EXPERIENCE WITH PRE-DRAINAGE OF SEAM GAS IN THE WESTERN AREA OF THE NATIONAL COAL BOARD

By

W. HIGHTON[1]

ABSTRACT

Methane predrainage from coal seams in the Western Area of the U.K. has been practiced over the past decade. The differing reasons for the practice include the controlling of gas emission rates in coal headings required to win out coal faces and also the need to control the gas emission rates in the roadways of retreat faces in order to comply with the statutory requirements.

There are some similarities with predrainage experience in the Bulli Seam NSW.

The several case studies highlight the varying conditions in the Western Area coalfield where the use of predrainage was required.

INTRODUCTION

British bituminous coals are generally thought to be highly impermeable to gas flow and are of low porosity, most of the gas being held in the coal by a process of absorption. The diffusion of gas through coal is extremely slow and appreciable gas emissions occur only if there is present a crack network along which gas can flow.

Coal with a high crack density will therefore degas more rapidly as the virgin headings or developments are being driven. The actual distribution of cracks in a coal seam will generally depend on the stressing and destressing due to both mining and geological action.

The gas content of a seam which has previously been over or under-worked ought to be less than the gas content of an undisturbed seam. However, if the seam is beyond the sphere of influence of the methane drainage or migration paths of the previously worked seam, then the gas content can be virtually unaltered. In this instant, the stressing set up by the previous workings can create a condition whereby the gas is no longer held by the process of adsorption but is contained in the strata by the process of absorption.

In this case, whilst the total gas content of the seam may be unaltered, the propensity for the seam to give its gas up as the headings or developments are being driven is greatly enhanced and the inseam drivage takes on the characteristics of a large diameter methane hole.

The paper theorises and illustrates case studies to show the various methods used to control the gas emission rates from the working seam under differing circumstances.

THE CONCEPT OF WHY WE MUST PREDRAIN FROM THE WORKING SEAM

Over the years I believe a general state of apathy has grown to become associated with the subject of draining gas from the working seam. Part of this condition has been created by the very large degree of success attained with the cross measure method of methane drainage. With drainage efficiencies as high

[1]Area Ventilation Engineer, Western Area National Coal Board, U.K.

as 90% the remaining 10% of the district gas emission, which is generally from the working seam, could be controlled by a high standard of general ventilation.

Therefore, with the tremendous improvements in standards of cross measure methane drainage achieved over the last decade, the need to combat the principle of drainage gas from the solid of the seam being worked came well down the list of priorities.

This was especially so where the system of working was by the advancing method of mining and the length of inseam drivages was relatively small in relation to the coal face length. The increase in the percentage of longwall retreat mining altered this position and where previously an advancing coal face could be developed with seam drivages of relatively short lengths, the development for a retreat face could necessitate the drivage of inseam roadways of extreme lengths.

In such conditions, extremely large surface areas of coal seam are exposed and the previous relatively small problem of gas from the seam being worked takes on a completely new significance and in certain cases the only answer is to drain the polluting gas by means of an inseam methane drainage system.

If the economic situation in the fossilised fuel world evolves on a path similar to that of the past decade, then we mining engineers must accept that one of the major cost factors in the production of deep mined coal is going to be that of labour. Whilst not trying to over-simplify matters, it does appear that one of the ways of maintaining acceptable coal costs is by obtaining more coal without increasing manpower. One such way could be the increase in the use of the retreat method of mining. Thus the necessity to successfully drain gas from the working seam could become of prime importance and eventually just as important as cross measure methane drainage has become in the past two decades.

It is my intention to deal exclusively with methane drainage from the solid with particular application to the working seam. The following case studies are some examples of differing applications experienced in the British Coalfield.

CASE STUDIES

A. POINT OF AYR COLLIERY

My first case study deals with Point of Ayr Colliery.

Over the years, high rates of gas emission from the solid coal have been experienced at Point of Ayr Colliery when driving headings into virgin ground. The sorption properties of the coal seams were found to be consistent with other British coals of similar rank.

It is considered that one of the contributory factors to the degassing of the solid coal may be the presence of friable fusain horizons which may provide degassing channels. Shallower burial depths may also be significant relatively low overburden pressures allowing fractures and pores to remain more open than in coals of similar rank found at greater depths at other collieries.

Initially it was considered Point of Ayr Colliery was atypical of British collieries in that the coal seams appear to be rather permeable, however, this condition may not be as atypical as first thought.

Large quantities of high purity gas have in past years been drained from the working seam by means of methane boreholes, and extremely high gas emissions from the solid coal have been experienced when driving headings. In fact, the driving of a single heading has been shown to effectively degas a large zone of coal.

The methane content of all the Point of Ayr seams is relatively high considering the shallow cover of approximately 500 metres.

At the outset, the methane sorption characteristics of the working seam was evaluated using the gravimetric method. The results were calculated and compared with those for a wide range of coals from elsewhere in the coalfields and the sorption constants measured on the Point of Ayr coals seemed to be similar to values obtained from coals of equivalent rank in other coalfields. Other factors would therefore have to be considered if a case for Point of Ayr coals being different was to be accepted.

When studying lumps of coal before crushing, it was noticed that some of the vitrain had a granular texture rather than the normal glossy texture. There also appeared to be a considerable number of thin fusain horizons present in the samples. It is possible that fusate bands in a coal seam fracture readily thus forming degassing channels within the coal.

Method of Degassing

After a period of successfully working longwall by the retreat method in non virgin areas, continuity of production necessitated the driving of development headings in the Durbog Seam in virgin conditions. The Durbog Seam in the area to be worked was 3 metres thick of which a total of 2.7 metres was extracted in the headings. The proposed layout (figure 1) is shown following.

As past experience had shown that, when driving headings into areas of completely virgin strata, very high rates of gas emission could be expected, a system of methane drainage from the working seam had been planned in the initial design stages. Again based on past experience the first driven heading would be the gassiest, and consequently would require the greatest emphasis on methane drainage. The rate of gas emission in the second heading would be dependent upon its position relative to the first heading, and the time elapsed between the driving of the headings.

