

Spontaneous Combustion

Kendiliğinden Yanma

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ABSTRACT

In the variable conditions of the French deposits, modern equipment permits to improve combatting of spontaneous combustion considerably. Above all there are to be mentioned : telemetry of the carbon monoxide content for early detection, and nitrogen injection for the control of starting combustion and of detected fires.

However elimination or preventive treatment of danger zones remain important.

*ÖZET

Fransa kömür yataklarının deęişken koşullarında, modern teçhizat kendiliğinden yanma ile mücadelenin iyileştirilmesine izin vermektedir. Bu çalışmaların önemlileri ; karbonmonoksit içeriğinin (erken teşhis amacıyla) telemetrik sistemle saptanması ile başlayan kışmalar ve saptanmış yangınlara azot enjeksiyonudur.

Herşeye rağmen tehlike zonlarının eliminasyonu veya buralarda önleyici çalışmalar yapılması önemini korumaktadır.

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SPONTANEOUS COMBUSTION
PREDICTING, PREVENTING AND COMBATTING
AT CHARBONNAGES DE FRANCE

1. THE CONDITIONS OF EXPLOITATION

The French coal deposits exploited have very different characteristics. Among the ones having a direct relationship to the danger of spontaneous combustion, the following can be mentioned :

- the nature of the coal, from anthracite to long-flaming coal
- the geometric shape of the seams : slope of 0 to 90°, the exploited seams varying from 1 meter to more than 10 meters in thickness,
- the depth, from 0 meters at open cast up to 1 300 meters,
- the treatment of the abandoned workings : caving or hydraulic stowing,
- the susceptibility for heating, practically non-existent in certain deposits, very important, however, in others, particularly because of the pyrite content in the coal.

In the following, only caved-in long faces on flat or semi-steep seam on a slope, which represent the essential part of the French production potential, are dealt with, as well as underwinning workings, the importance of which is declining, but which are still interesting to be analyzed with regard to checking the risk of spontaneous combustion.

It should be noted that at hydraulic stowed rise faces, which continue to play an important role in French production, incidents of this kind have not happened recently. This result is attributed to hydraulic stowing, which eliminates the risks of fires in abandoned workings, and to the generalization of providing these workings with tubings submerged into the filling, a fact that permits the elimination of excess air circulation (figure 1).

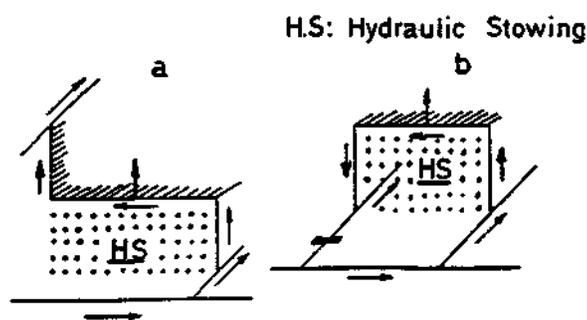


Figure. 1. - Mining scheme of the Lorraine very steep seam

2. EXAMPLES OF SPONTANEOUS COMBUSTION

A schematic distinction can be made between spontaneous combustion in the massif or on the surface on the one hand, and the fires at the abandoned goafs, on the other hand.

The first category represents about 40 % of all incidents recorded in France. The remaining 60 % are divided into fires at the goafs (50 %) and fires in panels that have been exploited and closed (10 %).

2.1 FIRES IN THE MASSIF AND ON THE SURFACE

In all these cases there is air circulation in a split or deconsolidated mass of coal.

In the case of a fire in the massif there is a possible exchange of air between two galleries, generally at the intake and at the return of the air (figure 2).

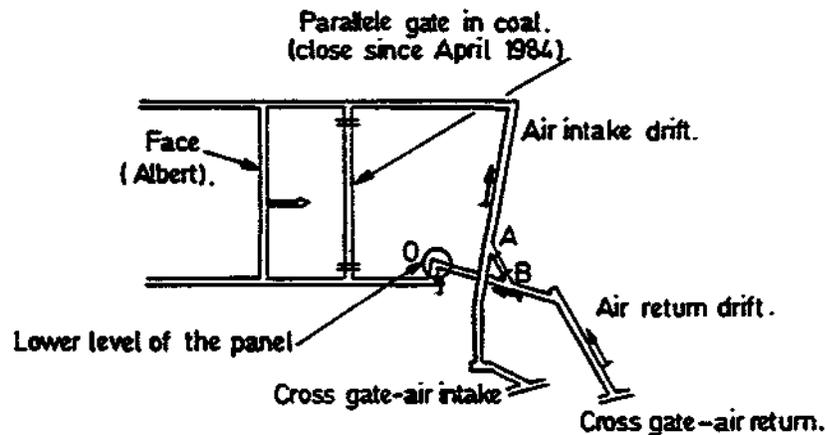


Figure. 2. - HBL La Houve Albert seam - Site 4
Face removing.

