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# MODERN INACTIVATION METHODS APPLIED INTO THE MINING UNITS IN JIU VALLEY

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**Abstract**

Nitrogen is widely used in combating underground fires, first of all in France, Germany, Ukraine and India. Because of the inactivating properties of Nitrogen, this was used throughout the world mining history for the following purposes: elimination of explosion hazard, reduction of fire range and fire intensity, chilling fire workings.

Inactivating by means of Nitrogen was first applied among others in the following causes: longwall mining both advancing and retreating; fire outbreak in workings with circulating ventilation; fighting fires in workings with the auxiliary ventilation; reducing the fire range and eliminating the seat of fire.

**Keywords:** inactivating, mining, methods, spontaneous combustion, nitrogen.

## Introduction

This paper serves the purpose of studying possibilities of application of several methods of inactivation by means of Nitrogen, so as to prevent and to fight against spontaneous combustions inside mining abates with the coal undermined behind the production line.

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The inactivating with nitrogen application should have a positive impact in the normal performance of mining activity, because of:

- endogenous fires' producing hazard reduction, by means of applying the preventive method;
- the diminution of the risk of explosion due to methane accumulation from the working area, by means of creating the inert atmosphere in this space.

These results will implicitly lead to a decrease in the number of endogenous fires, respective, of the immobilization time of the coal store, thus creating the pre-requisites of the increased safety at mining work.

Taking into consideration that the most used mining method in Jiu Valley within the last years consist in the method where the coal is undermined behind the coal face, the inactivation methods presented in this paper will consider this mining method.

As result of these facts, from the analysis of data connected to the above mentioned mining method - on the one hand, and from the ones obtained from specialized literature – on the other hand, it results that at the mining units in Jiu Valley the following general inactivation methods can be used:

- Preventive inactivation**,** respectively the inactivation by means of which it is prevented the spontaneous combustion within the mined area, without insulation of the coal face;
- Fire fighting inactivation, respectively the inactivation by means of which the endogenous fires from coal faces are extinguished by closing the faces with insulation damps.

In this article we will refer to the preventive inactivation method, respectively the inactivation method by means of which it is prevented the spontaneous combustion within the mined area, without insulation of the coal face.

**Preventive inactivation method used for prevention of spontaneous combustions**

The preventive inactivation of mined area can be performed in the same time with the coal mining process.

Moreover, the inactivation used for fighting against the spontaneous combustions can be performed in the same time with the mining process, by using execution personnel when the CO and $CO_2$ concentrations do not exceed the admissible limits, or by using specialized rescuers when these limits are exceeded.

For both types of inactivation (preventive or for fighting against the spontaneous combustions), the maximum flow rate of nitrogen to be introduced into the mined area should be calculated in such a way not to involve a decrease of oxygen below the admissible limits, corresponding to the case when it will produce an accidental occurrence of it into the working area.

In the aim of achieving the preventive inactivation or of fighting against the spontaneous combustions, the following two general methods can be applied:

I. General method, where the pipes used for introducing the nitrogen into the mined area are installed/located in the fresh air gallery;

II. General method, where the nitrogen is introduced into the mined area by means of drills carried out from the mining works located near the area to be inactivated.

**I. General method** - the pipes used for introducing the nitrogen into the mined area are installed/located in the fresh air gallery

The way the pipes are placed in the field and the way the nitrogen is introduced into the mined area are presented in 4 phases in figure no.1 a, b, c, and d.

The pipes located in the base gallery (1 and 2) can have diameters between 50 – 100 mm, and the ones located in the main gallery (5), preferable 100 – 150 mm.

These pipes are assembled/connected by means of flanges and screws.

There are used only pipes that are clean inside, without any impurity (ex. sand, flying ash, water etc.) to prevent the accidental increase of pipe network resistance.