Figure 1

Point Of Ayr Colliery

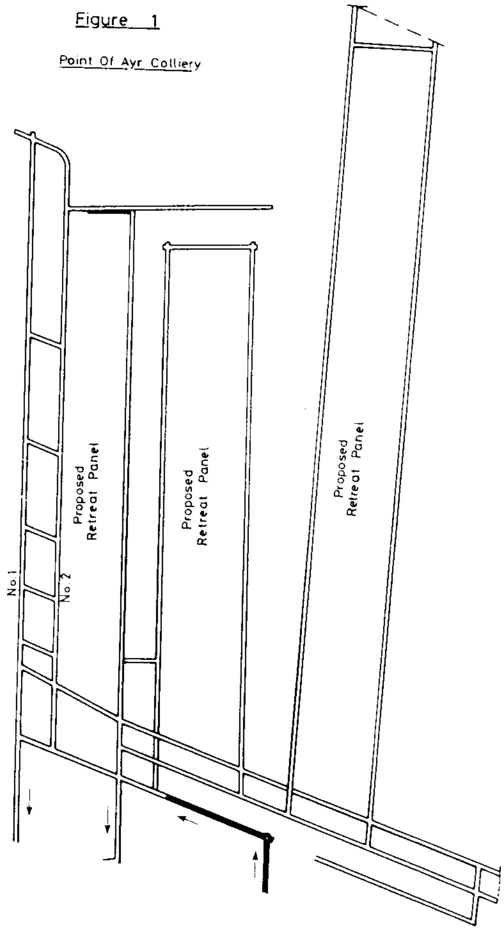
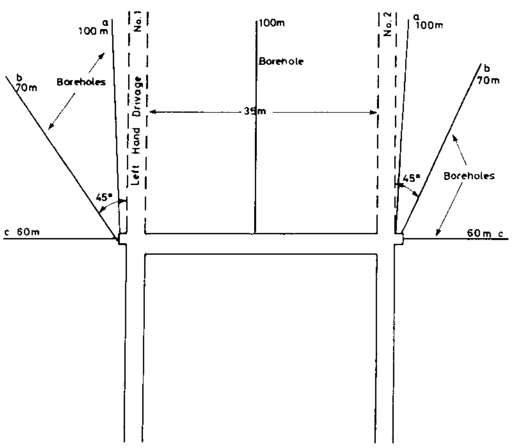


Figure 2

Point Of Ayr Colliery



(i) From out of the crosscut between the two headings, a long borehole was drilled in the seam for a distance of 100 metres. The pillar between the two roadways was approximately 35 metres and the methane hole was drilled in the centre of the pillar.

(ii) From a small recess on the left-hand side of the No.1 heading, three holes were drilled. These were:-

(a) The first hole was in the seam, as near as possible parallel to the heading line for a distance of 100 metres.

(b) The second hole in the seam, at an angle of 45° to the line of heading for a distance of 70 metres.

(c) The third hole in the seam at right-angles to the roadway for a distance of 60 metres.

(iii) Out of the second drivage, three holes were drilled at the face of the drivage. These holes were on the right-hand side of the heading.

(a) The first hole drilled almost parallel to the proposed heading for a distance of 100 metres.

(b) The second hole drilled at 45° to the line of the heading for a distance of 70 metres.

(c) The third hole drilled at right-angles on the seam for a distance of 60 metres.

This pattern of boreholes was repeated for each completed circuit of the development and was phased in with crosscuts at every 100 metres interval.

Technical Details of the Methane Holes

All the boreholes were drilled at a diameter of 50 mm with the exception of the standpipe length which was drilled at 75 mm. The standpipe length was 6 metres and used 52mm steel tubing. The standpipe was sealed with quick drying cement.

Quantity of Gas Captured

Based on past experience when working in virgin conditions it was estimated that up to 500 litres per second could be released in the solid headings when developing the first retreat panel. Therefore with a maximum ventilation quantity of 12 cu.m./s in each heading and designing the system for a maximum methane content of 0.8% a total of 192 l/s could be diluted by the ventilation. The remaining 308 l/s would have to be captured by the drainage system.

The boring programme was implemented and experience indicated that up to 30 holes were required on suction at any time to maintain the desired standards of ventilation.

By the time the two headings approached the boundary, the methane captured by the drainage system was peaking at 645 l/s at a purity of 50% representing a flow of 327 l/s. The flow from individual boreholes varied from 50 l/s when initially drilled to a flow of as low as 5 l/s. To obtain optimum results from the holes the methane drainage system had to have sufficient capacity to create a suction at the inbye end of the hole.

Summary

A system of seam gas drainage from the working seam is essential at Point of Ayr Colliery when working in virgin conditions and depending upon the production layout the borehole pattern is designed accordingly.

It is possible that a contributory factor to the degassing rate which thus allows very successful inseam drainage may be the presence of friable fusain horizons which provide degassing channels. However it is unlikely that the fusain bands are sufficiently continuous to provide degassing of such extensive zones as have been found at Point of Ayr. Another factor to be considered is the relatively low overburden pressure which may allow fractures and pores to remain more open than in coal of similar ranks found at greater depths elsewhere. These two factors may be contributory in partly creating the condition which allows gas drainage from the working seam.

B. SILVERDALE COLLIERY

The production plan called for the development of the Rowhurst Seam for retreat mining using Dosco Mk2A machines. The development plan called for extensive inseam drivages. The Rowhurst Seam in the area to be extracted was in non-virgin conditions having been extensively overworked in the Winghay Seam some 100 metres above and underworked in the deeper seams some 300 metres below.

Progress with Developments

Once the Rowhurst seam was contacted the gas make in the drivages began to increase. Initially the auxiliary ventilation systems adequately dealt with the emission, however, areas of ground were reached where gas issued from the coal sides and floor under pressure. Attempts were made to contain this gas by sealing the whole of the floor and sides, leaving only gas collecting pipes projecting. This system however met with little success.

An inseam boring programme was then designed and introduced, boreholes being drilled into the seam in front of and at right angles to the drivages. These holes did not capture any significant amounts of gas, and did nothing to lower the gas make into the drivages. Permeability test on the boreholes showed that the area of influence of adjacent holes was limited and the area effected by the very limited applied suction from each borehole was almost negligible. Indeed, as soon as fresh coal was exposed, gas was discharged into the roadway, and after a very short period, it became evident that the most effective gas collector was the roadway itself.

