SEAM GAS DRAINAGE EXPERIMENTS IN SOME COLLIERIES OF B.H.P.

By

S. BATTINO[1] and A.J. HARGRAVES[2]

ABSTRACT

Pre-drainage experiments have been conducted at Appin, Cook, John Darling, Leichhardt, Macquarie, Metropolitan and Moura No. 2 Collieries. Appin (550 m deep) experiences particular gas problems in development drivages, and the almost pure CH_4 seam gas makes difficult the compliance with statutory maxima in intakes and returns. Patterns of 43 mm diameter drainage holes drilled ahead and laterally into virgin coal have improved gas conditions in working places and have allowed tolerable advance rates.

Cook, Leichhardt, Metropolitan and Moura No. 2 Collieries have experienced gas and stress phenomena ranging from conical bursts of less than one tonne to full scale instantaneous outbursts of hundreds of tonnes with tens of thousands of cubic metres of seam gas. Gas drainage experiments with patterns of holes up to 200 mm diameter have been undertaken with gassiness monitors on the coal to establish relative effectiveness. Incremental flows into long 43 mm diameter boreholes have investigated drainage patterns relative to length, and at low comparative incremental flows have indicated lowered permeability zones at stress abutments. In some CO_2 seam gas areas where flammability problems are reduced to perhaps nil, but where outbursts proneness is increased, drainage has no possibility of utilisation to offset drainage costs. Moreover, drainage with CO_2 appears to be more difficult.

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INTRODUCTION

With the progressive deepening of mining of Australian high rank coals, the problems with seam gas are mounting correspondingly. Appin Colliery, mining the Bulli Seam at over 550 m depth is the gassiest, and it is apparent from experience, including the explosion of 1979, that methane drainage will be a permanent feature of mining there. Already post-drainage of adjoining seams at Appin is virtually routine. Much pre-drainage experience has been assembled as successive longwall development have been more and more progressively affected by urgency of development due to rapidity of extraction of longwalls. To date, the high virgin seam gas pressure (over 4 MPa) has been sufficient to adequately feed 43 mm diameter drainage holes and small, short, pipe ranges without the need for exhausters, although the effectiveness of exhausters in increasing output has been shown.

Metropolitan Colliery, at a depth of 450 m and with seam gas largely CO_2, has the particular problem of instantaneous outbursts of coal and gas. On the basis that the gas state can be better defined than the stress state, and can be monitored too, the alleviation of the problem is seen particularly as partially removing the gas down to a benign level. Gas pressures and flows and incremental flows have been measured in 43 mm bore holes. Long experience has indicated the inadequacy of practical numbers of 43 mm diameter holes. A programme is under way to investigate drainage patterns using progressively greater diameters. Already tentative results of flow relative to diameter have been obtained. Head losses due to friction in drag bit drilled holes are under examination. The relationship between applied suction and flow completes the field data in this exercise. In the laboratory the natural desorption of run-of-mine coal, sampled at the face and at the surface bin has been studied. Macro-permeability of trepanned coal specimens has been measured.

Similar investigations, but on smaller scales, have been employed at Cook, Leichhardt and Moura No. 2 Collieries, where depths are 200 - 420 m and seam gas is largely CH_4, with a little CO_2. Minor work has been undertaken at other mines, including the Newcastle area, particularly John Darling at depths between 360 m and 420 m and Macquarie Colliery at a depth of 340 m. It is not improbable that within the next decade all mining with CH_4 seam gas below 300 m depth will have some form of methane drainage.

APPIN COLLIERY

THE NEED FOR DRAINAGE

Although several instantaneous outbursts of coal and gas had occurred at Appin, the most consistent gas problems arose from rising concentrations of CH_4 at development faces, rising concentrations in the bleeder headings of longwalls and sporadic rising concentrations of CH_4 on the tailgate corner. Clearly, in single seam working, the cure for development problems could lie in pre-drainage, but for the longwall problems, only post-drainage of adjoining seams seemed to provide the answer. The need for methane drainage in longwall was anticipated and early trials of pre-drainage of No. 1 retreating longwall block and post-drainage both from over the goaf and into the floor were unpromising (Ryan and Beath, 1970). But

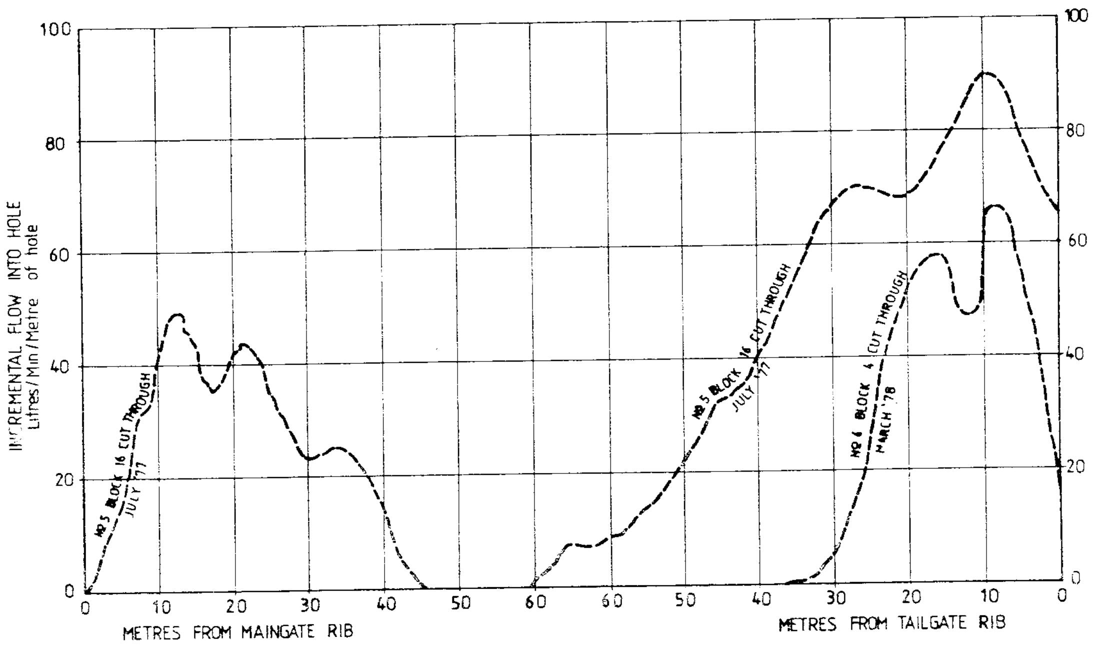

Fig. 1. Incremental gas flows into holes traversing longwall blocks

subsequent increasing experiments with gas gave rise to resumption of both pre and post-drainage experiments.

