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UPDATE ON OUTBURSTS AND IN-SEAM DRILLING IN 2002

John Hanes¹

ABSTRACT: There have been some developments in understanding the outburst mechanism and improving the control of in seam drilling. Experience with techniques for draining from the surface has shown promise. There is a need for operators to provide facilities for more research so that the outburst phenomenon can be better understood

INTRODUCTION

During 2002, there has been:

- Improved understanding of outburst mechanisms,
- Improved understanding of why the coal in some areas will not drain,
- A contribution of the usual hard-grind in-seam drilling for drainage and exploration,
- Some minor improvements in in-seam drilling technology from underground, but
- An increased effort in surface to in-seam drilling.

The information herein has been extracted, in some cases verbatim, from the notes of various workshops and seminars including the Coal 2002 pre-symposium Gas Workshop, Outburst Seminars and ACARP In-seam Drilling and Gas Workshops. Authors of papers are quoted, but the comments of many colleagues have been used with gratitude, but without specific reference.

MODELING

The aim of the ACARP funded research application of mathematical modeling by CSIRO (Choi, 2002 and Wold, 2002) is to try to get a better understanding of the mechanisms of outbursts using a simple mechanistic approach. In an outburst, as with pricking an inflated balloon, failure at the weak spot removes the energy barrier and allows the gas to expand, causing further failure of the membrane until the system reaches a new equilibrium (or stable) state. CSIRO have developed and used a coupled geomechanical-reservoir model to simulate outbursts. The model has shown that the coal deforms at a high strain rate after outburst initiation and as the coal continues to expand and disintegrate into smaller fragments, new surfaces are formed. Gas pressure around the new surfaces and in the voids, which are close and connected to the new surface, drop very quickly. The model has shown that the initiation of outbursts can be controlled by a number of factors. Much of the modeling to date has been based on data from Leichhardt and early West Cliff Collieries, ie 20 year old data. As the understanding of the mechanism improves, better data will be required for modeling and the willingness of collieries to help collect data will be essential.

Slater, and Yurakov, (2002) showed how mathematical modelling of gas reservoirs can provide practical assistance to facilitate gas emission evaluation and control during gate road development.

PERMEABILITY

Gurba, 2002 showed that, in the mines sampled for her ACARP project, the main difference between coal that does not drain and coal that drains easily is the nature of infilling of micro-cleats. Impermeable coal has micro-cleats which are typically infilled by carbonates and permeable coal has micro-cleats which are free from infilling. There is a need to understand the post depositional fluid flow and geology and precipitation of the carbonates. This appears to be a fertile area for research in an attempt to provide the link between microscopic and macroscopic features. The ideal outcome will be to use the microscope to help understand the causes of low

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permeability so the mine geologist can better map areas of varying drainage potential in the mine. Micro-markers could also be developed as a useful exploration tool.

Robertson, (2002) stated "Permeability appears to be well understood in reservoir engineering terms, but it is still poorly understood in the coal industry and it is such a critical parameter. There are not enough permeability tests done. We let permeability get lost in the empirical approach we have to gas drainage". If a reservoir simulator is used, or if it is necessary to design a gas drainage system, reliable information on permeability is required. It is then necessary to get real permeability testing including interference tests. An interference test requires at least three observation wells and a central pump well. On top of this is the cost of a pumping system and a monitoring system. Depending on depth and drilling costs, the total cost would be between \$100,000 and \$200,000. Permeability testing should be extended to the entire reservoir, including over- and under-lying seams and sandstone reservoirs, not just the working seam. In the Bulli seam, only around 10% of the gas comes from the mined seam. Stress measurement should be considered as part of a permeability test because the permeability is so closely controlled by stress. Relative permeability is very important.

The oil and gas industry has shown that the method of drilling can influence permeability tests. The hole skin factor can control desorption pressure. In-seam drilling is conducted mainly at or below gas desorption pressure. In such cases gas is desorbed uncontrollably while drilling and this can cause damage to the hole and can lead to bogging of the rods. If the hole is pressurized while drilling, the environment is quite benign. The Sigra borehole pressurization tool could be very useful here. In-seam drilling from the surface uses water pressure to stabilize the hole and drilling is easy compared to drilling under ground. Gas desorption only commences when the water pressure head in the hole is reduced below sorption pressure. According to Williams, (2002), when drilling from the surface into permeable coal, the weight of the drilling fluid can force fluid into the formation. Once the pore pressure is reduced to around gas desorption pressure, if the gas is migrating a long way to the hole and is carrying a lot of coal fines, a sudden drop in pressure can cause the coal pores and fractures to block and thus reduce the permeability. In permeability testing, it is necessary to reduce the in-hole fluid pressure very slowly to reduce hole damage. The problem of blockage is accentuated in friable strata.

