Lupu Constantin - PhD. Eng., Toth Ion - PhD. Eng. ,Gligor Cornel - Eng., Cioclea Doru - PhD. Eng., Morar Marius - Eng., Chiuzan Emeric - Eng.
National Institute for Research and Development in Mine Safety and Protection to Explosion - INSEMEX Petroşani - Romania, 32-34 Gen. V. Milea street, postal code 332047
tel. 04 0254 541621 / 541622, fax 04 0254 546277, e-mail: insemex@insemex.ro

INCREASING IMPERMEABILITY OF THE SEALING WORKINGS IN THE ROMANIAN MINES

Abstract

This paper reviews the researches carried out in the field of increasing impermeability of the sealing workings in the Romanian mining activity. This paper:

– settles the technical requirements necessary for the selection of materials used to seal the sealing workings;

– shows the stand that is being used to determine the impermeability of the sealing materials;

– shows the tests performed on different sealing materials; these tests have been made in the laboratory and in underground.

Introduction

The following types of long-lasting structures are used frequently to seal off the mine workings:

- clay made dams made of mine wood;
- cast concrete dams;
- dams made of keystones.

The sealing dams used nowadays lose their sealing properties as time goes by; this is the very reason why they need additional sealing (clay wash or cement wash).

Clay washing is an operation which is specific for the dams made of pieces of mine wood and clay, structures good for high pressures but which after a short period of time (30 days maximum) lose their sealing characteristics due the clay drying. Accordingly in the first stage of this process clay wash method consists in covering the dam surface with a mixture of clay and NaCl (kitchen salt) in several layers.

Cement washing is an operation specific for the cast concrete dams or for the dams made of keystone walling.

These structures are used when an average and high mine pressure occur. The concrete dams crack when high pressures occurs, accordingly, die sealing properties are lost and an

improvement in the sealing is necessary by covering on a regular base the whole surface with a water-cement-sand mixture.

All through the years, several methods have been used to get a better sealing and they have consisted basically in covering the surface with a film (one or several layers) made of materials or mixtures such as: latex; vynil polyacetate (vinarome); mixture of plaster, ashes, vinarom and water.

It is stated that these aren't used on an everyday mine basis.

Establishing the technical requirements for the selection of the materials necessary in the additional sealing of dams

As these sealing materials are to be used in underground, they have to fulfill a set of technical requirements related to the geological and mining conditions and to the microclimate conditions. They should:

– provide a high sealing level,

– adhere on different types of materials (sterile rock, coal, wood, metal mesh, concrete, clay, etc.);

– use simple engineering methods during their layering;

– stand in a humid atmosphere with an environment favorable for the development of microorganisms, in a dusty atmosphere;

– stand the fire and they should not propagate the burning process and they should not be toxic;

– there should be possible to get these materials in sufficient amounts;

– the validity of these materials should be as extended as possible.

Test stand to determine impermeability to air currents of the materials used on the sealing dams

To get a clear picture on the sealing of different types of materials that should be used for the intended purpose, they should tested to impermeability a parameters that indicates the sealing level of dams.

Consequently, there has been designed a test stand that allows the modeling of dams with the use of different sealing materials.

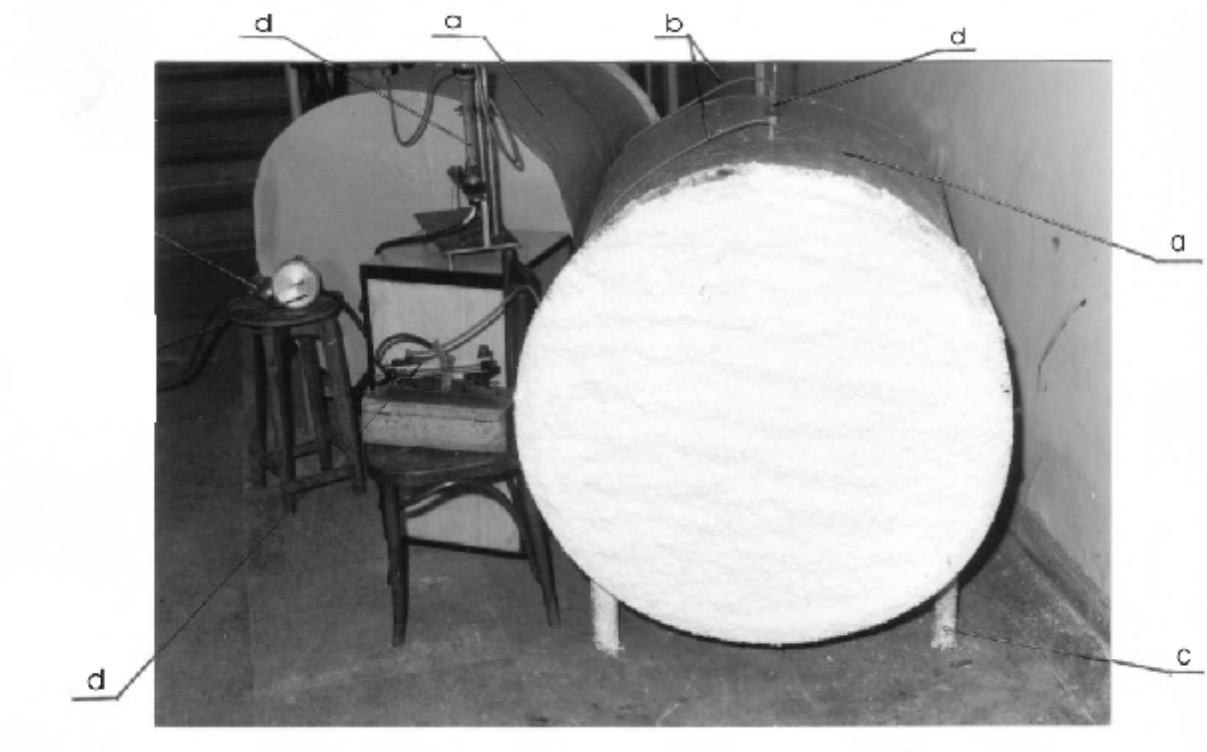
The test stand is made up of the following parts:

