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J. Hanes
ACARP

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CURRENT IN-SEAM DRILLING TECHNIQUES

John Hanes[1]

INTRODUCTION

In-seam drilling has two main purposes: gas drainage and exploration. Each hole can yield information on the geological structure of the ground drilled, but in the drilling of some gas drainage holes, valuable geological data is lost. Drilling technology has changed in some ways over the last ten years, but still has some way to go. There is room for more improvements to reduce the costs, to reduce the risks and to increase the information gathered.

DRILLING EQUIPMENT AND TECHNIQUES

Drill rigs have undergone some changes for the better in the last ten years. They have been increased in power and manoeuverability for drilling longer holes. Examples of these rigs are the Boart Longyear LMC75 and the Cram RamTrak Diamec 262 with automated rod handling. Drill rods have been improved with the introduction of the Boart-Longyear NRQHP which has a totally new thread and better strength properties.

Hole surveying has also advanced considerably over the last 10 years. Currently the Advanced Mining Technologies'(AMT) survey tool, the DDM is the norm. Since 1994, AMT has sold approximately thirty-five directional drilling survey instruments to companies in Australia and approximately twenty to overseas countries, such as USA, Japan, China and Republic of South Africa. The majority of these tools have been DDM MECCA instruments. AMT recently developed the Drill Guidance System (DGS) and trialled it at Tower Colliery. The DGS allows for the addition of other geophysical tools when they are developed and approved. A profiler or indicator of proximity to roof/floor is required by industry. Sigra's torque-thrust tool should also be a useful add-on when its output can be interpreted. A non-IS version of the DGS can be used for surface to in-seam. A major problem in getting new in-hole surveying and logging technology into the industry is the long delays in getting IS approvals. IS approval has been obtained for NSW for the DGS, but there have been considerable delays getting approval for Queensland. Why do we have two different approval systems especially for equipment manufactured to Australian standards?

Guided drilling is mainly conducted as "flip-flop" drilling: 6 m is drilled to the right then 6 m to the left. Gray (1998) advised that the main limit to hole length was the strength of the drill rod joints under tension during pulling of the rod string. Hole friction was a major factor. To reduce hole friction, he recommended that holes be drilled straighter using the oilfield technique of rotary-slide. This technique has been routinely used at Appin Colliery since early 1988.

At Appin drilling is conducted with a down hole motor (DMH) which is slowly rotated at 200 RPM. A 92 mm bit and a 1.25 degree bend are used. The bit stays central and does not wave about. The result is a gun barrel spiraled hole. The AMT Mecca system is used for survey and has not been affected by rotation. There is less friction in the hole and there is better flushing of cuttings. Hydraulic pressures are reduced leading to the ability to achieve longer holes if required. The maximum drillable lengths previously obtained with the Diamec drill rig were around 500 m to 600 m, but with rotary drilling with DHM, +700 m has been achieved. Penetration rates are better, having increased from 40 to 70 quality metres per shift. Without rig moves, an extra 15 m to 20 m are achieved. There have been no detrimental effects on the survey tool. Rotation speeds are 150 to 200 rpm, ie about half of normal rotary drilling rotation. There is very little lateral deviation of the holes compared with holes drilled by the flip flop method. Some drilling contractors refuse to use the technique stating that it subjects the downhole motor to too much vibration.

CMTE are currently working on an ACARP funded project, Project C 9020, to develop a non-rotating high pressure drill string used to advance a pure waterjet cutting head. The technique will use a conventional bent sub for directional control.

[1] Coordinator of ACARP In-seam Drilling and Gas Research

Conventional rotary holes are still used, mainly for infill drilling and gas content core collection. Although BHP developed a monitored ProRam drill rig (Danell, 1999) and showed that it could detect outburst prone structures, the drill has not been used for detecting structures ahead of advancing faces, nor have other drills been fitted with monitoring equipment. This is a case of good research ignored by industry.

Drilling contractors and mine drillers are continually reviewing drilling methods to improve their methodologies and to reduce risks.

DRILLERS

The information which is gained from any in-seam hole is still completely dependent on the vigilance of the driller. An experienced and dedicated driller can detect even small structures through minor changes in drilling characteristics. The mine can only use this information if it is accurately recorded then properly interpreted. The Australian coal industry now has many experienced in-seam drillers. Tahmoor Colliery and BHP-Billiton's South Coast mines employ their own drillers and equipment for most of their drilling requirements. Other mines use drilling contractors. The industry is well serviced, but better communication appears to be required to improve results and satisfaction.

