WILL FIREDAMP EMISSION STOP PROGRESS IN LONGWALL PRODUCTION?

By

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ABSTRACT

When lying over 200-250m depth, many seams and surrounding strata are gassy enough to create mining difficulties, particularly in highly productive longwalls as well as in their development headings.

In addition to the gassiness of seams or strata in the outgassing volume around working, the shape and limits of this one influences much the intensity of gas emission. These characteristics of outgassing volume differ very much according to the permeabilities of the seams and strata encountered by their fracturation due to mining. Moreover, the shape of the outgassing volume is very much modified by the rate of advance of the face.

In nearly impermeable deposits, gas flows from a limited outgassing volume. When the rates of advance of a face are medium or low, the shape and dimensions of this volume do not change very much and outgassing volume is translated progressively with the face advance. This explains why, in the past, it was observed that there was for each seam an average steady specific emission of gas, round which the volume of gas evolved per mined ton or per mined unit area, calculated over a certain time, was oscillating. Combined with a statistical irregularity coefficient, this allowed prediction gas of emission and thus to take decisions for air ventilation, drainage, and eventually production.

With the high rates of advance of the face, the shape of outgassing volume changes often and significantly.

No longer is there a steady specific emission figure to use to manage longwall mining correctly. What is necessary is a method for calculating gas emission over a short imminent period based on detailed informations from studies of previous ones. Moreover some recent methods using tracer gas to improve efficiency of and to simplify drainage should be introduced.

In deposits of quite high permeability, gas flows from a much wider, continuously extending, outgassing volume. (Gasmake is always evolving and computer models are necessary to evaluate it.) If initial contents of gas are not decreased by predrainage of all the levels of influenced volume, longwalls cannot be mined at high rates of production. But fortunately permeable deposits are often easily, predrained by prior longwalls above or below by special crossmeasure borehole patterns. Thus very high rates of production can be realised only in naturally permeable deposits or in parts of impermeable deposits whose destressing has been achieved due to an overlying mined zone.

INTRODUCTION:

Methane maximum concentrations in mining workings must be lower than the safety limits fixed by regulation. This condition is more and more difficult to realise because high rates of advance of new workings induce high firedamp emissions and
make more difficult some prevention methods.

As inducing and affecting firedamp concentrations in mining workings atmospheres, particularly in ventilation outlets of reatining longwalls, four basic factors are to be considered:

1. Intensity and variations - in space and time - of firedamp emission from seams and strata.

2. Efficiency of an eventual gas drainage (predrainage and/or postdrainage).

3. Dilution of firedamp by airflow, i.e. intensity of the ventilation and its irregularities in space and time.

4. Finally, as a result of non predictable combination of the above variations and irregularities in space and time, and considered as an independent factor the maximum irregularity of gas concentration in the working outlet, i.e. the ratio between maximum and average concentration (over periods for which we can predict average values of the above factors).

The possible maximum methane concentration "g" in a ventilation outlet of a working area, over a certain period of time can be expressed by:

\[ g\% = \frac{(1-d)Q_g}{Q_a} \times i \times 100 \]

where:

\( Q_g \) = firedamp average flowrate over the considered period.

\( Q_a \) = ventilation average flowrate

\( d \) = average drained part of evolved gas

\( i \) = statistical coefficient of irregularity, appropriate valuable in this type of working over a period of working time (such as a month, week, and perhaps later, last day of a week, as examples).

Some of the above factors are influenced by natural characters of the deposits, and any factor depends on mining working type and characteristics.

The most important natural characters of the deposits to consider are stratigraphy, initial gas contents and natural (or induced) permeability of the seams and rockstrata. But particularly the permeability modifies the volume of ougassing and the possibility of predrainage.

In any case, the higher is the initial gas content in this volume, the higher is the gas emission.