EXPERIMENTAL RESULTS

In the development of Longwall No. 5 along with study of gas-make into roadways, pillars of various sizes and ages were bored with 43 mm holes, and incremental flows were studied. Flows from such pillar holes - even in large pillars - decreased markedly with time, in inverse relation to pillar minor dimension. It is clear that at Appin, pillars of normal sizes (34 m, 32 m etc.) are winded of gas four months after formation. Figure 1 illustrates incremental flow into 43 mm holes in No. 5 longwall block. The maingate rib had been exposed for 24 months at the time of drilling and measurement, and the tailgate about three months. The width of the longwall block was 130 m. A similar experiment from the tailgate side of longwall 6 block giving a similar pattern of results is also shown in Figure 1. The hole was drilled two months after the roadway was developed.

In wet holes, flows increased initially, and maximum flow took days in some instances before the flow rates fell. Gas problems in drainage of No. 7 Longwall maingate were two-fold, gas from outbye fouling the intake, and gas issuing in the face area during machining. Lateral drainage from No. 7 Longwall block - holes into virgin rib - was tried with 43 mm holes in directions perpendicular to rib and to cleat (45°, approx.) and perpendicular holes to the rib were adopted because of higher flowrates, length for length. A pattern of 43 mm holes up to 50 m long, spaced 25 m apart drilled into this ribside yielded gas averaging 18 l/min/metre of hole. A group of 15 holes of average length 45 m discharged 3.5 m^3/min through a small range of individual hoses into the return. Some drainage holes were connected to holes drilled through the narrow pillar into the return for removal of gas. As the maingate advanced, flows fell off from outbye holes which were disconnected as new holes inbye were drilled.

It is clear that virgin rib emissions can be intercepted by regular patterns of 43 mm holes say 50 m long as the face progresses and that flows from earliest holes may decline sufficinet to disconnect them, depending on geometry. The length and spacing of holes are interdependent.

There is no doubt that abutments strongly affect gas flows. Indications are that the centre of front abutments at Appin are of the order of 5 m ahead in development and 15 m ahead in longwalls. (But other work has shown that the effect of the front abutment of longwalls commences about 100 m ahead of the face.) Holes of 43 mm diameter drilled in direction of advance inbye in the centres of pillars in formation (up to 50 m long) gave maximum flow 365 litres/minute. Generally flows fell off at about 1% per day whilst development continued. Whilst lateral drainage has been used to reduce ribside emissions into current drivages, it has not been used in long holes across planned retreating blocks to provide reduced gassiness conditions for next panel developments, although this is intended.

The attempt at degasification of the Bulli seam by hydrofraccing, with sand propping, ahead of 'L' Panel development is described by Stewart and Wilkinson (1983). As an adjunct to this work certain monitoring was done to determine the degree of success of the experiment:

1. Monitoring of roof conditions during drivage to identify any deterioration.
2. Emission value testing (an empirical gassiness monitor) during drivage to identify any changes in gassiness.
3. Ultra violet examination of emission test cuttings in the laboratory to identify residual fluorscein dye used