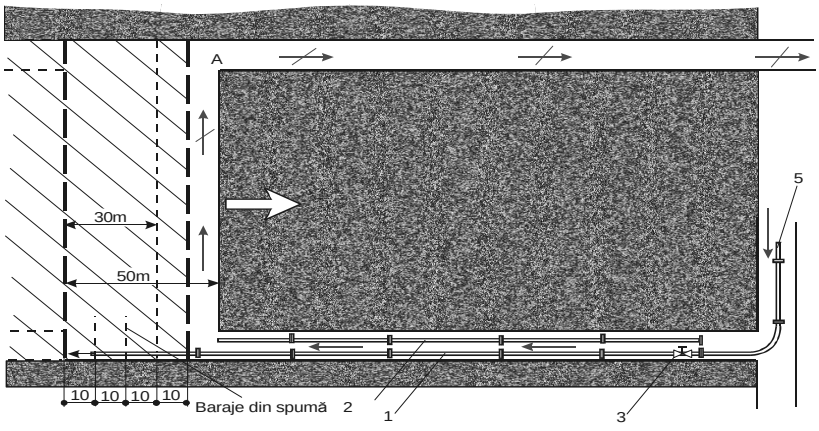


Fig. 1-a. Phase I

a) Pipe 1 is installed in the phase when the coal face is started, and is connected to the main pipe 5 by means of valve 3.

b) Nitrogen start to be injected when the coal face arrive at about 30 meters from the starting line.

c) The pipe 2 is installed when the face arrived at about 50 meters from the starting line.

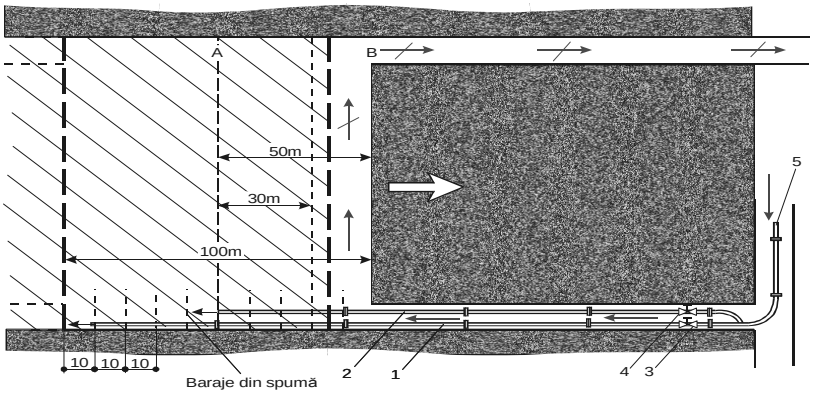


Fig. 1-b Phase II

a) It continues to inject the nitrogen through the pipe 1 until the coal face arrives at aprox. 50 meters from the coal face line from the phase I (100 meters from the starting line);

b) It is connected the pipe 2 to the main pipe 5 by means of the valve 4 and it starts the injection when the coal face reached aprox. 30 m from the face line from the phase I (to aprox. 80 m from the starting line);

c) The inactivation stops and the pipe 1 is disconnected when the coal face reached aprox. 50 m from the coal face line from the phase I (to 100 m from the starting line).

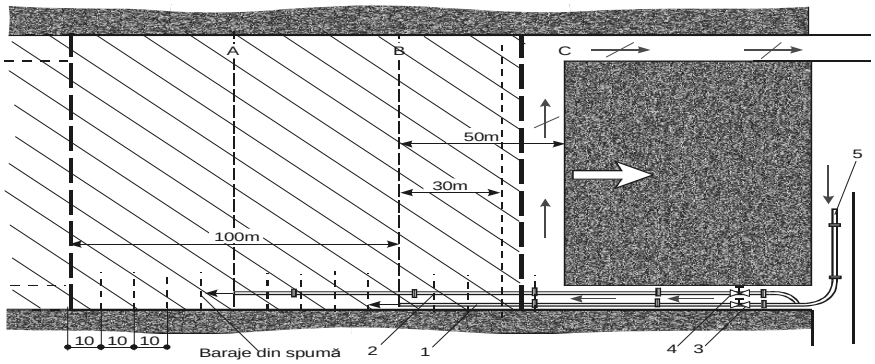


Fig. 1-c Phase III

a) It continues to inject the nitrogen through the pipe 2 until the coal face arrives at aprox. 50 meters from the coal face line from the phase II (aprox. 150 meters from the starting line);

b) It starts the injection in the pipe 1 when the coal face reached aprox. 30 m from the face line from the phase II (to aprox. 130 m from the starting line);

c) The inactivation stops and the pipe 2 is disconnected when the coal face reached aprox. 50 m from the coal face line from the phase II (to aprox. 150 m from the starting line).