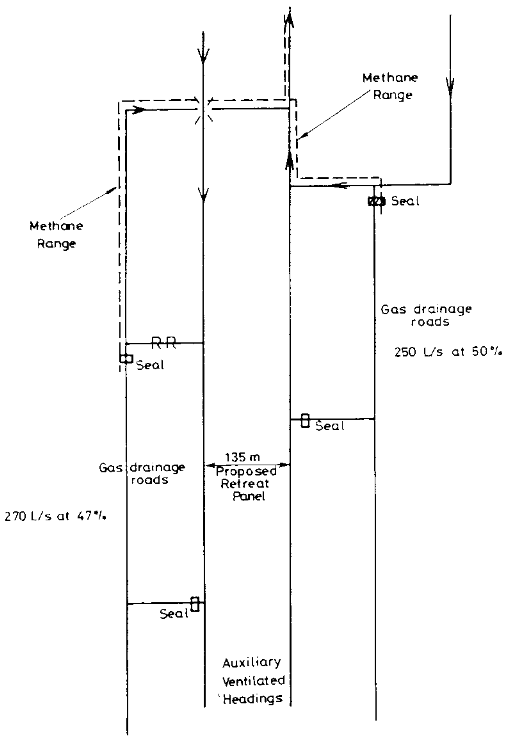
After reviewing the results it was considered that because of the under and overworking the stresses set up on the Rowhurst Seam had changed the gas conditions from an adsorbed to an absorbed state. Thus the majority of the seam gas content had been released by the workings above and below, but was beyond the effect of the methane drainage or migration paths from those workings. Thus the gas was contained in the minute breaks as within a sponge and any new exposure of coal very quickly released further gas.

With the disappointing results from inseam drainage then the standards of ventilation were solely dependent upon the amount of ventilation that could be forced into the headings. Ultimately the auxiliary ventilation systems were utilising a total of six 37 kw fans running in a series parallel formation using twin 760 and 900 mm ductings. Delivered air quantities in excess of 20 cu.m./s.failed to keep a 300 metre heading within the statutory limits. Gas drainage roads were thus proposed.

Experience had shown that if a roadway was driven on the lower side of an existing roadway then that drivage effectively cut off the gas migration paths to the original roadway and gave an almost gas free condition.

When designing the new layout with gas drainage roadways congnisance was taken of this phenomena.

Figure 3
Silverdale Colliery



The gas roads were driven parallel to the main drivages and the method of work was such that the retreat face roadways were driven to the limit where they had to stop because of gas limitations. The machine was then transferred to the drivage of the gas road, and this road was then driven to a point beyond the main drivage position, the machine withdrawn and seals erected. The seals were fitted with methane drainage pipes and sampling facilities. Methane was then extracted from the sealed areas. Using two gas drainage roads as shown in figure 3, methane capture values of up to 300 l/s could be drained from the sealed areas. The drainage efficiency from the development area in total could vary between 45 and 55%. By this method the main access roads for the retreat panels were maintained relatively free of gas.

Further controlled tests were carried out with inseam gas drainage holes and with holes drilled at right angles from the roadway gas flows of up to 11 l/s pure were obtained with suctions of up to 2 kPa. However, because of the limited suction available due to the low resistance gas from the gas drainage roads, it was felt that the system of gas road drainage was more suited to the Silverdale layout.

Summary

After the initial failure with inseam drainage the second series of holes were drilled close to the face of the coal heading, these holes were quite successful from a gas flow aspect, in fact one hole produced up to 35 l/s pure. However, when the methane is held in the absorbed state as at Silverdale the majority of the gas is emitted in the first 50 metres of roadway from the newly exposed coal. To maximise on the gas captured by boreholes this zone would have to be saturated with holes. A condition which would mitigate against rapid rates of drivage advance.

Under these conditions it was considered that the gas drainage road system was more effective.

C. GOLBORNE COLLIERY

The L4 face was in the Lower Florida Seam and was worked by the advancing method. The Face was 180 metres long working a 2 metre seam with a depth of cover of 400 metres.

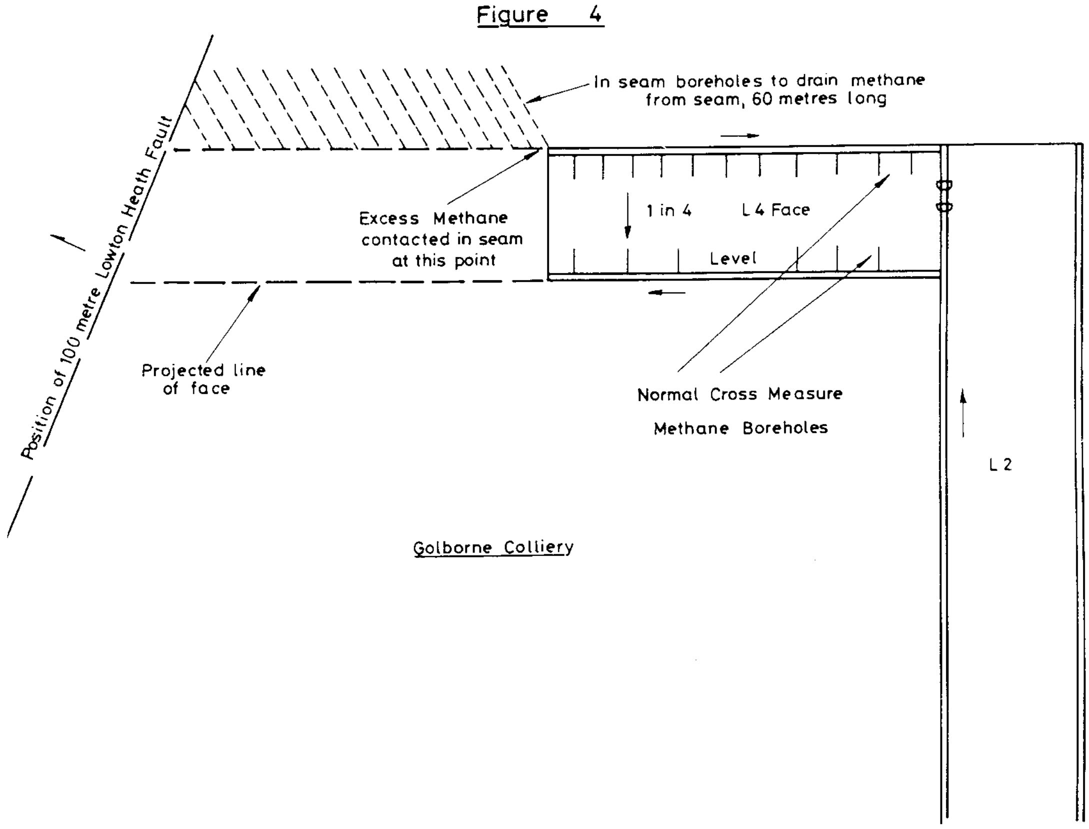
Normally when working the Lower Florida Seam in virgin conditions a system of cross measure methane holes from both intake and return gates are utilised. The upholes are drilled over the goaf area to contact the Ince Six Feet Seam some 40 metres vertically above. Whilst the downholes are drilled under the goaf to contact the Pigeon House Seam some 30 metres below. With these cross measure boreholes at intervals as close as 10 metres then up to 600 l/s pure methane can be captured by the drainage system. Ventilation quantities of between 15 and 20 cu.m./s. are circulated around the district with a methane content in the return of up to 1%