Boucher, (2002) described the use of hydrofracture for in-seam holes at Dartbrook to increase flows from impermeable coal. Water fractures improved flows initially, but flows reduced in a few days to pre-frac levels. Sand fractures gave initial flows 20 times normal flow rates which appear to be sustainable over 6 months. Fractures were induced at 3 to 6 m spacings in holes.

HARD GRIND OPERATOR EXPERIENCE

Pryor, (2002) reported on the proposed upgrading of Tahmoor Colliery's in-seam drilling capabilities for Tahmoor North. Previous drainage has been with holes 350 m long at 25 m spacings. For Tahmoor North, hole lengths will be 600 m. The longer holes require more powerful drills and the Mecca survey system developed by Longer exploration holes will also be necessary for testing seam structure. Dewatering of holes will also be required and a trial will be conducted of VLD's tube feed roller system for introducing the dewatering tube into the holes. Tahmoor will change from multiple branches of holes to single holes to improved monitoring of drainage efficiency. Methods for maintaining borehole stability across dykes are being investigated.

Newman, (2002) reported that although borehole maintenance is a very basic need, it is often given a low priority. If maintenance is ignored, a lot of time and money can be spent forming boreholes which serve no purpose. Maintenance is required to fix problems of three main types - blockages by solid material, water removal and leakage. In many cases these problems can be avoided by applying good standards at the time holes are drilled and connected to the drainage system. The main aim of a drainage hole is to efficiently drain gas and to monitor the efficiency of a hole, it is necessary to monitor gas flows from the hole. Currently, gas flows are measured weekly in the early part of the hole, reducing to about once per month. Although automatic flow monitoring for the life of the hole would be ideal, it is not currently being conducted by any colliery. Under ACARP funding, Sigra developed a flowmeter with automatic monitoring, but no colliery has expressed sufficient interest to enable commercialization of the system.

Brown and Eade, (2002) reported that Tower Colliery has a 250 m wide structural zone which is nearly impossible to drill or drain. It is associated with a fault which varies between a thrust fault and a bedding plane fault. The coal in the zone contains 15 m³/tonne CH₄. The area is highly stressed with a prominent horizontal stress which has created enormous roof problems. Some intense bolting patterns with 8x8m fully grouted bolts per metre in the maingate roads is required. Attempts have been made to drill numerous drainage holes through the coal, but with little success. The zone is outburst prone and two outbursts occurred while remote mining was

conducted to cross it. The permeability of the coal is effectively zero in places. There is no gas flow from any holes which penetrate the zone.

SURVEY AND EXPERIMENTAL DRILLING

Verhoef, (2002) described recent advances in borehole surveying. These advances over the last 10 years occurred through close co-operation between collieries and AMT. Borehole surveying is approaching the ideal of a drilling guidance tool. There is still a need to incorporate some forms of "geophysical logging" into the drill guidance system so that geological changes in the coal seam can be detected and quantified during drilling. One of the major stumbling blocks in achieving this aim seems to be compliance. According to Verhoef, "The compliance issues severely impact on the technologies that can be applied. Aluminium cannot be used. Designs are restricted due to the total inductance and capacitance that can be used in combination with the battery voltages used. Current/Power restrictions i.e. resistors, zener diodes to prevent sparking. Enclosure strength because of flameproof requirement, add weight to designs and limits physical space available. It is very time consuming and difficult to obtain full compliance, in particular the State differences in paperwork, although both comply with Australian standards".

Thomson, (2001) stated that current in-seam drilling technology is "sort of" providing a solution to outburst problems, but it is part of the problem. In-seam drilling for drainage is expensive, interferes with mining, provides insufficient lead times for drainage, has water and power issues. There have been no real advances in outburst detection methods and it is unlikely that detection will ever replace reduction of gas content. He suggested that medium radius surface to in-seam drilling, cheaper (less accurate) underground drilling and an analytical approach to in-seam drilling results should be considered as alternatives. With in-seam drilling, Thomson highlighted the need to monitor the drilling parameters for detection of structures and the development of in-hole geophysical tools. Any tools that reside behind the bit are prone to loss, especially when drilling in underbalanced pressure conditions. The risk could be reduced by drilling using water pressure in excess of desorption pressure. He expressed the opinion that the industry should consider a combination of oilfield rotary drilling technology and pump-down survey tools to reduce the cost of equipment at risk. Verhoef, in response, reported that AMT have developed the Drill Guidance System (DGS) which can incorporate natural gamma and other geophysical tools which might be developed in the future. They have also developed an IS computer for underground use. The expense of tools must be weighed against the benefits of the tool. A pump down tool takes time to collect data. A down hole tool used during drilling allows holes to be drilled more quickly and therefore more holes can be drilled.