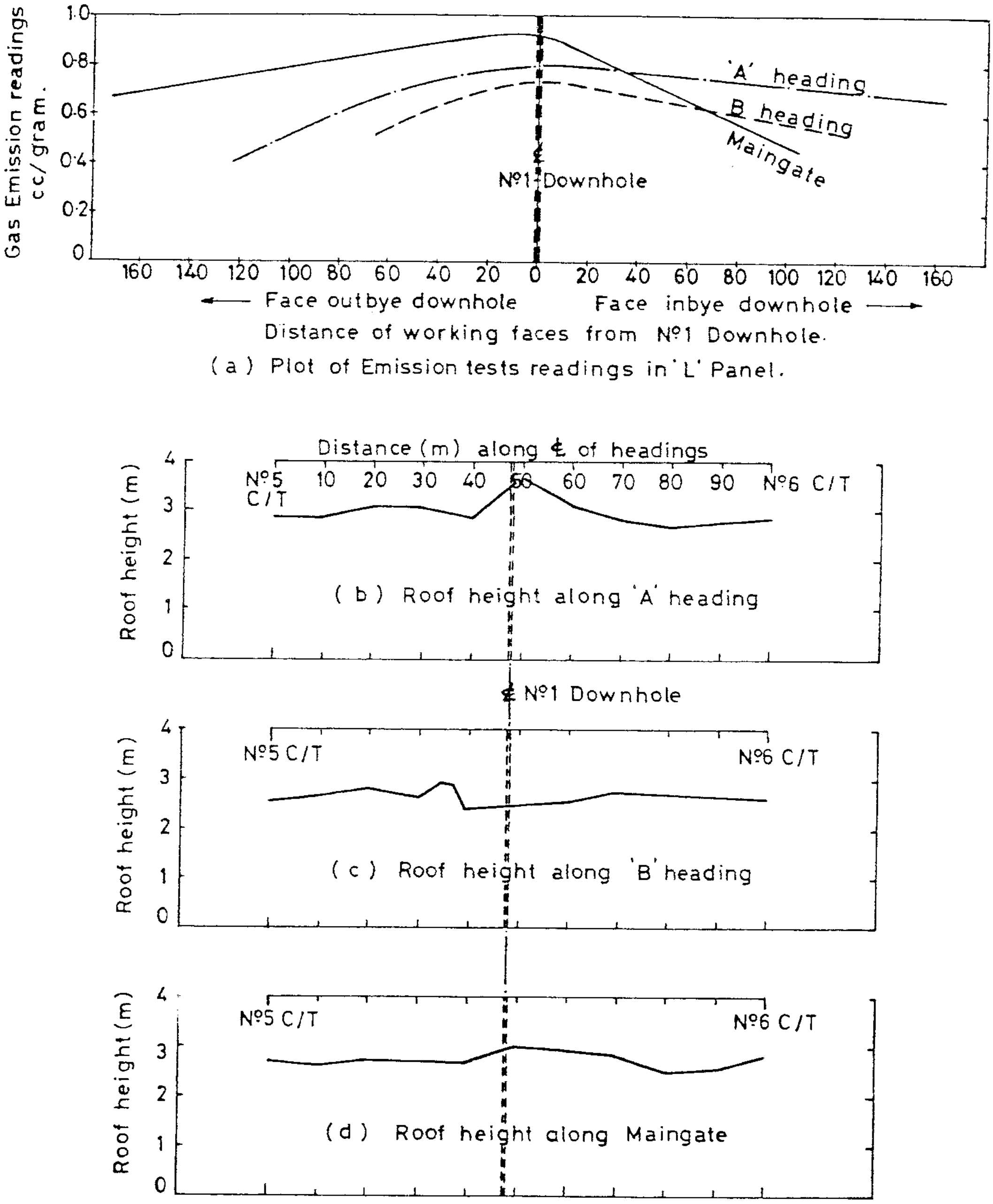

Fig. 2 Emission tests readings and Roof heights in the 3-headings of 'L' Panel Appin Colliery.

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4. Ultra violet examination of all 'L' Panel places around the penetrated pillar with portable U.V. source to locate any residual fluorscein dye.

Items 3 and 4 gave negative results. The results of 1 and 2 are shown in Figure 2, indicating no apparent positive gas trends, suggesting reduction.

At various times and for various geometries, patterns of 43 mm advance drainage holes have been proposed for panel developments, such as the example in Figure 3. Because of the need to avoid holes discharging CH_4 freely into advancing faces, and the uncertainty of keeping holes on alignment, holes are necessarily short. This situation retains the advantage of allowing the continued use of a light portable compressed air operated drill, suitable for use in most underground situations. Need to incorporate advance drainage hole drilling into non-productive times, such as service and maintenance shifts, and, on weekends, generally acts against provision of full patterns. The 100 mm holes bleeding away from cut-through faces into returns, introduced after ventilation pressure surveys established an appropriate pressure drop when an exhaust fan is in use in the advancing face, appear to be successful.

COOK COLLIERY

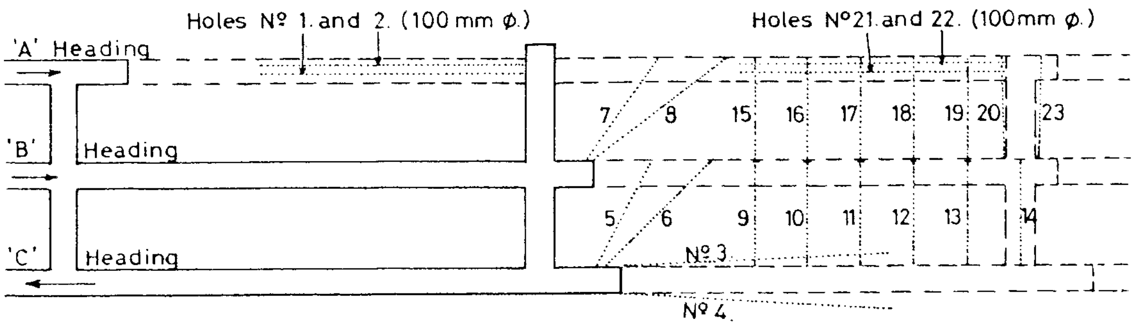
THE NEED FOR DRAINAGE

Cook Colliery mining the 3 m Castor Seam at a depth of 250 m has experienced the beginnings of gas problems. In the 1 NE area of the mine, during continuous mining, small cones of coal have burst off the face and face corners. From Leichhardt experience such burst cones are known to be symptomatic of instantaneous outbursts at greater depths, at fault intersections etc. In another area a fault intersection in drivage resulted in continuing emission of methane to such an extent that the immediate area of the fault intersection was sealed off with a barricade and the issuing gas was piped to the return under the over-pressure developed behind the barricade.

Experiments conducted in the 1 NE area included drainage hole boring, and incremental and total flow measurements.

RESULTS

Flow rates from holes drilled perpendicular to cleats were marginally higher than from holes drilled parallel. Flow rates from holes drilled near the top of the seam were generally lower than elsewhere and flow rates at mid seam height appeared greater than top or bottom. The higher flow rates, compared with Leichhardt correspond with higher gas pressures measurable; the



All holes are 43 mm dia. except No. 1 and 2 and No. 21 and 22 which are 100 mm diameter

Fig. 3 Proposed pattern of advance drainage holes for Panel development maximum pressure registered was 900 kPa at a hole depth of 25 m. Flow rates from 21 m holes 43 mm diameter ranged from 85-175 l/min perpendicular to cleat and to 75 l/min for holes parallel to cleat.