In the case of a fire on a coal wall the air penetrates not very deeply into the fissured massif thanks to an air brake placed there, a crib brake and even the front of an advance working hit by a strong current of air. This results in a dynamic pressure excess proportional to the square of the speed.

A typical example is that of a bottom road in which a change in the cutting horizon had created both an air brake and a perpendicular crib brake to the air flow. The splitting of the coal, which is due to the nearness of the workings had created the latter condition, which is necessary for the outbreak of the fire (figure 3).

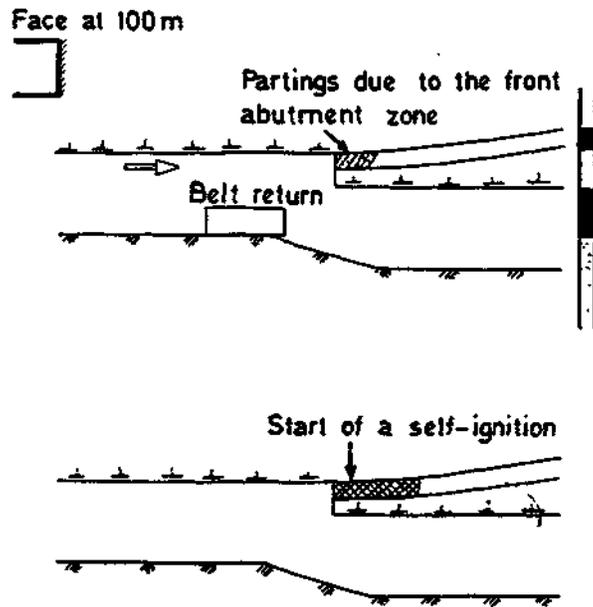


Figure.3. - Roadway wall fire in a narrowing area

Sometimes it is difficult to distinguish between these two classes. In the following example (figure 4), the heading of the bottom road of the upper panel led to a fault. In order to verify the exploitability of panel 2, a probe was extended to the fault. A fire started on the bottom road, at the extremity of the gallery, after the ventilation had been changed, which resulted first in the air drawn in at the intake being forced to the secondary ventilation fan, and secondly in the air of the return of the workings being forced to the secondary ventilation fan. Thus it cannot be specified whether the air circulation was created by the dynamic pressure caused by the ventilator jet, or by the pressure difference between the two points where the fault crosses the galleries again. These two mechanisms can coexist, by the way.

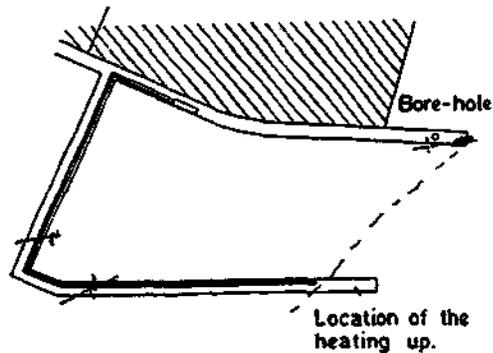


Figure.4 - Heating uplinked with an air flow in a fault or with dynamic pressure

2.2 FIRES AT GOAF

The problems arise mainly at underwinning workings, and at caved-in workings in a thick seam, where coal is left on the roof.

2.2.1 Underwinning workings

Workings exploited in the Bassin de Blanzly (figure 5) are dealt with. The method permits, by reason of its principle, the existence of fragmented coal at the rear part of the piles. For the start of the phenomenon it is therefore sufficient, if the atmosphere contains enough oxygen. This situation occurs easily if the deposit is low-firedamp, which is the case in Blanzly.