A CMTE ACARP project C9020, Longhole Waterjet Drilling for Gas Drainage is due for completion at the end of 2002. The project combines pure waterjet drilling technology with conventional directional drilling technology. The final field trial is due to be conducted at Moura. CMTE are also involved in developing drilling technologies for soft and low permeability coals (ACARP project C10016). The system under development utilizes a combination of high pressure waterjet drilling and a casing advance system. For stimulation of impermeable coal, slotting equipment has been prepared. CMTE have made numerous attempts to secure a mine site for trials, but with no success.

SURFACE TO IN-SEAM DRILLING

Bos, (2002) described trials in surface to in-seam drilling conducted by Anglo Coal who experimented with tight radius drilling at German Creek and medium radius drilling at Moranbah North. "MRD will provide good exploration data with 9 holes sufficient to cover and hopefully predrain a 4 km block. If drilling were conducted up to 3 longwall blocks in advance, there should be sufficient time for drainage, good exploration data can be collected and near pure gas can be collected for sale. TRD could be as good as MRD if directional control while drilling can be obtained". The value of surface to in-seam drilling could be greatly enhanced if geophysical logging of the in-seam section of the hole could be conducted.

Johnston, (2002) showed how surface to in-seam drilling complimented in-seam drilling to solve a longwall scheduling problem at Oaky North. Holes were drilled from the surface and turned in-seam to intersect vertical holes. The water lowering effect of these holes dramatically increased the flows in the in-seam holes drilled from underground resulting in no longwall delays.

GAS RESEARCH

Filipowski, (2002) described a novel and relatively inexpensive method of assessing face outburst proneness. "The gas composition of a coal sample changes with time. The proportion of each component relative to other components is transient. This is due to the different rates of desorption of the different component gases. Some gases desorb very quickly, eg the higher hydrocarbons and CO₂. CH₄ is slower and N₂ is the slowest of the coal seam gases. Nitrogen remains in the coal for a long time... If you have a gas composition, you can assess the degree of coal degasification. This is a much more economical method of gas content assessment than desorption testing. It will not replace all content testing, but offers a quicker and less expensive method for infill testing in the mine". He found that that if N₂ is greater than 20%, the gas content will be below the outburst threshold. He hypothesised that Nitrogen can be used as a faster assessment of outburst potential than gas content.

Harvey, (2002) defined a major problem of outburst research "the outburst problem appears to have been solved. Outburst risk in the Bulli seam is deemed to be successfully managed through adherence to the threshold values". It is difficult to examine outburst parameters if there are no outbursts. He emphasized that gas thresholds only relate to one aspect of outburst risk, gas content. Gas content thresholds, like any other standard, need to be analysed and reviewed on a regular basis and placed in the context of other contributing parameters. An understanding of the warning signs at the face is the fundamental final barrier. He commented "A number of us who are involved with outburst studies are concerned that the collective knowledge of the industry could be lost unless something is done to promote further research and document the knowledge. Without ongoing research and documentation, future generations of miners will have a steep learning curve." There is also a need to make miners aware that drainage is not a panacea and that other factors such as warning signs at the face should be re-emphasised in training.

Eade, in a comment from the floor at the Coal 2002, pre symposium Gas Workshop, stated "Outbursts are seen to be under control, ie there is a fair factor of safety in gas content threshold values. In the factor of safety there is a cost component to productivity and safety... We need to continue research towards a fundamental understanding of outbursts. Until we have this understanding, it is difficult to go much further on a lot of the outburst parameters and put them into a threshold. The reason for outburst management success in the Bulli seam is the healthy safety factor with gas content." If the gas content can be reduced to a manageable level, outburst should not occur from structure free coal. The structures are the focus for potential outbursts in otherwise drained coal. Techniques to reliably detect structures should be advanced.

A survey of collieries carrying out in-seam drilling and many individuals employed in the industry was conducted by the author as part of ACARP Project C10012 to assess the needs for ACARP funding of research into outbursts and gas drainage. No results are available at the time of writing.

CONCLUSIONS

There has been some progress in recent times in in-seam drilling and gas management, but in some cases industry has delayed taking up new developments or providing sites for research and has frustrated data gathering trials.

A great leap seems to have been made in overcoming initial inertia regarding surface to in-seam drilling. This technology will allow the use of non-IS equipment and bigger equipment to handle the task. Many operators express a desire to get drilling out of the pit. Drilling from the surface removes many barriers. There will be a change in thinking required to fund drainage from the surface several years in advance of mining.

There was not much good news from the researchers over the last year. Several projects have been frustrated by lack of colliery support for field trials.

Although the industry co-operates well to overcome problems associated with gas management, Tower Colliery clearly showed that Mother Nature can turn around and bite from time to time. In some cases it is necessary to walk away from problems.

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