JOHN DARLING COLLIERY

THE NEED FOR DRAINAGE

John Darling Colliery, one of the deeper BHP mines in the Newcastle area, has had problems with CH_4 from time to time. With the development for the 75 m wide No. 1 Longwall in the Borehole Seam, some problems were experienced in increasing gas-make in the intake of the panel, with virgin rib on the longwall block side. This intake in development will become the tailgate for the longwall. A drilling programme from this roadway tested the interception of virgin ribside gas to control gas emission into the roadway whilst an intake, and incidentally, could channel some gas out of the longwall block into the tailgate when the longwall commenced.

RESULTS

The 43 mm drainage holes 70 to 75 metres in length were oriented a little inbye as a result of prior investigations of gas output relative to orientation. The output from the various holes with time shown in Table 1, did not bear out the expectation that the inbye holes from a rib more recently exposed would produce more gas. Gas flows were low in any case. Accordingly, inbye, spacings between holes were increased. These results do not give great promise of in-seam drainage in the Borehole Seam.

DISCUSSION

There are no significant seams below the Borehole from a gas drainage point of view. The roof seams, the Dudley 30 m overhead and the Victoria Tunnel 60 m overhead where unmined and expected to be sources of gas in the goaf during longwalling. In such cases seam gas post-drainage should be examined. In areas where upper seams have been extracted, gas

TABLE 1
GAS FLOW MEASUREMENTS FROM
DRAINAGE HOLES IN THE NO. 1 LONGWALL BLOCK
BOREHOLE SEAM, JOHN DARLING COLLIERY

Position of drainage hole	Hole length (m)	Gas flowrate (l/min)		
		24 hrs after drilling	7 days after drilling	14 days after drilling
No. 30 C/T	73	90	35	30
No. 31 C/T	75	70	70	60
No. 32 C/T	50	70	10	5
No. 33 C/T	50	100	10	-
No. 34 C/T	70	300	140	100
No. 36 C/T	72	180	120	70
No. 40 C/T	70	40	30	10
No. 44 C/T	70	50	30	
No. 48 C/T	70	50	30	
No. 51 C/T	71	30	-	-

problems in longwalling the Borehole Seam should be minimal.

LEICHHARDT COLLIERY

THE NEED FOR DRAINAGE

The problems of gas at Leichhardt are well known - as well as being a gassy environment with CH_4, there are also instantaneous outbursts of coal and gas, some without faulting. Most investigations were conducted in the 6 m Gemini Seam underlying the 3 m Aries Seam by 40 m.

RESULTS

In an arched standing heading, four 43 mm holes, of lengths ranging from 4 to 21 m yielded maximum total flow of 14 l/min. The maximum gas pressure measured was 9 kPa. In a rectangular heading, 6 boreholes of 43 mm diameter and 6 to 30 m long yielded flows from 10 to 44 l/min. Direction relative to cleat did not appear to have much influence on flows which was surprising in the light of experience elsewhere. At such low rates of flow, comparisons might be invalid. Maximum pressures measured (440 kPa) were also low for the 380 m depth below surface suggesting the possibility of significant natural drainage prior to the experiment.

A 43 mm hole to 7.5 m in the Aries Seam yielded only 12 l/min. This place had been standing for eight years and the maximum seam gas pressure recorded was 70 kPa, both understandable in the case of such low flow and attributing similar properties to the Aries as to the Gemini Seam.

MACQUARIE COLLIERY

THE NEED FOR DRAINAGE

As the deepest BHP Colliery in the Newcastle area, and with some specific ventilation problems to date, largely associated with faults and dykes, it is likely that methane drainage will be useful. Pre-drainage experiments have commenced and a post-drainage experiment is planned for the longwall. The presently worked Young Wallsend Seam is overlain at 10 m by the Victoria Tunnel Seam, 2.5 m thick, and underlain at 16 m by the Borehole Seam, 2.3 m thick.

RESULTS

Two in-seam holes were drilled towards a dyke in the vicinity of the No. 1 longwall in the Young Wallsend Seam. One 43 mm hole intersected a dyke at 44 m depth and the other, 117 m long produced less than 50 l/min of gas.

METROPOLITAN COLLIERY

THE NEED FOR DRAINACE

Metropolitan Colliery has the longest history of instantaneous outbursts of coal and gas in Australia, both with CO_2 seam gas and with mixtures. There have been seven fatalities from 1895 to 1954. Outbursts are still occurring, mostly explosively induced because face coal gassiness cannot be readily reduced to limits allowing continuous mining. CO_2, the present seam gas is in greater quantity than CH_4 would be, and the high rank coal leads to difficulties in drainage. Much drainage experimentation has been done but much remains to be done.

RESULTS

The two 43 mm holes up to 40 m long drilled ahead of development faces introduced since the 1925 fatalities, were unsuccessful in prevention of outbursts (Hargraves, 1958). Flows from these holes have been variable and were measured first by windmill air meter, which had problems due to water, and later by orifice and other airmeters, especially in the case of incremental flows (Hargraves 1963).

After experimenting with effects of large diameter holes on seam gas pressure and stress change, (Lwee, 1968) degasification was adopted to allow continuous mining. One 300 mm diameter hole was bored on each rib line for distances up to 80 m. The progress of drainage was monitored with emission value testing to determine whether it was safe to proceed. If the value was too high, an extra hole would be bored or the advance would be delayed (Hargraves, 1969). The drilling machine was an extra piece of heavy equipment involving logistics problems; there were problems with gas emission during boring and with coal cuttings at the face; there were delays awaiting gassiness reduction, and the need to drill holes quickly led to deflections, shorter holes, thus compounding the problems. The method of 300 mm holes was superseded by the arbitrary pulsed infusion shotfiring method, using advance 43 mm holes, shotfired with submarine explosive under reticulated (about 1.5 MPa) water infusion conditions for degassing (Ward, 1980).