The face had advanced some 200 metres when problems arose with gas under pressure being emitted at the return end of the face and the general body methane content in the return commenced to clumb until the statutory limit of 1.25% was exceeded. Steps were then taken to alleviate the condition.

Steps Taken

An investigation of the layout plan showed nothing untowards as regards faulting or other workings with the exception of a major fault some 350 metres in front of the face position.

Figure 4



Golborne Colliery

Extensive tests showed the extra methane was being emitted from the working seam itself and not from the roof or floor.

A programme of inseam drilling was quickly implemented and the agreed plan was for inseam holes to be drilled on the higher side of the coal face at 10 metre intervals. The holes were 60 metres long at a diameter of 50 mm. The standpipe length was 10 metres using 52 mm internal diameter steel tubing. The standpipe was grouted in with quick drying cement.

On one occasion the seal was faulty and the gas pressure projected the standpipe out of the hole a distance of 20 metres down the gate.

Whilst the gas pressure was extremely high with a figure of in excess of 2400 kPa being measured the gas flows only averaged 15 l/s pure methane from each hole. The methane content in each case as a new hole was drilled was between 90 and 100%. By the time a total of six holes had been drilled the general body methane content had returned to normal.

Summary

Once the programme had been established various tests were carried out to ascertain the optimum hole interval at varying applied suctions.

Suction tests showed that providing a depression could be applied over the full length of the hole then the maximum benefit was obtained from each hole. Tests indicated that to obtain flows of between 15 and 20 l/s a suction value of 15 kPa was necessary.

With a suction value of 15 kPa on each hole tests were conducted on adjacent holes to ascertain the sphere of influence. The tests showed that with holes at 15 metres intervals the sphere of influence from adjacent holes did not overlap, but at 10 metre intervals interaction did occur.

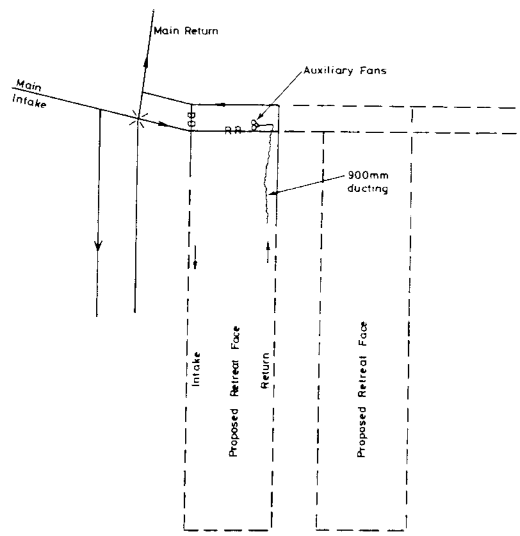
As optimum ventilation standards were of prime importance on this district the interval was agreed at 10 metres and by the time the district approached the finishing line methane pollution from the working seam was virtually negligible and the district drained efficiency was in excess of 80%.

D. CRONTON COLLIERY - WIGAN FOUR FEET SEAM

At Cronton Colliery the production plan called for an area of coal in the Wigan Four Feet Seam to be worked by the retreat method of mining.

Figure 5

Cronton Layout



The proposed method of retreat mining only called for two access roadways to each working unit. Thus, if the take or piece of coal was not to be spoiled with interconnecting roadways, long distances would have to be driven on single entry ventilation systems.

The return drivage was the first to commence and by the time it had advanced some 200 metres the methane emission from the working seam began to increase considerably. In a very short time it reached the position where percentages of up to 1.2% could be obtained at the outbye end of the drivage in an airflow of 10 cu.m./s.

It was agreed that extra ventilation quantity would have to be circulated in the drivage and other precautions taken if the drivage was to be driven to its full length of 1200 metres without a thirling.

Action Taken

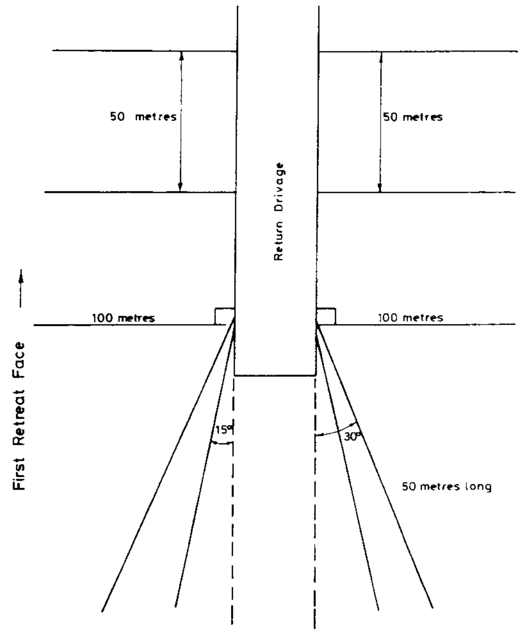
A second 900 mm ducting complete with two 37 kw fans running in parallel was installed in the drivage and with the two 900 mm ducts a total quantity of 20 cu.m./s. was measured at the face of the drivage. The extra volume reduced the outbye end methane content to a figure of 0.6%.