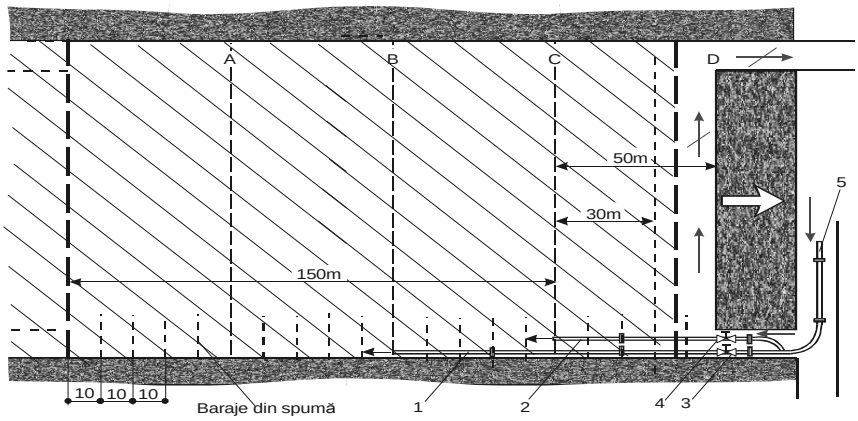


Fig. 1-d Phase IV

a) It continues to inject the nitrogen through the pipe 1 until the coal face arrives at aprox. 50 meters from the coal face line from the phase III (aprox. 200 meters from the starting line);

b) It starts the injection in the pipe 2 when the coal face reached aprox. 30 m from the face line from the phase III (to aprox. 180 m from the starting line);

c) The inactivation stops and the pipe 1 is disconnected when the coal face reached aprox. 50 m from the coal face line from the phase III (to aprox. 200 m from the starting line).

Further on the process is repeated starting with the phase II.

The pipes from the base gallery (1 and 2) may have diameters between 50 – 100 mm, and the ones from the main gallery (5) preferable between 100-150 mm.

**II. General method** - the nitrogen is introduced into the mined area by means of drilled holes carried out from the mining works located near the area to be inactivated.

The nitrogen is introduced into the mined area by means of long holes drilled from mining works located near the area to be inactivated.

The nitrogen should be introduced through these holes only in the moment when their free end (used for discharging the nitrogen into the mined area) is located to minimum 30 m from the coal face.

In fig. 2 is presented the way there are placed the drilled holes through which it is introduced the nitrogen, for the case of a coal face where the coal is undermined into a coal seam with large thickness and high declivity.