Pillars of various sizes were investigated for rate of natural gas drainage. Holes were drilled to the centres of pillars 27 m wide, formed three months and flow rates were monitored. Initial peak flow rates fell, and after 40 days were 10% of the maximum. In another area, with pillars 23 m wide, initial hole flow rates fell to less than 20% of initial in 100 days. In a 66 m width pillar, higher initial flow rates were experienced, and fell to 35% of initial after 140 days and to virtually zero after 170 days. These results confirm the established notion that pillars of normal size are virtually winded within six months of formation (Hargraves, 1958).

Holes of different diameters but separated from each other and in comparatively similar positions, were drilled into virgin rib as a basis for establishing a relationship between diameter and flow. The results are shown in Figure 4, indicating that flows increase with diameter, but not in direct proportion.

Attempts at lateral drainage were made to protect specific roadways of a panel by drilling from an adjoining roadway, and to protect an advancing panel from an adjoining panel. The success of this work was assessed by emission value testing.

Figure 5 shows the first instance of emission values relative to lateral holes intersection during the drivage of 'A' heading in the New

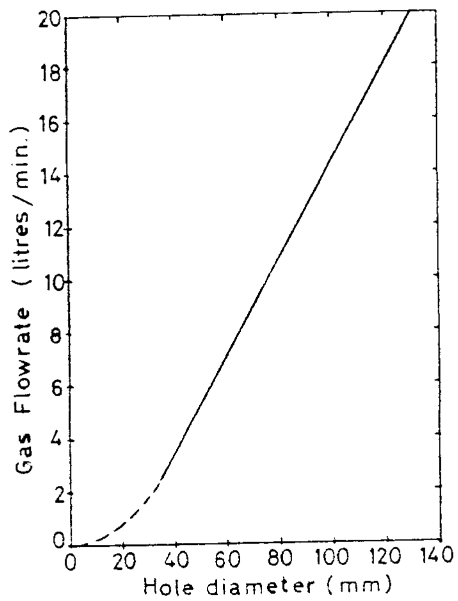


Fig. 4. Relationship between hole diameter and flowrate

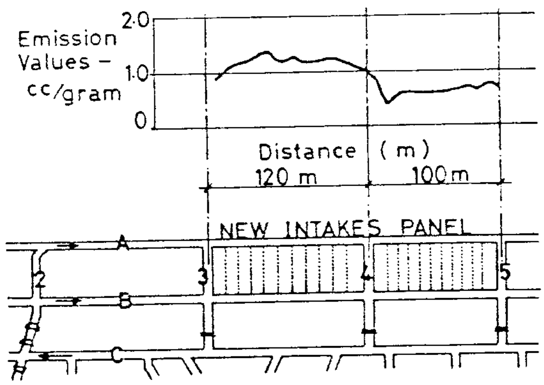


Fig. 5. Emission values during 'A' heading drivage relative to intersection of drainage holes

Intakes Panel. Drainage holes 43 mm diameter were drilled at 10 m centres in the 120 m pillar block between No. 3 and No. 4 cut-throughs and resulted in the continuing high emission values during the drivage of 'A' heading to form that pillar. In the next 100 m pillar block between No. 4 and 5 cut-throughs the holes were spaced at 8 m centres and a marked reduction in emission values was shown as 'A' heading was driven to form that pillar. Figure 6 shows the emission values during the drivage of B heading in A Panel. Holes of 43 mm diameter and up to 130 m long were drilled at 7 m spacings from an adjacent panel to intersect A and B headings as part of a pre-drainage experiment to reduce the high emission readings recorded in A Panel. Now drainage experiments are proceeding with flank holes in ribsides of roadways to pre-drain heading alignments a pillar length at a time. Holes of 43 mm and 100 mm are being used and suction is being applied to some holes. Gassiness monitoring on an incremental advance basis is by emission value testing.

Figure 7 illustrates the comparative air dilution and CO_2 outputs relative to suction employed. These results are tentative as the hole outputs are well below the capacity of the exhauster. It is considered that the difficulty of release of CO_2 from coal is much greater than of CH_4, and this, together with the higher sorptive capacity of coal for CO_2, do not make for outright comparisons of extraction under CH_4 conditions.

MOURA NO. 2 COLLIERY

THE NEED FOR DRAINAGE

The Moura 'D' Seam is worked to 200 m depth. Seam gas is virtually pure CH_4 and burst cones appeared during the course of continuous mining. As a result of this and other Bowen Basin experience, it appeared that this was at the minimum depth for gas and stress phenomena and that the burst cones were symptomatic of instantaneous outbursts of coal and gas at greater depth or on intersection of faulting. Hence initial experiments were conducted into drainage as a preventive measure.