A methane survey of the full length of the development drivage showed that approximately 60% of the polluting methane was being emitted from the outbye 180 metres of the roadway, this represented a volume of 72 l/s out of the total of 120 l/s. The remaining 48 l/s was found to be emitted in and around the face of the heading, the gas being under pressure. Thus 40% of the total methane was being given off in an area covering approximately 20 metres of roadway, it was considered this aspect of the problem should be dealt with first.

A programme was drawn up to include the drilling of flank holes to a depth of 50 metres in front of the face of the heading to endeavour to release the methane pressure and capture some or all of the emitted methane.

Two holes angled at 15° and 30° were drilled at a diameter of 50 mm on either side of the coal drivage and connected to a methane drainage system. In this case, as the colliery had previously not practised methane drainage, an L6 Nash Hytor was sited underground close to the district.

Figure 6
Cronton Colliery



With upwards of 20 kPa suction applied to the methane holes, the results were satisfactory and providing the holes were maintained at least 20 metres in advance of the face of the drivage, at no time was methane under pressure found at the face and the polluting effect in the ventilation was reduced to a figure of approximately 10 l/s.

The methane captured from individual boreholes varied between 10 and 15 l/s with a total of between 40 and 60 l/s from the system. As a set of holes reduced in flow and purity as the drivage advanced alongside them, the applied suction was controlled by valve adjustment and providing the purity was in excess of 20%, a borehole was left connected even if the flow reduced to an immeasurable figure.

The value of the captured methane was reflected in the methane content in the air current, however the pollution occuring in the outbye section of the drivage still constituted a problem.

Over the next 100 metres of roadway drivage the results from the individual boreholes were closely monitored and compared with the effect they had on the methane emitted into the roadway.

The investigation recorded that, when initially drilled the holes were at their most prolific in flow and purity and as the face of the heading advanced in along the line of a borehole, the flow of pure methane from the hole diminished. This was generally shown as a reduction in purity, the hole therefore had to be regulated to maintain a minimum purity of 20%.

When comparing the results of the 15° and the 30° holes it appeared that the 15° holes had more effect on the methane emitted from the face of the drivage but the 30° holes appeared to remain active longer and have some control over the methane emitted outbye of the heading face.

Assessing these results, it was assumed that if the 30° holes had a partial control over the methane emitted into the roadway outbye of the heading face then an additional hole drilled at right-angles to the roadway (figure 6) to a depth of 100 metres in the seam would partially control the outbye emission. These holes were drilled to a length of 100 metres, at a diameter of 50 mm, at intervals of 50 metres. If the hole contacted roof or floor before attaining the 100 metre mark then the hole was stopped and connected to the methane range.

By the time the 1000 metres mark had been reached with the return heading the holes drilled at right-angles to the heading were capturing in excess of 150 l/s.

Summary

Whilst the inseam drilling programme created slight problems as regards to rates of production, without the inseam holes the development drivages would not have reached the planned face line without an interconnecting roadway.

By the time the return drivage reached the 1200 metres mark approximately 50% out of the total make of 370 l/s was captured by the inseam drainage system. The remaining 50% was effectively controlled by the twin 900 mm auxiliary ventilation system which produced an air quantity of approximately 15 cu.m./s. at the inbye end of the drivage.

E. PARKSIDE COLLIERY - NO.3 SOUTH HORIZON

This problem whilst being slightly different still involved the draining of gas from the solid seam.

The number three horizon at Parkside Colliery was driven for a distance of 1500 metres to the first inter-horizon connecting point where the first coal face in the Lower Florida Seam was to be worked.

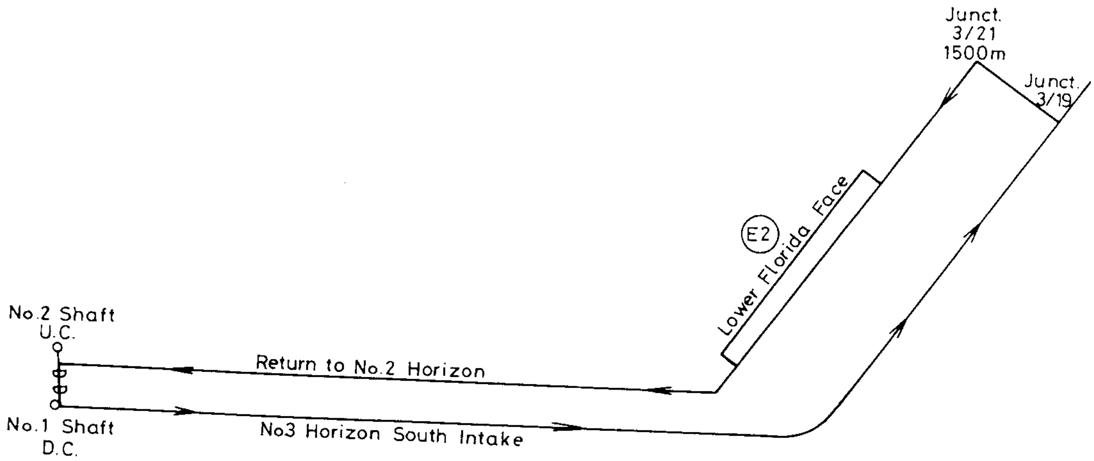
The depth of cover to the horizon was approximately 620 metres. Whilst being driven the horizon was ventilated by twin forcing auxiliary ventilation systems which delivered air quantities of up to 15 cu.m./s. with a maximum methane content at the outbye end of 0.8%.

After completion of the thirling the main ventilation circuit for the first coal face was formed with a circulating air quantity of 25 cu.m./s. The methane entering the first working place (new coal face) was found to be 0.5%, a figure far in excess of the statutory limit of 0.25%

A thorough methane survey of the full length of the intake circuit, including horizon, shaft and surface was carried out

Figure 7

Parkside Colliery



and the pollution was traced to two main sources.

Working back from the coal face the 0.5% persisted until at the 400 metre mark in the horizon the methane content suddenly dropped to a measured figure of 0.15%. In this area the Trencherbone/Peacock Seam, a total of 3 metres of coal, was in contact with the Horizon for a distance of almost 70 metres

A more detailed investigation of this area showed it to be the polluting factor.