a) Two cylindrical vessels A and B, of 1000 mm in diameter;

b) Connecting tubes (hoses or pipes);

c) The supporting system;

d) Instrumentation.



Analysis of the Materials that Form the Additional Sealing Solutions

Considering the technical criteria (demands) for those materials used for an additional sealing of dams, several mixtures were tested and they were grouped into the followings:

a) mixtures based on urelite (urea-formaldehyde resin),

b) mixtures based on cement and inert dust;

c) mixtures based on sodium silicate (soluble glass).

Laboratory tests

Six mixtures (sealing solutions) were tested and applied under the form of a film in 1, 2 or 3 layers.

The measurement started the day after the first film was applied, and went on for several days (10 days max.).

For a comparison of the results and to determine tile best solutions for an additional sealing of dams, the values of the specific air outputs corresponding to a pressure of 1 mm H_2O as well the specific strengths for a square flow state for each tested solution were used.

Considering the results, the additional sealing materials for dams which displayed the highest sealing degree were the ones made of bentonite + sodium silicate and clay + sodium silicate.

Underground tests

Aninoasa Mining Unit was chosen to test in underground the additional sealing materials for the dams selected after lab tests.

Selection of the test places

The following aspects were considered to get as may information as possible about the behavior of the additional sealing materials of underground dams and to select the test places:

- the classical dams made of walling and stone key and of mine wood parts and clay;
- different values of humidity,
- dams with positive, negative or ”zero” pressure;
- current state of the dams surface (clay washed or not, cement washed on not partial concreted forms);
- occurrence of mine gases m different rations behind tire dams (CH_4, CO_2, O_2).

Working method

The sealing materials that were used consisted in:

- sodium silicate + bentonite + water
- sodium silicate + clay.

Bowls with pre-determined volumes were employed to produce the sealing solution.

The component materials of the solution were mixed up to homogeneity.

The solution was brushed in several layers, after the previous one had been dried.

Results

For a surveying of the behavior and the efficiency of the additional sealing solutions used on dams, measurements were carried out before and after their brushing and they consisted in measuring the gas concentration in front of and/or behind dams the temperature, the pressure difference on the dams, the air pressure and the difference humidity.

The following aspects derive from the tests:

1). The specific consumption for each layer of sealing solution made of bentonite 1 sodium silicate is between 1.4 ÷ 1.6 l/m^2, and made of clay + sodium silicate is between 1.3 ÷ 1.6 l/m^2, values which correspond to the first layer. This consumption reduced with 20% and with 30% for the second and third layer compared to the amount of material used for the first layer.

2). The drying period necessary for the sealing layers had wide limits depending on the underground climate (temperature, humidity air speed), on the quality of the dam surfaces smooth or rough surfaces, dams with or without concrete forms, etc.) and the engineering conditions (the ventilation of the area in front of the dam.).

3) A longer survey of how the sealing layers behaved showed that the film, preserved its continuity all through the testing period (5 months), even when it changed the initial glossy appearance (some white spots appeared) the exception is represented by the occurrence of areas with needle type crystals as a result of high concentration of CO_2 and a high air pressure behind the dam where the sealing film damaged after about 2 months.

On the surfaces made of concrete (concrete dams made of keystones walls) as well the ones made of clay (dams made of mine wood parts and clay-washed), the sealing solutions had a good catch, with no tendencies of peeling off or cracking all through the testing period.

Based on the results, it may be concluded that the solutions presented in this paper shall improve the sealing of goafs and they may be used for an additional sealing of the dams made of concrete, keystone walls or of wood parts and clay.

Conclusions

1. An increased impermeability of the sealing workings shall be accomplished with the help of additional sealing materials bushed over them.
2. There have been established the technical requirements for the materials that are going to be used as sealing materials.
3. There has been devised a test stand to determine the impermeability levels of materials. It is used to measure air currents proofness of these dams.
4. The sealing materials (mixtures) with a good behavior on the test bench were made of sodium silicate +- clay and sodium silicate + bentonite. They increase hundreds of times the impermeability compared to the support (dam) which is not additionally sealed.
5. When choosing the sealing solutions for the classical dams, two aspects were considered: the material used to build us the dam and the compatibility of adherence on the surface of the dam.
6. The underground tests of the above-mentioned sealing solutions showed that they improve the sealing of goafs, aspect that shall diminish the risk of occurrence of underground fires and the period of not using the darned coal deposits.