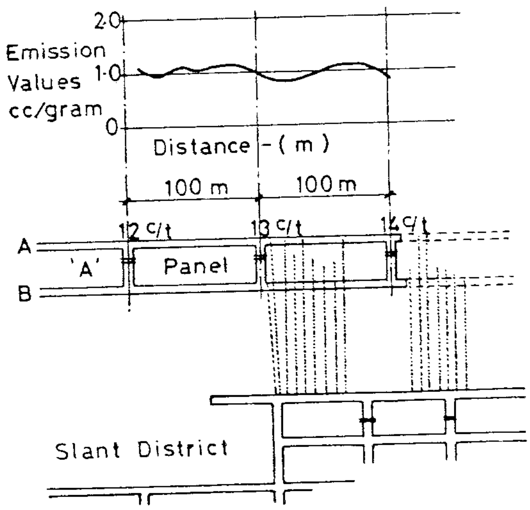


Fig. 6. Emission values for 'B' heading drivage

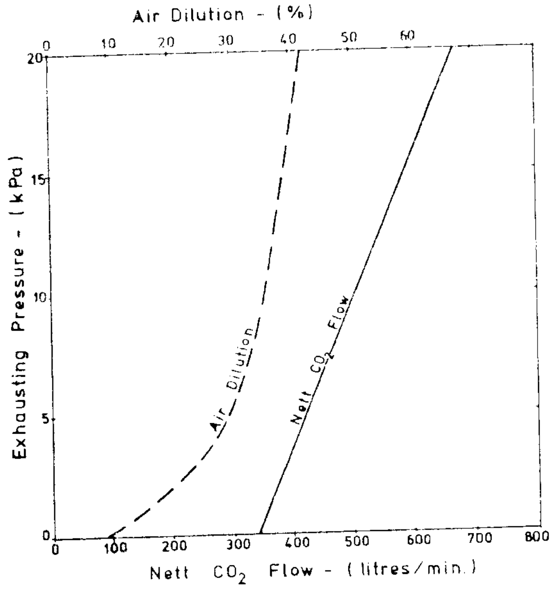


Fig. 7 Air dilution/nett CO_2 flow - Metropolitan Colliery

RESULTS

The results of the investigations showed that in return air, when machining ahead, there was less methane addition to ventilation when holes had been bored in the face than without them - including the flows from holes up to 21 m in advance. The apparent effect of the holes was to spread total emissions more regularly in time than the situation without holes and with surges of gas during machining. Tentatively the reduction in gas-make with time, during machining, improved with increase in the number of holes, and diameter of holes as shown in Table 2. There are many other variables, including geographic, to influence the results.

TABLE 2

RELATION BETWEEN GAS MAKE DURING MACHINING AND SIZE AND NUMBER OF HOLES IN HEADING FACE

Test Number	Hole Specification				CH_4 Make Whilst Machining (m^3/min)
	43mm dia.	length (m)	100mm dia.	length (m)	
Test 1	0	-	0	-	5.18
Test 2	2	6	1	21	4.47
	1	21			
Test 3	2	3	1	18	
	1	18	2	21	3.91
Test 4	1	18	0	-	4.99

LABORATORY WORK

Desorption

Coals sampled at faces are examined for sorbed gas. The samples are encapsulated and desorption-time relationships are studied. One aspect of this work is examination of coals leaving the shaft collar via drift portal. At Appin (CH_4) and Metropolitan (CO_2) it has been found that at least 1 m^3/tonne of desorbable gas remains in the coal on arrival at the surface. No attempt was made to determine residual gas by crushing the coal, considered to be of minor importance because it has no influence on gas problems during mining. Table 3 shows some typical results of desorbable gas investigations.

TABLE 3

DESORBABLE GAS FROM VARIOUS COALS

Colliery	Seam	Depth (m)	Desorbable Gas m^3/tonne
Appin	Bulli	550	13.8
Metropolitan	Bulli	450	7.5
Bulli	Bulli	300	6.0

Macropermeability

Samples are trepanned from lump, both parallel and perpendicular to bedding, and are encapsulated in a length of steel pipe with epoxy resin. The ends of the coal are faced and the CH_4 and later CO_2 is passed through the coal to measure macropermeability. Typical results of some mines with significant gas are shown in Table 4.

TABLE 4

MACROPERMEABILITY OF SOME AUSTRALIAN COALS

Seam	Colliery	Average CH_4 (darcy x 10^{-3})	Average CO_2 (darcy x 10^{-3})
Bulli	Appin	180	100
Bulli	Metropolitan	90	100
Bulli	Coal Cliff	184	-
Gemini	Leichhardt	8	10
Borehole	John Darling	9	12
Wongawilli	Wongawilli	185	175
Castor	Cook	190	510

General

Other gas-coal properties are also studied including properties which could influence drainage such as sorption coefficients of expansion, inherent moisture and maximum inherent moisture.

DISCUSSION AND CONCLUSION

Advance pre-drainage needs longer and straighter holes than presently generally available for in-seam drilling. The ability to drill ribside holes straight and for long distances would be a valuable contribution to advance drainage. With shorter distances of drilling, the need to use diverging holes, or holes curved, then straight or the need for cutting, at intervals, drilling offsets from main and tailgate into what will later be the longwall block are all seen as shortcomings in present drilling practices in the need for advance drainage.

In advance drainage holes, and lateral virgin holes, whatever flowrate natural drainage commences, the flowrate will usually settle down to about half of the maximum or initial flow and may continue virtually indefinitely.

Over the years the length capability of the 43 mm bit, airmotor driven airleg mounted drill, with E rods and water flushing, has been extending and the outfit now, with 130 m holes possible is a really viable, versatile drill.

One such 130 m length hole has been reamed to 100mm diameter with the same equipment.

Where pre-drainage is used with more than one hole of any diameter ahead, some thought has been given to boring a centre hole for infusion of compressed air (under CO_2 conditions) or N_2, or water (under CH_4 conditions) to accelerate drainage.

In the Metropolitan exhausting experiment, as shown in Figure 8, nett CO_2 flows are examined against suction and the consequent leakage.