Among mining working characteristics, the production rate or, better, the rate of advance of the faces (or headings) can induce important effects on constraints. The main purpose in this paper is to define some peculiar effects and constraints on basic factors and on their combinations due to high rates of advance compared to the low or medium rates existing in the past, and to suggest some ways and some trials or researches for the future.

But it is easier and clearer to consider separately the cases of highly permeable deposits and low permeability deposits.

**FIRE DAMP IN WORKINGS MINING NEARLY IMPERMEABLE DEPOSITS.**

**General:**

In such deposits, in zones not destressed by near mining or tectonics, the permeability of seams and adjacent strata is less than a few microns (i.e. flowrate of gas into crossmeasure boresholes per meter thick seamlayer is less than a few liters per hour).

1. In Europe it is considered that:

Seams are quite gassy when \( C > 10 - 12 \, \text{m}^3/\text{t} \) - Seams have low gasiness when \( C < 0.5 \, \text{m}^3/\text{t} \)

where \( C \) is initial "desorbable" gas content surged on samples, that is the gaskfive \( \text{cm}^3/\text{g} \) from in situ stage right through to compressed very fine crushing in an atmosphere of evolved gas at 0.1 MPa.
Noticeable firedamp flow comes only from the volumes of strata distressed and fissured by mining, because strata and particularly coalseams become quite permeable when distressed (permeability of seams increases up to a few millidarcys).

**FIREDAMP IN LONGWALL OUTLETS**

**Intensity and Variations of Gas Emission**

Case of rather low rates of advance of faces - average gas flowrate: studies made in the past in Europe showed that for similar faces which mined various panels of the same seam in the same non-mined surrounding, the ratio \( \frac{S_2}{S_1} \) of the total gashouse on mining time and over) to the total production from the panel) was the same. A, in mined ton, was defined as the specific emission related to mining of this seam. (Now the term \( S_a \) is the (total gashouse)/(total mined area) is preferred when most part of gas comes from other seams and strata than the mined seam).

The same studies showed that, after 2 or 3 months since starting of the face, ratios \( S_2 \) - (monthly gashouse/monthly production) or preferably ratio \( S_1 \) - (cumulated gashouse)/(cumulated production) were oscillating round the above specific emission value \( S_a \).

The rather low rates of advance of faces pertaining (2 to 4m/d) is the reason why \( S_1 \) and \( S_2 \) were almost stationary at that time. This is understandable from the following physical description of outgassing zones. From this description the conditions of validity of the concept of specific emission can be deduced and the method of predicting average gas emission over a long time as established in the past can be understood. This description results from many measurements of residual gas contents at different places and levels behind faces, and from interpretation of some phenomena such as variations of \( S_2 \).

Above and below a longwall goaf there is an outgassing volume as shown on Fig.1. Gas flows from this volume through distressed seams and strata and is collected and drained out by cracks.

![Fig. 1 Patterns of gas flows around longwalls (naturally impermeable deposits)](image)
specially by peripheral cracks which necessarily stay always open, because of relative movement between subside strata over the goaf and unaffected surrounding strata.

This volume can be delimited on the front, on the top and on the bottom by surfaces $S_t, S_t, S_m^1$ on which decreasing of initial gas content starts - and on the back by a surface $S_r$ on which residual gas content almost stops to decrease. Lateral outgassing limit surfaces become nearly vertical close to $S_r$. Except regarding this last observation, exact shapes of limit surfaces are of no importance. The only important fact is that if there is enough slow and steady progression of the face, the shape and dimensions of outgassing volume as well as the spatial pattern of its gas contents are steady: this outgassing volume is translated according to the face progression (Fig. 2a: $V$ at time $t$, $V'$ at time $t'$).

With the approximate existence of such a translation,

1 there is a stationary average specific emissions (evaluated on a sufficiently long mining time), and

2 the gaskake due to the mining of a certain area (between $t$ and $t'$) is equal to the difference of gas contained in a parallelepipedic volume $V_E$ based on the mined area and limited on levels $S_t$ and $S_m$, where at first the strata would contain real initial contents, then final real residual contents $V_E$ is termed equivalent volume of outgassing.