Continuing the methane survey, outbye to the shaft the 0.15% persisted to the bottom of the downcast shaft, yet a sample taken at the top of the shaft showed the air to be free of methane as would be expected.

The shaft was thoroughly checked over at the point where the same Trencherbone/ Peacock Seam intersected the shaft, the methane content increased from virtually nil to 0.15% in an air quantity of 40 cu.m./s. At this time, excepting pit bottom leakage, only one completed ventilation circuit was open on the number three horizon.

Action Taken

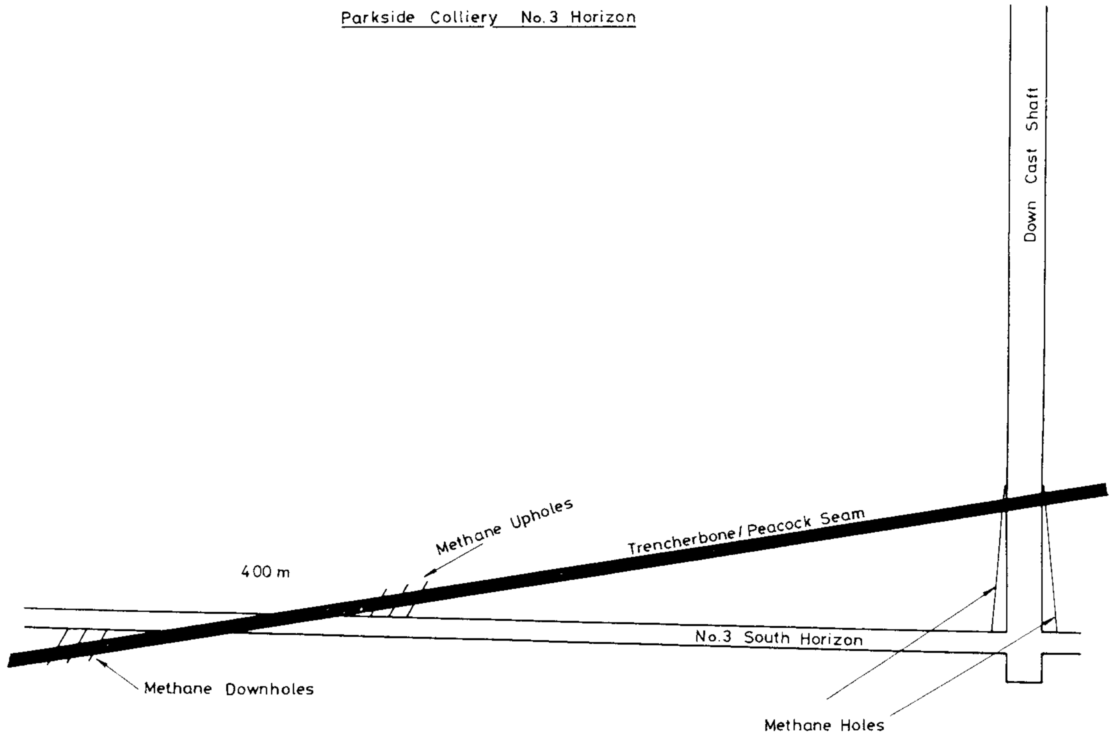
The first thought was to increase the overall quantity on the horizon to dilute the methane but to reduce the district intake methane percentage to 0.2% the air quantity would have to be more than doubled. With the colliery in an extensive state of development and the fan only producing a relatively low pressure this avenue was ruled out and methane drainage contemplated.

A methane drainage range was installed along the horizon to the seam intersection point at the 400 metre mark.

A series of methane drainage holes were then drilled on both sides of the horizon to contact the seam. Roof holes were drilled back towards the shaft to contact the seam after passing through approximately 5 metres of shale. Downholes were then drilled in an inbye direction almost parallel to the horizon. Again the seam was contacted after passing through

Figure 8

Parkside Colliery No. 3 Horizon



approximately 5 metres of shale.

It was thought the drainage system would be more effective if the methane could be drained from behind the shale, the holes crossing the migrating paths. If the holes had been drilled directly into the exposed seam then with a limited sphere of influence the boreholes may not have picked up the methane that migrated down the seam fractures some distance away from the intersection point.

With an applied suction of 12 kPa the flows from individual holes varied between 7 and 10 l/s pure methane. A total of between 50 and 55 l/s was captured over the affected zone. The resulting effect on the methane in the air current was to reduce it to 0.3%.

With the success obtained from the in seam holes in the horizon, it was then planned to drill two methane holes from the downcast shaft bottom to contact the Trencherbone/Peacock Seam at the point where it intersected the shaft. The holes were drilled to a depth of approximately 60 metres on opposite sides of the shaft, terminating one metre short of the shaft lining.

The holes were completed and connected to the methane range with an applied suction of 34 kPa. The total methane captured by the two holes was approximately 40 l/s and this reduced the methane content in the air current at the bottom of the shaft to 0.05%.

With the solid seam drainage from the two zones the methane content in the intake to the first working place was reduced to approximately 0.2%.

Summary

Whilst the method of methane drainage practised could not strictly be described as drainage from the working seam it could still be said to be drainage from the solid seam.

I believe this exercise illustrates how, with a little thought, the practise of methane drainage can be adopted to suit varying types of problems.

EXPERIENCE OF THE BULLI SEAM

Whilst my experience of methane drainage from the solid and the working seam in the U.K. goes back over a period of 15 years and covers incidents at more than 15 collieries, my experience in the Bulli Seam is to say the least rather limited. However, with your tolerance I would like to make what I consider to be some relevant comparisons and what I hope to be helpful suggestions on the subject of inseam methane drainage.

After underground visits at two of the Wollongong Area collieries a study of available records of tests carried out with applied suction to individual boreholes in the Bulli Seam was compared with results obtained from some of the Western Area N.C.B. collieries.

From the tests on the Bulli Seam I concluded that the seam appears to allow gas to flow through its section indicating an acceptable permeability from the gas flow aspect.

A study of the flow tests on individual holes indicated quite considerable variations; one interesting aspect was the higher flow rates experienced in areas of stressing. This phenomena is most important when the control of outburst is considered.

When comparing my available knowledge of borehole characteristics in the Bull Seam with experience at more than six of the Western Area N.C.B. collieries, a similarity of characteristics was obvious. Gas flow rates at varying applied suctions and static pressure were very similar.