EXPLORATION VERSUS DRAINAGE

Although most drilling is conducted for pre-drainage of gas, each hole can yield information on geological structures critical to mining continuity. Some holes are purpose drilled for exploration. Different drilling and data gathering techniques are required for each type of hole and there are different risks involved. Drainage holes are usually limited to across block distances up to 300 m length. There is generally little risk in these holes and they are drilled quickly, one recent example was the drilling of a 611m hole in a 10 hour shift. Exploration holes typically involve greater hole lengths (the record to date is 1602 m), slower drilling and delays for cuttings collection, and branching. Exploration drilling has a higher risk of equipment loss, especially in very long holes drilled into structured ground where up to $700,000 of equipment is in the hole.

To reduce the risk and cost of exploration drilling, an accurate prediction of seam structure and drilling conditions should be provided to the drillers prior to contract agreement. A competent geologist who can make decisions according to the information gathered during drilling should supervise the drilling. Drilling contractors report that most mining companies provide only sketchy information on predicted geology and leave the decision making and eventual blame if things go wrong, to the driller. These same companies would not allow surface exploration programs to be left up to the drilling contractors. During the 1980's, in a longwall mine, several drainage holes drilled across the block bogged. The drilling was overseen by the mine engineers as part of the production process. The geologist was not involved or provided any information from the holes until a fault was later intersected by the shearer in the block, but not in the gateroads. A review of the drilling plan showed that the drainage holes had bogged on the fault and provided valuable information that was not interpreted. Several weeks of mining were lost while the face was relocated beyond the fault. This was a costly way of learning that successful mining comes from teamwork involving several disciplines.

STRUCTURE DETECTION

When most drilling was conducted with rotary drilling, structures were detected by bogging of the rods. With downhole motor drilling, the more powerful drill rigs allow drilling through smaller structures without bogging. A vigilant driller is required to detect these zones. The industry still requires automated logging during drilling to detect structures. The brightest hope comes from the Sigra torque and thrust tool which is being developed under ACARP funding (Project C7023). In laboratory tests, it has successfully detected minor differences in coal strength during drilling. Another potential is the borehole dielectric probe (Murray et al, 1999) which detects changes in moisture in the coal. To get such tools into the mines will require mine support for initial field proving then financial support for the construction and approvals. Mining personnel need to champion research projects or progress will be slow.

STICKY DRILLING

Although drilling technology has advanced, sticky drilling zones still challenge the best of drillers. These zones are typically associated with geological structures or stress concentrations. When the drill bit enters such a zone, the rods, through an uncertain mechanism, become stuck. Perhaps the stressed coal tightens about the bit and motor. Perhaps the soft coal caves and before being fully cleared by the circulating water, blocks the hole behind the motor. The result is hundreds of thousands of dollars worth of equipment left down the hole. Recovery attempts are time consuming and costly. If the equipment cannot be recovered, it does not take many losses to bankrupt a drilling contractor. Tower Colliery has a few such drill rod graveyards.

The Sigra borehole pressurization system, developed under ACARP funding (Gray, 1998) and currently seeking a trial site for proving, offers a possible solution to drilling through sticky zones. It allows drilling to be conducted under applied fluid pressure which internally supports the hole wall. This technique is successfully used in surface drilling. ACARP are currently funding CMTE research (Project C10016) into better methods for drilling through sticky zones and impermeable coal.

One contractor reported how he encountered sticky zones which were passed by drilling in the roof. A stressed zone was intersected which had not been predicted by the mine personnel. When mined, the coal in the stressed zone leaped out from the face and ribs (was this an outburst?). No faulting or other structure was obvious. The intended drainage hole became an exploration hole.

LOST GEAR RECOVERY

When drilling equipment is stuck in the hole, there are a few ways of attempting to recover it. Stories abound from the past of trying to pull the rods with a shuttle car or Eimco with varying success. Today, it is accepted that the best method is to overcore the rods and bottom-hole-assembly to free them. Recently, a set of gear was stuck at 960 m and then recovered by overcoring; this was a record.

CONCLUSIONS

In-seam drilling has advanced considerably in the last ten years in respect of the equipment used for drilling and surveying the holes and the expertise of the drillers. There is still much to be done to improve the collection of data from the hole for identification of geological structures and reporting of the data. The development of downhole probes for the detection of structures while drilling has been frustratingly slow.

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