Many measurements showed the final residual contents in coals (depending on the residual gas pressure) was from 1.5 to 3 m$^{-3}$/t in all the seams, from limits 100 to 120m above the goaf to 10 to 15m below it. The gas contents were almost linearly increasing up to initial values at around 50m above and below these limits.

Some sandstone strata contain and release gas. Their content is related to their porosity and gas pressure, the latter being the same as in adjacent coalseams. Often their emission is more than that of a coalseam 10 times thinner than these rocklayers. But some very thick sandstone monolithic layers can stop the extension of fracturation into overlying (underlying) strata, and limit the outgassing zone. Some moist clays or mudstones can do the same.

At that stage, average gas emission related to a coalproduction $P$ on a sufficiently long period of time can be expressed by $Q_g = P \cdot s$, with $s = \frac{(1+\alpha)(1/t)}{4} \cdot \sum h_j (C_j - C_j^1)$ where $m$ and $t$ are lower and upper levels of outgassing, $h$ is the thickness of coal or rocklayer at level $j$ above or below mined seam, $C_j^1, C_j^1$ initial and residual gas content of this layer, $h_j$ thickness of mined seams.$*^v$ can also be deduced from gaskakes and production of previous similar longwalls in the same seam in equivalent environments.

$*^v$ Jeger's model.

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3 Values of specific emissions can be different according to the deposits: in some deposits it can be under 15 m³/t; in others it can exceed 30 m³/t.

Variations of specific emissions and of gas flow-rates. Variations of concentrations in longwall outlets and irregularity coefficient.

On the first period of mining (1 to 3 months) s1 and s2 are lower than s and are increasing until outgassing volume V reaches its normal stationary shape and dimensions. So does s3 the specific emission calculated weekly (Fig.3). Later s2 oscillates around s; also s3 oscillates around s2. The major reason is that shape, dimensions and contents evolution of outgassing volume V is not constant (when the face is moving); at first, daily, even weekly, advances of the face are variable; moreover above and below a daily or weekly mined area, the new strata fracturation and destressing and related new gas emission occur and extend irregularity in time.

Further, the gas emission from a new destressed part continues, almost exponentially decreasing over several weeks or months after destressing, and is not at all related to the next mined parts.

As well, after the face passes, the vertical expansion of destressed and fractured zone due to the new mined area spreads progressively in time, independently of the subsequent rate of advance of the face.

To the present no good relationship has been found between a weekly or a daily gassake and other factors like recent coal production, previous productions and gas makes on more or less long periods of time, and eventually stratigraphy and its gassiness. (English trials for predicting next weekly gassake from general laws of rock mechanics and gas desorption did not give satisfactory results; Neither did German trials to predict maximum daily gassake on the next week, by statistical multivariate procedure on previous gassakes and coal productions). Probably more numerous physical phenomena and data should be allowed for as well as unavoidable dispersion values to which an attempt can be made to attribute probabilities. It could be a next useful topic of research.

The only quite good, but not very useful relation found in the example presented in Fig.3 was an almost linear relation between gassake on the unworked 2 days of the weekend and gassake on 3 previous worked weekdays (Fig.4). Linearity of this relation is probably a starting point of more general (biproponential) relation. In this case, it should be noted that a high proportion of gassake comes from the mined seam and from rather close (20m) underlying seams.

But finally, as seen later, to predict gassake trends it is nevertheless necessary to use statistical irregularity coefficient to attribute a value to maximum possible gas flowrate, or more usefully, to maximize.
mum possible gas flowrate, or more usefully, to maximum gas concentration in a longwall outlet.