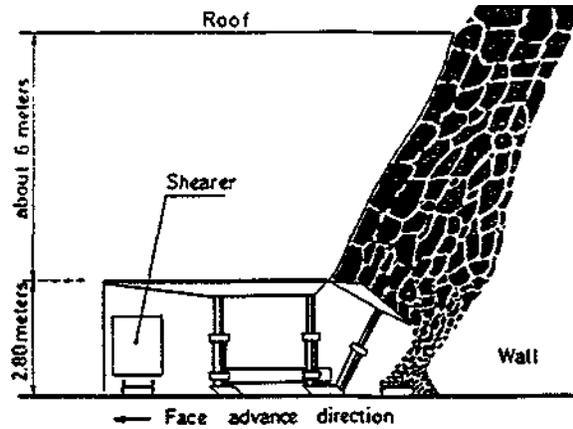


Figure.5-Underwinning face

2.2.2 Caved-in workings

This is the case of the Lorraine deposit, which is characterized by a strong specific release. Assuming that the abandoned workings are connected with the ventilation only by means of ways providing the workings, problems only arise if one of the ways is kept open.

There are two typical situations :

- the air passes above the crib, into the fractured roof, in sufficient quantity to cause heating of the abandoned workings (figure 6),

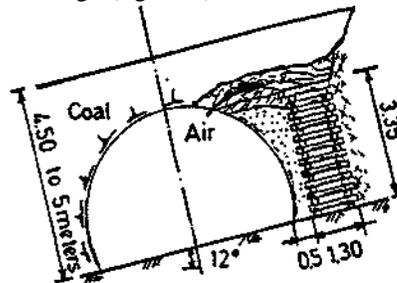


Figure.6. -H.B.L. La Houve Albert Seam

- the entrances are normally not sufficient to effect an oxygen content sufficient to start heating, but if the working is closed for removing, fire-damp release diminishes, and the amount of oxygen increases : a spontaneous combustion can then happen (figure 7).

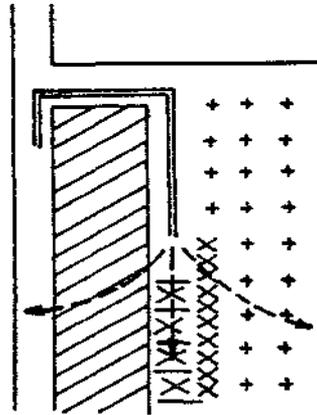


Figure7. - Face being removing

In the case of workings being removing a spontaneous combustion can even happen with a purely folding ventilation, if coal mined near the workings is bathed by the ventilation. The utilization of protection cribs and the sealing of the voids created in dependence on their dismantling diminish this risk considerably.

3. PREDICTING

Predicting comprises two stages : an evaluation a priori of the risks and a continuous supervision of the atmospheric content of the mine, in ventilation as well as in the goafs.

3.1 EVALUATION A PRIORI OF THE RISKS

First it is important to know the susceptibility a priori of the coal : either from experience with other panels or by laboratory measures (test with oxygenic water, test with adiabatic calorimeter, pyrite content).

Subsequently it is intended to find out the suspect configurations requiring closer supervision : destroyed coal pillars, a narrow pillar between an entrance and a return of air.

3.2 CONTINUOUS SUPERVISION OF ATMOSPHERIC CONTENT

The possibility of measuring the atmospheric content of the mine continuously has revolutionized the detection of heating.

3.21 Underwinning workings

Experience has shown that a sufficiently low oxygenic content in the abandoned workings suffices to guarantee the absence of a heating risk : the threshold is 10 % at 30 meters of the workings and 5 % at 60 meters.

Samples are taken at different levels of the face by means of plastic tubes (ill. 8).

If the threshold is exceeded, the situation is corrected by injection of nitrogen.

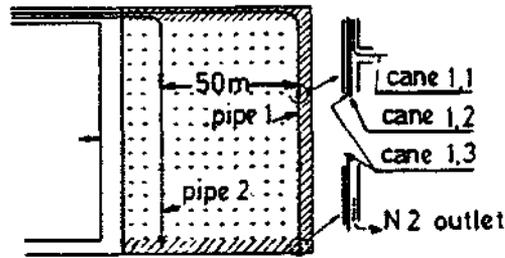


Figure.8.-Sampling in the goaf

3.22 Caved-in workings

The carbon monoxide content is continuously measured at each access point to the workings.