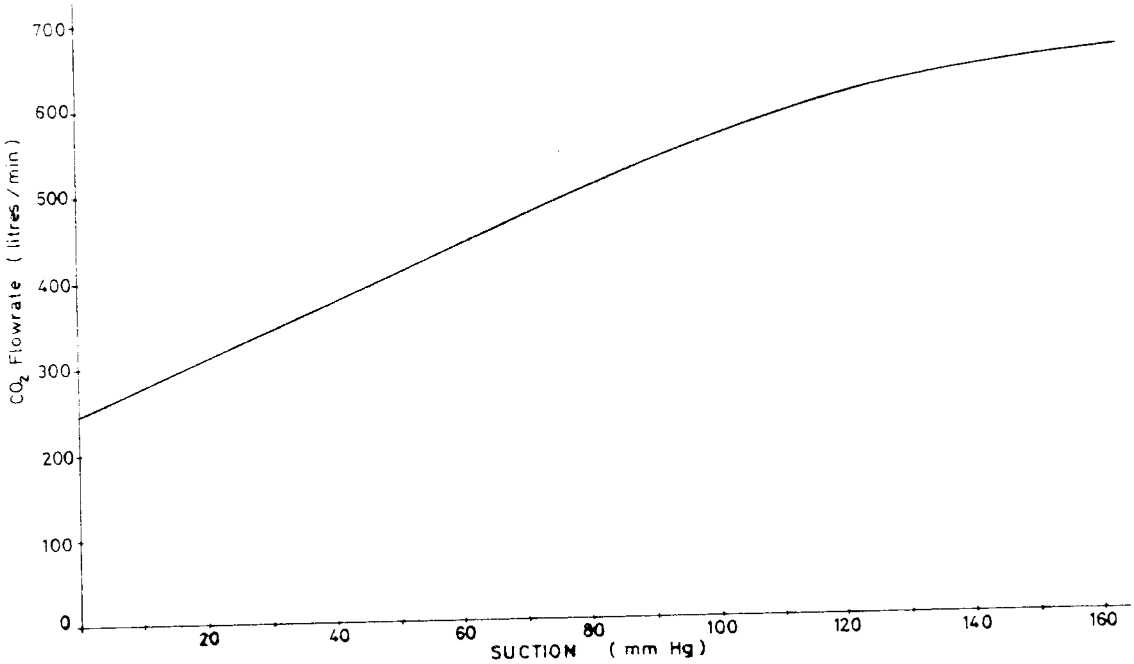


Fig. 8. Variation of CO_2 flowrate with applied suction from drainage holes - using Nash Hytor exhauster pump. 1 NW Panel, Metropolitan Colliery

Such leakage would be more important in the case of CH_4 than of CO_2.

The composition of mixed gas changes during drainage. If mixed gas is to be used for utilisation prolonged tests should be conducted first to establish the real average seam gas composition, which varies so much with time elapse. Purity is important where the gas is utilised in the case of CO_2 where utilisation is not considered, dilution is not a factor. If purity is drained gas is an important factor, the alternative of more holes and natural drainage by the high seam gas pressures pertaining should not be overlooked.

The rate of natural drainage of pillars of normal size is such that pillars are virtually winded of gas within 6 months of formation. Thus unless there is a special reason for doing so, there is no need to attempt drainage of such individual pillars.

The case of large retreating longwall blocks could be more appropriate to examine as a drainage venue, although times taken for development of longwall blocks should give outbye coal, at least, a chance to degasify naturally down to tolerable figures. Holes drilled into longwall blocks have, in themselves failed to produce desired quantities of gas to allow running of a suction plant. The collection of gas from relaxed adjoining seams to prevent its release into mine openings appears to be the only significant need for drainage in longwall. It is presumed that some delay occurred between completion of Appin No. 1 block and the in-seam experiments.

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DISCUSSION

B. HAM (M.I.M. Holdings): It was stated that the Bulli Seam is very dry. In Collinsville having the same CO_2 outburst problem the seam is very wet. As in the Bulli Seam water has been used to effectively dampen some of the outbursts risk; because there is more water up at Collinsville, would the pulsed infusion shotfiring be much less effective? Are there any other side effects which might be seen by comparison with the work which has been done at Metropolitan Colliery.

S. BATTINO (BHP Steel Division Collieries): No, there should not be a parallel there because most of the draining is done dry. However the effect of wet drilling or even water in the seam would probably affect the coal's permeability and sorptive capacity. There does not appear to be a parallel to draw, each case will have to be considered on its own merit. It would probably be necessary to carry out a similar type of drainage test to the one currently being done at Metropolitan.

A.J. HARGRAVES (BHP Steel Division Collieries): Perhaps Dr. Williams should contribute to this, in comparing the mositure contents of the Bulli Seam and the Bowen Seam. The telling thing appears to be the inherent moisture content and the appearance of wetness at Collinsville is more likely to be adherent or superficial rather than inherent moisture.

R.J. WILLIAMS (Collinsville Coal Company Pty. Ltd.): Emission value readings are taken at Collinsville without any problem at all from water. The seam has always been regarded to be essentially dry, even though in a current mining area problems from water are being experienced. It is doubtful whether the original question is all that relevant if the seam is not terribly wet.

D. FOWLER (Thiess Dampier Mitsui Coal Pty. Ltd): There are no recorded results in the paper from Moura No. 2. It does state in the paper the depth of 200 m was the shallowest where outbursts had occurred. Outbursts have occurred at Moura No. 4 at 120 m. Tests have been taken at No. 2 and No. 4. But no results have been received.

S. BATTINO: There are some results from Moura No. 2 which could be made available.

C. JEGER-MADIOT (CERCHAR, France): Figure 3 indicates that there is a relationship between the hole diameter and the flow rate. Which flow rate was used - at which moment after the boring of the boreholes was this flowrate measured?

S. BATTINO: The boreholes were drilled and the gas flowrates were tested and measured on the very same shift the drilling took place.

C. JEGER-MADIOT: Yes but was it the first moment of the beginning of the flow?

S. BATTINO: These holes were drilled in a reasonably virgin coal area and the flow was measured as soon as practicable after boring.