To take into consideration the irregularities of outlet gas concentration due basically to variations of gas emission, but also to variations of ventilation flowrates and eventually of drainage efficiency, a coefficient of irregularity \( i \) is established from continuous measurements of outlet concentrations \( "i" \) on previous similar longwalls.  

\[
i = \frac{t \text{ max.}}{\bar{T}} \quad \text{where } t \text{ max. is maximum measured concentration after eliminating a few (5%) abnormal values, } \bar{T} \text{ is average of the quite numerous series of average values } T \text{ calculated on the periods of time selected for a prediction of for a study (days, weeks, weeks of peculiar average rate of production); e.g. if later, average next weekly gasmake, and even possible evolutions round these average values can be predicted. } "i" \text{ can be established for these peculiar periods). In Europe average daily emissions over a long period of time and daily average expected production are used; } "i" \text{ was found to be 1.7 to 2.2; later, if prediction can be made shorter next period of time, the "i" value could be lower.}
\]

- **Case of high rates of advance of faces**

- **Production**

Now, daily production of faces which are less than 180m long, and mine around 2m thick seams, often exceed 6,500 to 7,000 t/day; it corresponds to more than 10m rate of face advance per day. Such high level productions are very variable, not only daily but often weekly and sometimes monthly.

- **average gas flowrate**

As a first consequence, the concept of specific emission is often not valid, particularly if it is considered as a constant mean value around which \( s_1 \), \( s_2 \) and much more \( s_3 \) oscillate; these values are not stationary.

The first reason is that the outgassing volume is no longer almost steady in shape, size and contents make up \( t \) there is no more a translation of this volume with face advance, but there are big changes of this volume with high variations of face advance. This is particularly because, as discussed above, the speed of vertical expansion of destressed and fractured volume above and below a mined part does not depend on the rate of advance of the face. Consequently when there is high progress in a week or over several weeks, the front surface \( S_1 \) of the outgassing volume (Fig.5A(b)) becomes sharper than \( S_2 \) corresponding to a lower rate of advance (Fig.5A (a)), whereas, for a certain time, shape and progress of backsurface \( S_3 \) does not change noticeably.

![Figure 5A](attachment:image.png)

**Fig.5A Effects of rate of advance on the shape of outgassing volume and on \( S_2 \) or \( S_3 \)**

Correspondingly the apparent specific emission ratio \( s_1 \) (gasmake/mined area or production) is lower than with a smaller rate of advance. Reciprocally it, later, there is lower rate of advance over a certain time, the outgassing front becomes less curved and for a same progress of the face the outgassing volume is higher than that which would exist with a similar steady lower rate of advance, and it is the same with corresponding apparent specific emission (Fig. 5A(c)).

The second reason is still more significant. It is related to the fact that from a new fractured part of a coal seam, flowrate of emitted gas decreases very quickly on a few days but then decreases slowly on a very long time. In the real case shown on Fig.5B (which is continuation of Fig.3) - after stopping of the face, the gas flow (flowing from a close...
quickly influenced (seam) decreased over about 10 days as quickly as on a weekend, then became almost stable for several months.

\[ s_3 = A + B \left( p + p_0 \right)^{2n+1} + C \left( p_0 \right) \]

\( A, B, C \) depend on the characteristics of strata stratigraphy and contents.

So, weekly apparent specific emission \( s_3 \) decreases when \( p \) increases.

It is like that, because in the way of calculating \( s_3 \) (even \( s_2 \)), there is a physical "error": we do not relate the gas emission neither to all the parts of production which induce it, nor to their stage of desorption; we do not take care of desorption delay and of its duration. As example with such an evaluation of \( s_3 \) (and \( s_2 \)), after the face stopping, \( p \to 0 \) and \( s_3 \) (or \( s_2 \)) should be infinite (\( 1/s \) goes on, for long); this has no sense, \( s_3 \) can be valuable only if \( p \) is almost constant \( = p_0 \) or if it is calculated as a mean value on many weeks.

Evaluation of specific emission \( s \) as used to predict gasmake into longwalls whose rates of advance are rather low and steady (e.g., case (1) on Fig. 5A), is not convenient to predict a value round which the average monthly or weekly gasmake of highly productive longwalls oscillate. It can give only flow-rates generally higher than real ones, usable as a first step of a quick evaluation of safety conditions. Only values given by measurements in previous similar mining conditions are usable and give presently the possibility of enough accurate prediction.