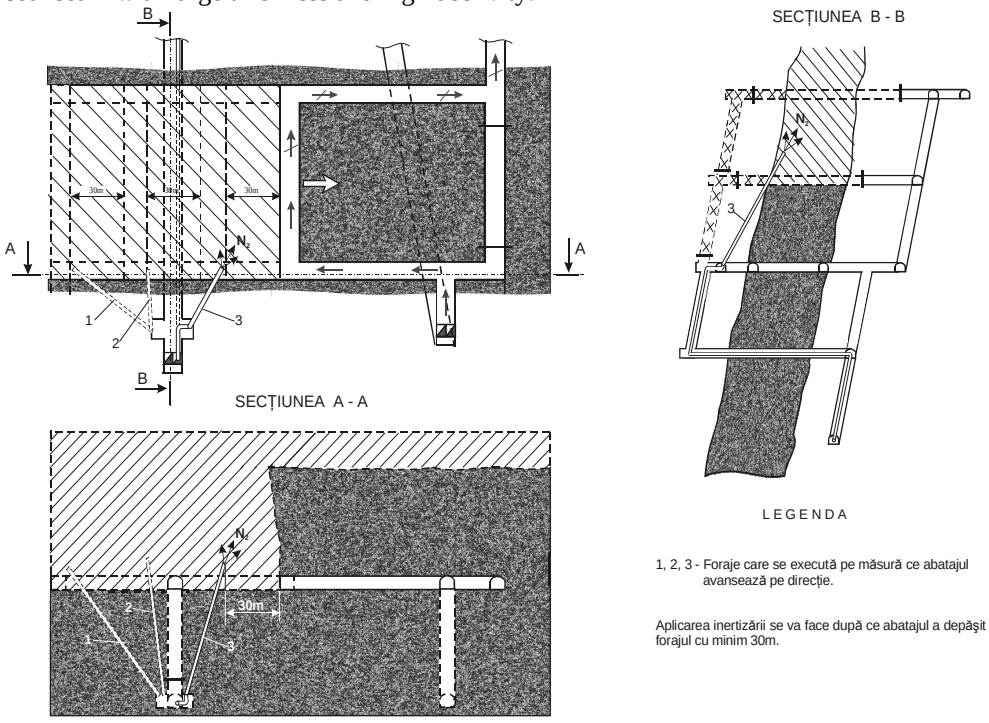


Fig. 2 Holes drilled out as the mining front advances following the direction of the coal strata

For both methods there should be taken into account the following elements:

a). for the case of preventive inactivation (is no sign of spontaneous combustion), the nitrogen is injected into the mined area until the oxygen concentration became ≤10%;

b). for the case of inactivation for fighting against the spontaneous combustions, due to the fact the pipe network or drilled holes are performed in advance, in the moment of the

first symptom of spontaneous combustion the nitrogen should start to be injected. In this case, the oxygen concentration should be ≤ 5%.

**Conclusions**

Four both methods is required to take into consideration the fact that in the area where is to be performed the inactivation it should be introduced a minimum volume of nitrogen representing three times of the inactivated free volume.

Provision of work safety conditions in the period when the inactivation is performed (for both inactivation methods) involves:

- measurement of gases ($O_2$, $CO_2$, CO, $CH_4$) performed with portable devices into the fresh air gallery, coal face line, used air gallery – in the case of not closed faces;
- automatic control of $O_2$ concentration, performed by means of oxygen traductors that are connected to the gases monitoring station, in the areas where these can reach values below admissible limits;
- alarming by means of a communication system (telephone, interphone, etc.) regarding every accidental decrease of oxygene below the admissible limits;
- provision of self rescue masks with oxygen that is chemically connected, for the personnel working in the coal face and for the personnel working onto the galleries where the oxygen concentration decrease below admissible limits.

For both above presented methods it is required to check previously the integrity of main pipe used to introduce the nitrogen into the underground, respectively to wash it with nitrogen in accordance with all above mentioned.

The technical management of the mining units where it was used the Mobile Inactivation Installation confirmed that the nitrogen introduced into the mined areas had a positive impact onto the evolution of endogenous fires registered there.

The specialists from the National Institute for Research and Development for Mine Safety and Anti-Explosive Protection (INSEMEX) Petroșani have elaborated a study at Vulcan Mine, which is a sub-unit of CNH-SA, after stopping the introduction of nitrogen into the underground, by means of which they confirmed the efficiency of nitrogen in fighting against the endogenous fires proved to this mine.

Practical experience showed us that the nitrogen volumes required to be introduced in underground should be of minimum three times the volume of mined areas and even more in the case where there are registered large volume of air that is lost through the mined space.

It was also noticed the fact that in the case when it was open an area where nitrogen was introduced, the temperature of rocks should be below critical temperature where the coal is self-ignited, in the way the re-mining of that area to be performed in proper conditions and high safety level.

Following the practical utilization of inactivation methods at the mining units within CNH – SA Petroşani, we can state with high certitude that in time these methods can be really improved and in the same time their practical usage will lead to better results.

The most important conclusion consist in that the nitrogen inactivation represent a very good and efficient method for preventing the spontaneous combustions; for fighting the mine fires already existing in underground it should be used in parallel also different other active fighting methods, such as: water injection, introduction of flying ash mixed with water, etc. for cooling the rocks and reducing the imobilisation time of respective areas.

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