
- formation of the measuring;
- data processing based on the mathematical model;
- the drawing up of protocols with the gained data.

The CTT 63/40 U station gathers the information from the measurming 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 state that the parameters that define the underground atmosphere should be monitored all through the preservation and closing period, as well during a temporary or permanent closing of those areas in underground 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 goafs 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.

The mounting of the measuring heads and the receiving of information, with the evaluation of the safety parameters can be made for the following categories of locations in underground: stopes, sublevel dams for the areas that have already been closed and abandoned, dams erected for contain the areas affected by fires, sealing dams erected during mine closure, etc.

All the component parts of the remote measuring system intended to be mounted in underground have intrinsic protection, are made by OLDHAM, (taking into consideration the fact that all the firedamp equipment used at CNH Petrosani are made by the same company).

Operationally, the remote measuring system uses a pyramid structure with 4 levels: it starts at the level 0 (gathering information from the underground) and it ends at the level 4 (general monitoring of the parameters at the company/mine).

Depending on functions, the sensing devices at the level 0 can sample different gases (CH_4, O_2, CO, CO_2), can measure air-flow velocity and temperature.

In relation to the results gained after analyzing data, it shall be possible to get the best decision and take the suitable measures to present the occurance of potential hazards which may come up during closure.

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