But for high rates of productions we must have another point of view than that of specific emission.

For safety in mining, the only important characteristic of gas emission is gas flowrate, i.e. emission intensity versus time. As a first approach, consider in a same time of mining the 3 situations of Fig. 5A, assuming rates of advance \( v \) and \( V_0 \) of cases (a) and (c) much lower than \( V_1 \) of case (b) and taking into account the fact that speed of vertical destressing expansion does not depend on the face rate of advance, \( V_1 \) can be deduced that the gas flowrate

\[ j \] is higher in case of high rate (case (b) Fig. 6)

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than in any of other lower rates (cases (a) or (c) Fig.6) and
2) is higher in case of medium rate after high rate (case (c) Fig.6) than for the same rate before high rate (case (a) Fig.6).

Fig.6 Effect of the rate of advance on gas flowrate.

A method for predicting gas flowrates otherwise than by comparison should take into account the fact that the flowrate $q_n$ over a short period (e.g. a certain week) does not depend only on characteristics of stratigraphy $S_t$ and gas contents $C$ and on the production $q_n$ over this period, but also on what happened previously as production and gas emission.

$$q_n = \left( p_n \cdot q_n \right)^{n-1} \cdot \left( S_t, C \right)^n$$

Such a method of prediction is still to be created. Progress in evaluating gas evolution in time with computing model, as well as results of measurements in strata mechanics, should be useful to establish such a method.

But, the same reasons as for slower longwalls there are other variations of gas emissions.

If, like for concentration in returnair of slower longwalls, a coefficient of irregularity is used to evaluate the maximum possible gas concentration, related to maximum daily, weekly or monthly average gasmake, it will often appear that to mine at such high rate should be impossible.

Effectively, with such high rates of production, it will be sometimes necessary to stop mining for 1 or 2 days at the ends of some weeks. (Now, mining is often continued until the concentration almost reaches the safety level; then, even if mining is stopped, this level is exceeded because gas emission results from previous mining).

To mine as much as possible with such longwalls, it would be very useful, before each new week, to be able to evaluate, according to planned daily production, the average gasmake on this week and maximum concentration. Presently no method is known in the world for doing such a prediction. To study it successfully it will be probably necessary to take into account not only gas flowrates and gasmakes as well as daily productions on several previous weeks and months, but also the level, the thickness, and the gassiness of overlying and underlying rock and coallayers, and probably their outgassing rate versus time (given by a computing model, like this one developed by ACIRL - CERCHAR).

Gas Drainage:

General

When daily coal production over 4000 t/d, is sustained, it is necessary to drain even in case of very low specific emission (10 m³/t) and with high ventilation flowrate (more than 40 m³/sec).

- Pre drainage:

Predrainage is inefficient in impermeable deposits, except in parts where seams would be quite permeable, i.e.:

1. some upper parts of some synclinals, where tectonic forces have extended the seams, and
2. parts destressed but not completely degassed by overlying workings (between 30m and 100m under a mined zone).

Predrainage would be also possible from a permeable rocklayer and through it from a seam coalseam (permeable or not). These cases will be examined below.

- Postdrainage: (behind the faces).

- Case of medium low rates of advance of faces.

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Several methods of drainage are normally used:

(1) boreholes drilled from lateral roadways and connected to suction network.

This method is easily achieved only if there are at least 2 lateral roadways (multiple entry developments) or if the ventilation is type "Z".

In Europe, upholes are more efficient than downholes. Postdrainage by downholes fails because accumulated water makes the suction inefficient, and gas flows by any fracture preferably towards a drainage borehole.

Moreover, as it was shown in experiments with tracer gas, an important part of gas evolved from strata lying under the goaf, flows up and is collected by drainage upholes or by any drainage room lying above the goaf, particularly by drainage installations used in previous overlying workings.