From these similarities and a past experience of inseam drainage it was believed that, providing the borehole seals are satisfactory, the application of sufficient suction will result in respectable flows of methane from each hole.

A secondary, but no less an important advantage to be gained from the pre-draining of the Bulli Seam, is the relieving of inseam gas pressures, which will certainly reduce the possibility of outbursts.

POTENTIAL OF DRAINAGE FROM THE WORKING SEAM

In virgin conditions, with a properly designed methane drainage system, I believe a quantity of up to 300l/s pure methane can be successfully drained from a 1000 m section of development.

To obtain the maximum degassing effect, the holes should be drilled at right-angles to the development roads and the length of the holes should be sufficient to drain the future workings. Thus the inbye end of the drainage hole should encompass within its sphere of influence the area to be pre-drained.

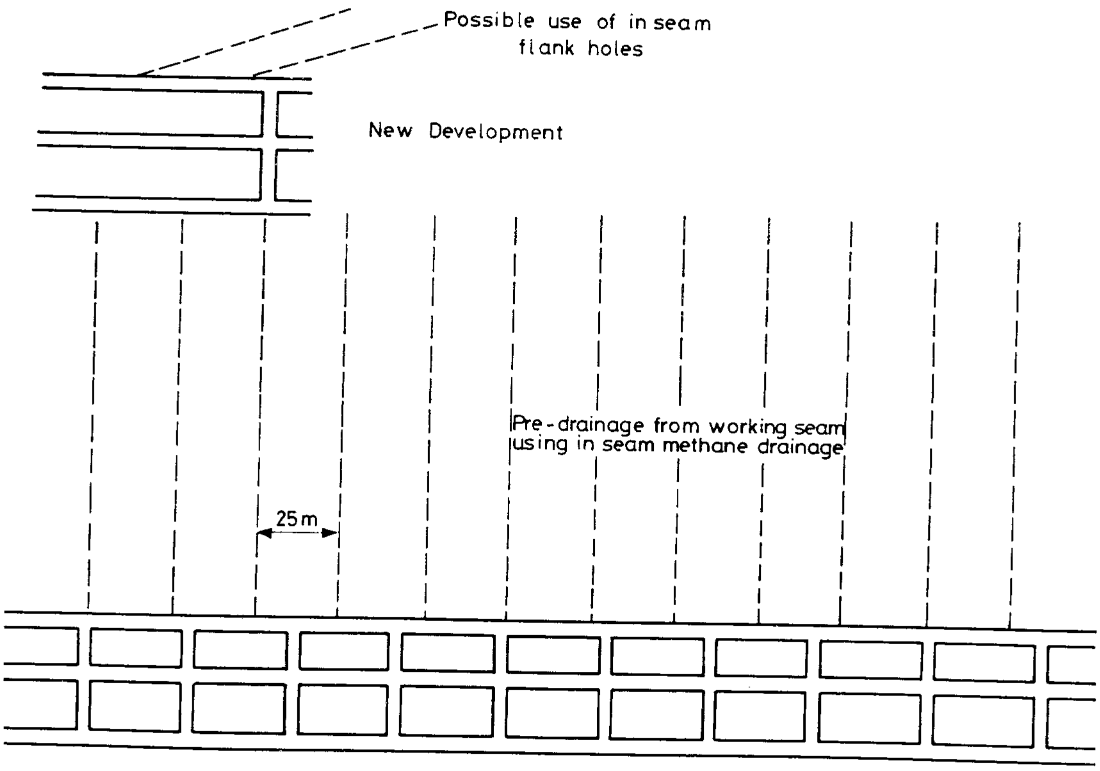
The permeability tests carried out on the Bulli Seam in virgin conditions indicated that, with individual holes subjected to a suction of over 30 kPa, the adjacent spheres of influence from each hole is initially 10-12 metres. Therefore, under operating conditions, when each borehole is continuously subjected to suctions in excess of 30 kPa, the interacting spheres of influence created by adjacent boreholes will be between 20 and 25 metres.

On this basis then, depending upon the method of mining when developing, to optimise on any degassing programme, the methane holes in the working seam should be at intervals not exceeding 25 metres and the holes should be on suction for at least six months.

The type of borehole pattern I envisage for maximum results is shown in Figure 9.

Figure 9

Methane Drainage from Working Seam



If limited pollution still occurs when driving the heading furthest away from the drainage influence then this condition could be improved by the use of flank holes drilled in advance of the heading.

CONCLUSIONS

First, let me say I fully believe that providing the problem is correctly assessed, then a solution can be found to deal with the problem of gas emitted from the working seam.

The case studies I have outlined in the paper only represent a proportion of the occurrences in which gas drainage from the working seam had to be implemented to allow production to continue.

At Point of Ayr Colliery where the gas emission rate in virgin conditions can be as high as 163 cu.m./ton, the driving of development headings in the virgin would be virtually impossible without methane drainage from the solid. In the case study, up to 70% of the total methane emitted in the development drivages was captured by the methane drainage system and without the system a ventilation quantity of at least 50 cu.m./s. would have been required to maintain an upper limit of 1%.

A careful study of the three types of inseam holes in the headings:-

(a) forward looking hole

(b) 45° angled hole

(c) right-angle holes

indicated the type (a) holes gave a greater immediate benefit to the heading drivage in the vicinity of the face. Whilst the type (b) and (c) holes produce greater volumes of methane for longer periods. The type (c) holes were prolific for a longer period than the others and also appeared to degas larger zones of coal for the future working.

The system of gas drainage roadways utilised at Silverdale Colliery to protect the working roadways was very successful and with a well designed gas drainage plan the efficiency of the system could exceed 50%.

Experience at Silverdale and other collieries, where the gas was thought to be held in the absorbed state as against the normal adsorbed state, has shown that the majority of the polluting methane is released in the coal face zone.

In seam methane drainage can capture this gas but the problems associated with the drilling of the holes and maintaining them close to the drivage face must not be minimised.

The gas drainage road system was considered to be easier to control and the resultant extra tonnage from the drivages was welcome. However, at a later date in the development programme, drainage from the working seam had to be implemented when driving the gas roads. Even with very high standards of ventilation, limited inseam drainage became necessary to enable the gas roads to be driven to their planned lengths. By this time however the methane drainage system had been improved and extra methane pump capacity made available at suctions of up to 30 kPa for the inseam holes. The flow from the low resistance gas drainage roads was controlled by valves.