C. JEGER-MADIOT: It occurs shortly after boring. It could look curious that a wider diameter borehole gives a lower flow than a smaller one. After the simulations with the CERCHAR computer model, it can be understood why this observation was made. It was probably true at a certain moment after drilling, but not true before nor after this moment. In fact, during the first time after drilling, there is a difference in flow depending on the diameter of the borehole. But, after a certain time, there is no more difference. That appears on Figure 1 of CERCHAR

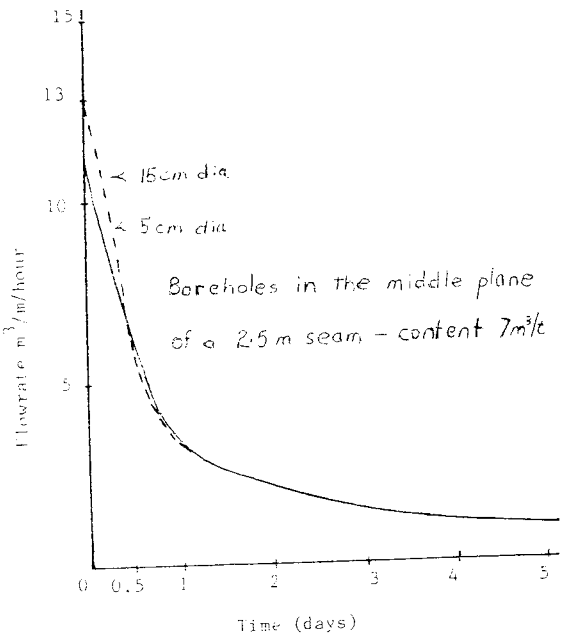

Fig. 1. Flowrate vs borehole diameter, d · indicating flowrate versus time for a borehole of 5 cm of diameter and for one of 15 cm. At the first moments (a few hours), the flowrate in the 15 cm diameter borehole is higher, then, during a few hours, lower than the one in the 5 cm diameter borehole. Finally, after 12 to 15 hours, the flowrate becomes the same in both boreholes. The durations of these different phases depends on the characteristics of the seam (thickness, initial content of gas, permeability).

The trials were made to know if the computer program would be able to indicate the real permeability of a seam by reproducing the results of measurement of flowrate of gas from boreholes. It will be possible only if the flowrate will not depend on the diameter of the borehole (in a certain range) because it is not possible to know the real diameter of the borehole in the seam (there is a lateral erosion by drill rods and lateral fracturing due to strata pressures).

Fortunately, after a certain time, the flowrate seems not to be influenced by the diameter of the borehole.

S. BATTINO: That pattern of results would also be duplicated under Australian conditions.

R. KING (Bureau of Mines, U.S.A.): The probable problem in taking the initial flow rates is as recognised by most people in the oil and gas industry, a well will flow much stronger in the beginning and eventually there will be a stabilised flow and probably the people at A.C.I.R.L. have seen that too in their longholes. Table one of the previous paper by King does give initial and stabilised flows, and typically may be 50 to 60 per cent down. This is the more important flow for drainage because that is the drainage in the long term.

S. BATTINO: The paper states that there is quite a rapid drop from initial gas flow to about 50-60% of the initial flow only a few days after drilling at which time it levels off. This was observed as well as determining the effect of hole orientation, length and diameter on flowrates. This Metropolitan Colliery work was part of the full project and similar experiments are also going on at Appin Colliery.

G. MOULD (Dept. Industrial Relations): Regarding Figure 1, at a distance from the maingate rib of about 45 m, there is no flow at all. The same applies to the curves on the right hand side. What is the explanation?

S. BATTINO: Some sort of a mirror image should be obtained from both sides, the maingate and tailgate with local variations conditioning for some different results. Of course these are incremental flow rates into the holes and as well there will be some gas drained out of the ribside. For this reason, possibly a little bit of difference between the maingate and the tailgate should be expected, rib drainage could be from the first four or five metres of ribside depth.

G. MOULD: At the most inbye part of the hole, when it gets to the bottom part of the line is there no flow of gas?

S. BATTINO: When the incremental flows were done that is right, very close to zero flows were obtained in that vicinity. That might have to do with the closure of the pores due to the stress in the core of the longwall block.

G. MOULD: Could that be right - as there is seam gas pressure that far into a pillar, it seems hard to accept no flow at all.

S. BATTINO: In both the maingate and tailgate side, this behaviour in gas flowrate was noted. There was a steady decrease to a minimum as the centre was approached.

R. LAMA (Kembla Coal & Coke): How are the measurements of incremental flow made?

S. BATTINO: These are done using a pneumatic rubber seal inflated to approximately 200 kPa in the hole. Starting from the inbye end of the hole the measurements are made working outbye. The seal consists of two rubber sections with exactly half a metre spacing between them. A hole in this spacing allows the gas to flow through hollow extension ¼ in. (6.3 mm) pipes to the flowmeter at the collar of the hole. Gas inbye the seal short-circuits into the hole outbye the seal. The flowmeter readings are converted according to calibration curves and plotted. Normally, the area under the incremental flow curve should correlate closely with the gas flow obtained for the total length of the hole, but large discrepancies were found. The magnitude of the differences amounted to 40 per cent or 50 per cent, in some cases.

R. LAMA: The incremental flows gave less values?

S. BATTINO: Yes, total gas flow rates appear to be greater.

K. NOACK (Westfalische Bergerwerkshafts, West Germany): Should the incremental flow curves in Fig. 1 have the consequence that it is useless to drill boreholes longer than 40 to 60 m?

S. BATTINO: That is not a general conclusion. The holes were in a longwall block. Experience with other holes and from other collieries shows that general gas flows increase with length.

I. GRAY (A.C.I.R.L.): Were the holes drilled from both sides of that area to get those results or is that one hole clean through?

S. BATTINO: Two separate holes were drilled, one from each side of the longwall block.

I. GRAY: There is a problem of changing horizon in in-seam drilling. With a Victor Borer the horizon may drop at times. Possibly the holes entered an impermeable horizon at the bottom, so explaining the seemingly anomalous results obtained.

A.J. HARGRAVES: That is possible - the holes were not surveyed and no cuttings log was kept.

It is pertinent to compare the lateral drainage used at Metropolitan Colliery and the lateral drainage described by Marshall, Lama and Tomlinson from West Cliff. At Metropolitan with lateral drainage it has been the principle to carry holes clear across the heading alignment and into the far rib and in the case of a panel wherever possible to traverse the whole panel. Maybe this can be done because of the CO_2 conditions with no risk from gas from the butt end of a hole blowing into the working place. Maybe this is the reason why the examples of West Cliff stopped far short of the nearest rib alignment of the panel.