(2) drainage by goafrooms and by overlying or underlying roadways:

For retreating longwalls with single inlet and return roadways, often postdrainage is possible only:

(a) From rooms created by supporting and separating some parts of roadways adjacent to the goaf, for example with anhydrate pillars.
(b) By taking advantage of previous overlying workings or by driving a specialised overlying roadway (both closed and connected to suction pipes).
(c) By early mining of a roadway in a seam lying more than 40m below the next mined seam, and drilling many upholes from this roadway. The boreholes are connected to suction pipes.

- Case of high rates of advance

Ventilation:

If specific emission is up to 15m³/t about 7000 t/day can be mined safely only if ventilation air flowrate stays over 40m³/sec and if efficiency "d" of postdrainage is more than 70% of total evolved gas. If specific emission is higher, it is necessary to consider the possibility of higher dilution:

1. by complementary airflow at the top of the face (Fig.7(a)),
2. by dividing faces into 2 parts ventilated separately (H system ventilation (b) Fig.7) but a single intermediate roadway well supported in front of the face is needed.

Fig.7 Ventilation methods for higher dilution of gas.

If specific emission is too high to succeed with such methods, a decision can be made to mine with 2 shorter longwalls of subcritical length, using the same long distance transportation in one of an intermediate roadways (subcritical length can reduce very much the outgassing volume).

Drainage:

Borehole drilling for drainage with upwards and downwards boreholes from lateral roadways, sometimes cannot follow the high rate of advance of the face. Particularly in this case, it is important to adjust borehole orientation (with tracer gas) to obtain very efficient drainage with very short and quite distant boreholes.

Recently it was discovered by using tracer gas that downwards borehole efficiency is increased...
by appropriate position and orientation of such boreholes, and by a natural outflow of water, owing to appropriate direction of the face. In such a way, lengths of boreholes can be shortened and the distances between them increased (Fig.8). The same observation with tracer gas could be made with upwards boreholes; for upholes there is no problem with water, but the choice of the length of the standpipes is very important; if too short, they drain air; if too long, they miss the gas collected by permanent lateral fractures and accumulated between blocks of the low part of the caved area.

But more often it will be necessary to complete this drainage with one or several of the methods indicated above.

![Diagram](image)

Fig.8 Downwards borehole direction and drainage efficiency.

**Useful length of drainage borehole.**

**GAS EMISSION INTO HEADINGS**

**Rather impermeable seams.**

Into headings driven in rather impermeable seams, gas flows only from parts which are destressed and fractured by the roadway itself. These parts are not very wide (less than about 12 to 15 m).

The residual gas content “Cr” was measured at different depths in the ribodies at different moments after passing of the heading front. Typical results are shown on Fig.9a. About 1,5 month after passing of the face, in a slice of ribside (perpendicular to the wall) outgassing was almost finished.

So, in the heading plan in Fig.9 (b) behind the actual front H1 there is, at time t1, advancing outgassing zone H1L1B1 which was H2L2B2 at time t0 when the front was at H0. Evolved gas between t0 and t1 is equal to the gas evolved from initial content C1 to final content C1 in the destressed seam volume contained between B0 and B1 (B0B1 = H0H1). In the pillar Pa separating 2 headings, more than half of the total gas content is degassed.

![Diagram](image)

**Fig.9 Outgassing of a heading ribside in impermeable seam.**

So laterally, the decrease of gas content is limited to L, gas make is quite low, average gas flows is easy to calculate; it is proportional to the rate of advance of the heading. High rates of advance are generally possible only with appropriately high ventilation flowsates. But, as for longwalls, must be introduced and this statistical coefficient of irregularity, must be previously evaluated experimentally.

**Firedamp from rather permeable deposits.**

A coal seam is considered as rather permeable when its permeability is over a few tenths of a millidarcy. From a 1 m thick layer of a quite permeable seam, gas flows into a crosssection borehole is over 10 m³/hour, sustained for a long time.