In the case study on Golborne Lower Florida Seam the use of methane drainage in the working seam to control the increased emission from the exposed coal rib side was completely successful. It could however be said that the area of coal was atypical of Golborne and the characteristics of the seam were temporarily altered.

Irrespective of this, the inseam drainage was completely successful.

The situation at Cronton Colliery reminded me very much of conditions I have seen in the Bulli Seam here in N.S.W. After initial apprehension as to how the problem should be overcome, the combination of forward flanked and right angled holes eventually captured the polluting methane and allowed the drivages to be driven to the face line without connections.

Finally, providing the situation or problem is correctly analysed, then I believe a system of inseam drainage from the working seam can be designed to solve differing types of pollution problems.

Whilst I firmly believe this, I must still admit there are problems to be overcome before the use of methane drainage from the working seam becomes as widespread and successful as cross measure methane drainage.

Such factors as:-

Having sufficient development slack to allow the methane holes time to full degas the area of coal affected by their spherer of influence.

Drainage systems of sufficient capacity to handle the gas and maintain high suctions on the boreholes

Having the correctly designed boring machines that will allow the drilling of these inseam holes to the required depth on the correct horizon in the period of time. These are only 3 of the major factors that must be completely solved if we are to be fully successful with drainage from the working area.

DISCUSSION

G. LAWERY (Bellambi Coal Company - Session Chairman): That was a most interesting paper providing much food for thought, particularly the comments about the Bulli Seam.

E. TOMLINSON (Kembla Coal & Coke): How was the figure of 130 m^3/t of Point of Ayr coal established?

W. HIGHTON (National Coal Board, U.K.): This paper was prepared with the main thought that the theoretical side would be well dealt with in other papers, so this paper should look more at the practical side. To talk about the value of the gas content in the coal, calculated in the laboratory, it appears that for some delegates, especially practising in line management it is not really relevant. If one looks at Point of Ayr coal when tested it showed a gas content of about 20 m^3/tonne. If the calculations were based on this figure and then given to line management the environmental conditions would be hopelessly wrong. So a high figure was quoted deliberately. It was based on the amount of tonnage produced in the headings and the amount of gas emitted in relation to the tonnage. It is believed that under working conditions total gas emission figures must be used when planning the environmental conditions for a working district.

L. LUNARZEWSKI (Visiting Polish Methane Drainage Specialist to BHP Steel Division Collieries): Regarding Cronton Colliery, what was the spacing of boreholes and length of standpipes?

W. HIGHTON: The rather different method of retreat mining of the Western area of the N.C.B. mitigates against the problems of seal pipes being contacted by the shearer. In other words the back return system of retreat mining leaves a pillar of coal on the return side of the face. This means a collar and seal pipe equal to the planned, ribside width can be used. In Cronton's instance this was 5 m. The length of the seal was equal to the width of pillar.

L. LUNARZEWSKI: When the boreholes were under suction, was the heading being driven?

W. HIGHTON: The flank holes were under suction continually whilst the heading was being driven.

L. LUNARZEWSKI: Was the heading driven at the time?

W. HIGHTON: Yes, continuously. It was a mechanised heading.

L. LUNARZEWSKI: What was the value of permeability in this region?

W. HIGHTON: A lot of tests were done and it varied from a very low figure up to about 10 millidarcys. What is found in some Western Area seams, excepting Point-of-Ayr, it is found that there is a dirt band something less than half a metre from the roof which considerably increases the permeability of the total section. The in-seam boreholes are drilled at such an angle as to get the benefit both from lateral and vertical permeability. It is found that if this band can be intersected to hit the roof at the end of the hole then maximum permeability is obtained from the boreholes.

R. LAMA (Kembla Coal & Coke): Regarding Silverdale Colliery, where the gas conditions had been changed from the adsorbed to an absorbed state. If there were large scale fracturing happening it is more an absorbed state than an adsorbed state and it would indicate the permeability of the seam is far higher. Would it not in that case be advisable to drill long holes which are far ahead of their developing face? Because of large permeability they would have a very large sphere of influence and could cater for the needs of drainage rather than having gas drainage roads which would be far more costly than having long holes.

W. HIGHTON: Theoretically it is changed from the adsorbed to the absorbed state, and one would think that this would have increased the permeability. The very fact that it has been changed into the condition where it is held in this sponge state allows it to be immediately liberated at the face of the heading without seeming to affect the permeability of the seam, so no benefit has been obtained regarding increased permeability from the conditions, all that has been obtained is a minus factor. In other words the gas is released a lot faster at the face of the heading, but doesn't migrate at the slower rate over a continual basis from the solid coals. Dr. Lama's forecast could have been expected exactly but it has not turned out so.

R. LAMA: Does some sort of micro or mini outbursting condition occur in this area?

W. HIGHTON: No, the Western area outbursts are mainly confined to outbursts brought about by destressing of coal measures from an adjacent worked seam where they are separated by a capping bed; under those conditions they are fairly predictable, this is not to say we have completely eliminated them, that is a kind of wishing one on, but their frequency is drastically reduced; they are they are very very infrequent now.

R. KING (Bureau of Mines, U.S.A.): When drilling a long horizontal hole into a seam, how is it planned to mine through the hole?

W. HIGHTON: Already these holes have been mined through with no problem.

R. KING: Were the holes grouted before being mined through?

W. HIGHTON: No. U.K. mining regulations don't demand that a methane drainage hole be grouted before mining through. This is believed to be not the case in the U.S.A. In the Western area of the N.C.B. holes are drilled chiefly from return airways. Therefore when coming up to mine through a hole that hole can be opened up to the return thereby exerting a negative pressure. So as soon as the hole is exposed the gas if present can be pulling away from the mining operations.

R. KING: That is right, in the U.S.A. those holes must be grouted. So it is a very difficult problem to drill a thousand metre hole to try to grout it.

W. HIGHTON: At the present moment in time the Western Area, National Coal Board, has not found it necessary to drill holes to extreme lengths as the present system of pre-drainage with hole lengths of up to 400 feet (130 metres) has proved to be successful.