There are two telemetric systems : the network UNOR, with infrared analyzers and, more recently, the network CGA, with electrochemical measuring cells, which have the advantage of being allowed to work in any methane content.

The systems work in an area of 0 to 300 ppm with a precision of 1 ppm.

A cell is monitored at intervals of four minutes.

The data are grouped for each day at the remote control places and treated by computer.

The treatment of the data is based on the finding that a spontaneous combustion is marked by a slow increase in the carbon monoxide proportion. In the absence of possible pollution by shortfiring or diesel locomotives, classical statistical techniques can therefore be used, like exponential rounding.

Otherwise the criterion of the type "window" is used ; this criterion is defined by three parameters : one threshold and two durations ($\Delta T1$ and $\Delta T2$) ; a window is opened if the threshold is reached and remains open as long as the content does not fall below the threshold for a duration at least equalling $\Delta T2$; if the duration of the window exceeds $\Delta T1$, alert is given ; usually the parameters are the following :

- 1 hour for $\Delta T1$ (note that the maximum duration of the influence of a shortfiring on the carbon monoxide content amounts to 45 minutes).

This control organisation is very efficient.

4. COMBATTING

4.1 PREVENTING BY PLANNING

It is important to avoid the risks of a short circuit of the ventilation near the coal seams and to avoid the creation of unstable pillars. In the case of certain susceptible seams one could be induced to renounce the re-utilization of the roads, in order to put into force a scheme purely retreating.

4.2 SEALING OF THE WORKS

The introduction of expansive injectible resins has given the miner an efficient means of eliminating air circulations in the massif.

Polyurethane resins can be used for sealing a closing dam of the quarter, which is fixed on the rock. This method has proved very efficient, and it can be noted that combustions in abandoned workings are very rare today (figure 9).

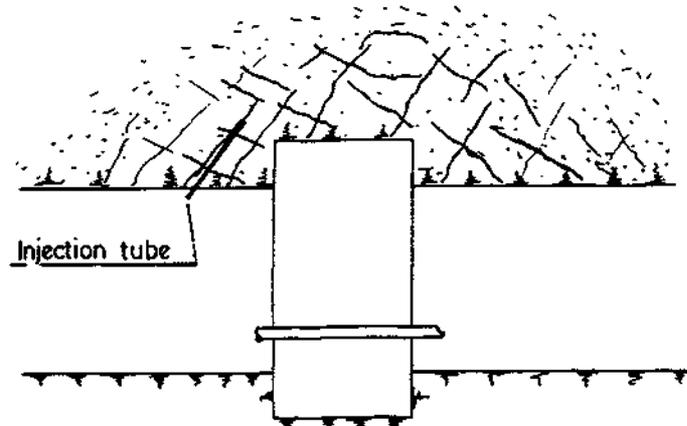


Figure.9. - Tightening by injection of expanding resins at a closing dam.

If a coal massif is to be sealed, a formophenolic, non-inflammable resin is preferred, and therefore the pyrolytic products are not toxic (figure 10).

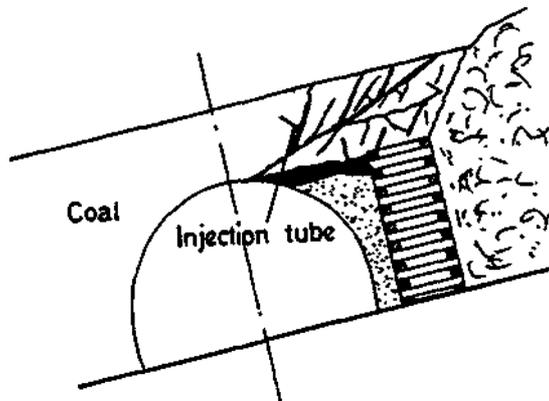


Figure. 10.-Injection above the face end pillars

4.3 THE INJECTION OF NITROGEN

The possibility of injecting nitrogen has considerably improved intervention means. The product can be delivered by cryogenic van and be sent to the bottom after evaporation in a device having a capacity of 1000 to 5000 m³/h, depending on the type.

The Lorraine Bassin Collieries are connected to a nitrogen duct supplied by a factory for air liquefaction, situated at about sixty kilometers from the Bassin. Every pit can be provided by it, up to 12000 m³/h. The use of mobile means would permit to raise this figure to 20000 m³/h (figure 11).