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From permeable seams, gas emission into mining workings should be much higher than that from impermeable seams having the same initial - not insignificantly low - content of gas. It can be understood immediately by considering gas emission into headings. But fortunately it is possible to decrease initial gas content before mining.

GAS EMISSION INTO HEADINGS (into permeable seams).

The same heading as studied in Fig.8, subsequently passed through a zone where the seam was quite destressed but not at all degasified by the overlying previous longwall (covering about 50m on the heading ribside).

As was done in previous impermeable part, the gas content was measured and found to be decreasing versus time in the ribside (Fig.10).

![Fig.10 Outgassing of a ribside in permeable seam.](image)

At a place passed by the heading front 1,5 month previously, gas flowrate is more than 8 times that shown on Fig.8, and continues to increase by laterally extending of the outgassing zone, almost without stopping during driving of the heading if the seam is permeable everywhere or destressed on a very wide area (Fig.11). Intermediate pillars Pa are completely degasified. High rates of advance of such headings are generally possible only if gas is predrained or postdrained by in-seam boreholes if gas is blocked by infusing water from long boreholes BH located about 25-30m away from the development headings. This infusion makes the seam locally almost permeable. Nevertheless it is useful to drain gas later from beyond this barrier (but not as much in a hurry).

![Fig.11 Extend of heading ribside outgassing in permeable seam.](image)

In such headings gas flowrate can be calculated only with a computing model like the ACIRL - CERCHAR "PARTRACE" MODEL.

GAS EMISSION INTO LONGWALL WORKING AND RETURN - Permeable seams

Intensity of Gas Emission and its Variations

Sources of gas.

Gas flowrate behind a longwall face includes not only the gas flowing from the same destressed and fractured volume as for longwalls mining in a non permeable deposit but also gas flowing in all seams and gassy permeable strata from a wide lateral distance on all sides of the fractured volume. This gas flows towards lateral fractures within this volume just as towards heading ribsides (Fig.12). It flows as long and as much as towards heading ribsides because these fractures always stay open.

Mining of the first panel in a permeable seam

General:

If a deposit is rather gassy, this gas flowrate is much higher than in a similar gassy impermeable deposit. The gasmake evolved from the destressed and fractured volume lying above and below the gas in the same as in case of impermeable deposit of the same gas content. Moreover there is a big gasstream from outside of this volume.
To evaluate gas evolving from the fractured volume the same method as for impermeable deposits can be used; but for gas flowing from outside of this volume it is necessary to consider each permeable stratum, particularly coalseams, as a side of a heading and to evaluate gas flowrate with a computer simulation such as ACIRL - CERCHAR.

This first panel must be mined at a quite low rate of production even if the mined seam is predegassedified by development roadways and by in seam predrainage boreholes during and after the development.

**Predrainage and Postdrainage:**

**Drainage from underground workings.**

**General**

Too high gas emission into this first longwall can be avoided by predrainage from development roadways, not only by inseam boreholes in mined seam, but also necessarily by crossmeasure boreholes drilled through overlying and underlying strata and to seams located within outgassing upper and lower levels. But this predrainage needs quite a long time in France, in a group of 9 seams destressed and quite permeable, 1.5 years were necessary to decrease initial content from 8m³/t to 3.5m³/t with a path of crosseam boreholes 60m apart.

But when initial contents of surrounding seams and strata are reduced to 3.5 - 4m³/t, it is easy to mine with a quite high rate of production. Nevertheless it is still useful to achieve postdrainage through previous crosseam boreholes, so that gas flow under ventilation air is very low even when production is high. Residual gas content is dropped to around 2m³/t.

Decreasing of gas content by crosseam boreholes can be difficult if all the influenced seams are very gassy and very permeable. In such a case one can try to establish lateral barriers against gas by infusing water into a first range of lateral crosseam boreholes drilled from developments. If there is enough time before mining, the volume between these barriers can be pre-drained, so that a high rate of production can be achieved even in the first mined panel. But with this method such barriers predrainage must be achieved for any of the next panels to mine, because behind these barriers the gas content does not decrease.

**Use of long in seam predrainage boreholes:**

This new technique is valuable only to degasify a seam area before development, or to reduce gas make into longwall when the specific emission comes from a single thick seam. But this method can not be sufficiently effective, if several layers of the seam are separated by impermeable clay or mudstone layers.

**Panels mined laterally to a first mined panel:**

Except in the case of the use of infusers, mining of the first panel degasses laterally all the gassy permeable seams encountering lateral fractures of the first outgassing volume. If the permeability of these seams and strata are high enough, their gas contents are reduced sufficiently for the...
next panel to be mined at a quite high rate of advance. If necessary, complementary predrainage or postdrainage can be used.

- Case of seam area destressed by overlying first mining:

In such a seam, the gas situation of a new panel can be similar to that of one of panels in permeable deposits, and gas treatment could be the same. Nevertheless the limited width of the destressed area can make quicker degassing of this area in all influenced seams.

- Predrainage and postdrainage by surface boreholes:

General

This important topic cannot be developed here. Nevertheless this technique can be very useful, particularly for postdrainage, because, for the latter, only a few boreholes are necessary over a wide area. But efficiency is less than underground boreholes drilled just behind a face, particularly than boreholes drilled from overlying or underlying roadways. Used for postdrainage, boreholes from the surface do not immediately drain the gas evolved just behind the face, from strata close to the mined seam. Two sorts of postdrainage boreholes from surface can be used:

- boreholes drilled down to the bottom of the mined seam; according to French experience, to avoid failure, the main precautions to be taken are to cement fully the bottom up to the roof of the mined seam. Gas is collected from 10–15m just above this level through a slotted pipe narrower than the diameter of the borehole. Above this part, the bottom of the main pipe is cemented for 20–30m, at first to support the pipe, but particularly to prevent closing of the draining slotted pipe by filling it with upperlying watered mud or clay layers flowing into it. All this main pipe must be free of lowering with subsidence of the lowest strata, particularly its top smoothly sealed in a wider pipe connected to exhausters.

- boreholes drilled only up to penetrating into the upper part of degassing volume. These boreholes can be nongased except from the lower part of the argileous lower water horizon up to the surface. But such boreholes start draining gas only 1.5 to 2 months after passing of the face.

For predrainage, the distance between boreholes must be shorter (60–80m); this solution is expensive except where boreholes can cross a great thickness of gassy coals. The feasibility of such drainage must include consideration of an independent source of gas. To increase efficiency of such boreholes, hydrofracking or increasing of the diameter of boreholes by hydrojet can be effective. The latter can treat more seams.

CONCLUSION:

Firedamp can hinder longwall production in reaching for high levels. Contrary to a first assessment, achieving high rates of production can be easier in permeable deposits (naturally permeable, or in some parts destressed by overlying mining) than in impermeable deposits. The case of medium permeabilities can be treated like the case of quite permeable deposits, but predegasification takes more time.

For managing well highly productive longwalls, preevaluation of the next gas emission would be very useful. For nearly impermeable deposits, such purpose needs some new studies using recording of previous gas emissions and previous face advance, as well as physical data concerning the strata.

In permeable deposits, gas emission is less variable, but could be higher or lower than in impermeable ones, depending on the previous workings and on efficiency of a predrainage. Preevaluation of gas emission would need existing computer models.

Predrainage is effective only in permeable deposits, and must be done in all of the outgas-
sing zone. Postdrainage efficiency can be very much improved by tests with tracer gas. Such studies would contribute to mine safety at high rate of production with longwalls.

REFERENCES:


The AusIMM Illawarra Branch, 21st Century Higher Production Coal Mining Systems—Their Implications, Wollongong, NSW, April 1988