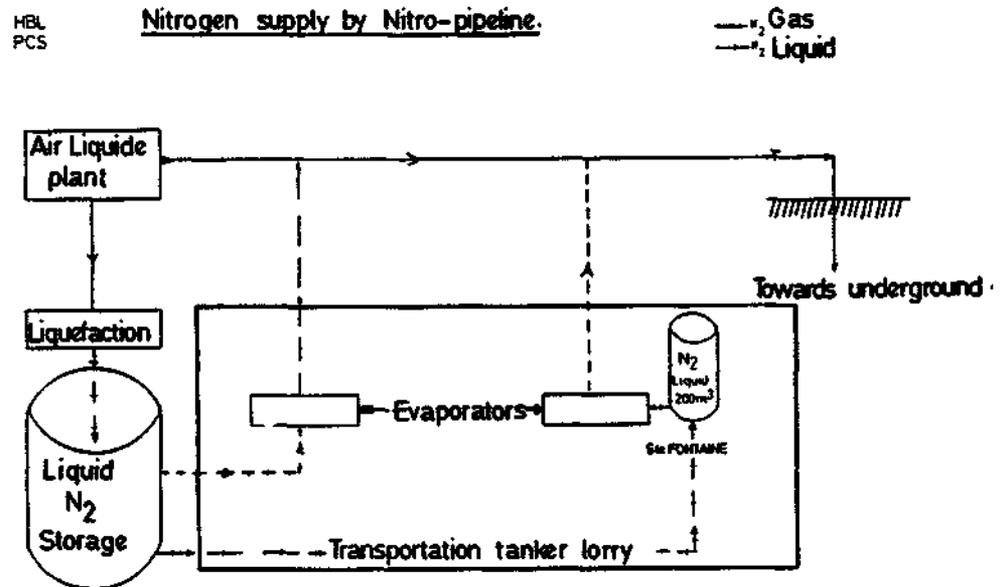


Figure 11-Emergency facility for important flows or plant incidents.

The trend is at present to install at each long face a nitrogen duct susceptible of being connected to the network. This duct continues in the abandoned workings : a tube is connected if its length in the goaf amounts to about 50 meters ; it is abandoned if it reaches about 100 meters.

At Blanzay, nitrogen is injected into the goaf if the oxygenic content is too high. The useful amounts are generally small, about 100 m³/h.

In Lorraine the carbon monoxide content is taken as a basis.

One panel has been exploited entirely by nitrogen ; it amounts were monitored in respect with a threshold of 10 to 12 ppm of carbon monoxide. The consumption of nitrogen has thus varied from 200 to 3000 m³/h (figure 12).

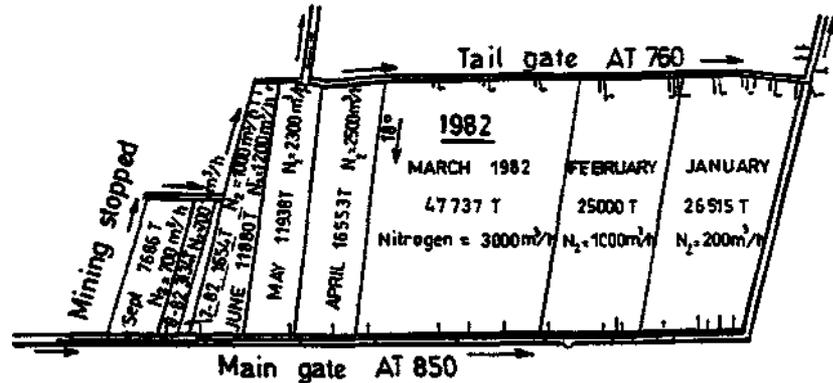


Figure. 12-The situation of face B2/2 - Ste Fontaine Colliery

The control of detected fires can demand higher amounts, often exceeding 10000 m³/h.

5. CONCLUSIONS

Modern equipment permits to improve combatting of spontaneous combustion considerably. Above all there are to be mentioned : telemetry of the carbon monoxide content for early detection, and nitrogen injection for the control of starting combustion and of detected fires. In any case recent experience has shown that it is important to remain vigilant.

Elimination or preventive treatment of danger zones remain important.