TODAY'S DEGASIFICATION

With the worldwide coal industry in turmoil, Stephen Kravits Target Drilling, USA, explains the importance of comprehensive longwall degasification.

The worldwide coal industry is in turmoil. Despite unprecedented long-term demand, especially within the developing world, certain historical pockets of supply – such as North America – have experienced rapid decline. Survival requires management skills honed to higher levels not previously appreciated. These skills, in turn, must rely on evolving technologies like never before.

Because gassy coal cannot be efficiently extracted underground without prior, effective degasification of the coal seams being mined, the speed, predictability and cost of that process can and will bear heavily on whether coal mining can proceed within this challenging environment. Target Drilling Inc. and its affiliate, Target Technologies LLC, (both referred herein collectively as TDI), have continued to develop and refine directional drilling technologies that address these needs. Specialised techniques, coupled with newly engineered directional drilling equipment, have positioned TDI at the cutting edge of cost-effective degasification, facilitating profitable coal mining amid all the current market disruption.

Comprehensive longwall degasification

Surface horizontal wells and in-mine boreholes

TDI has been directionally drilling in-mine long degasification boreholes greater than 1219 m (4000 ft) to shield gate road development since its incorporation in 1995. To date,

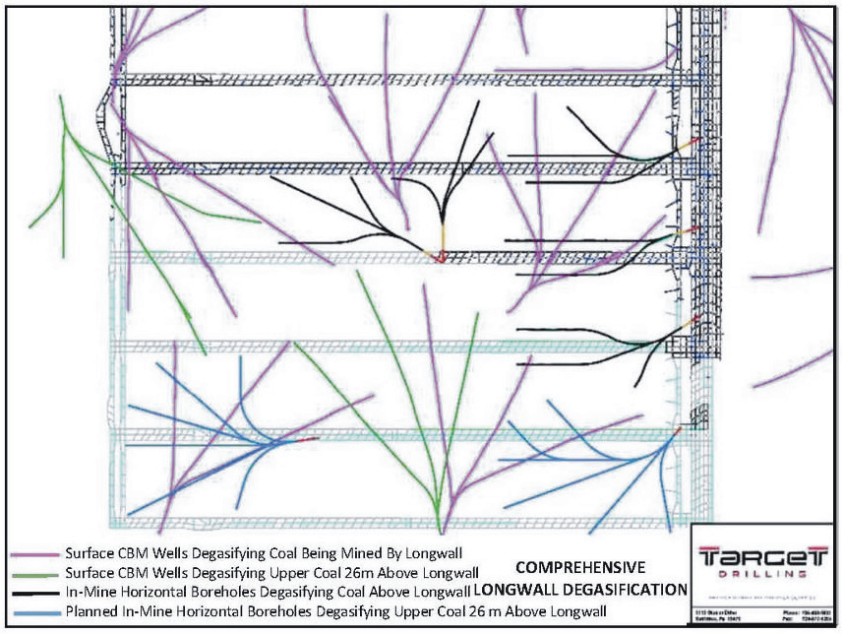

Figure 1. Comprehensive longwall degasification of the coal seam being mined by the longwall and the upper coal seam.

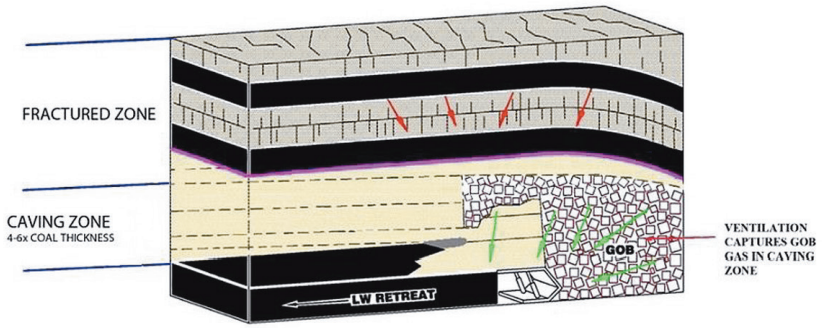

Figure 2. Sources of longwall gob gas can be coal seams located within the longwall gob caving and fractured zones.

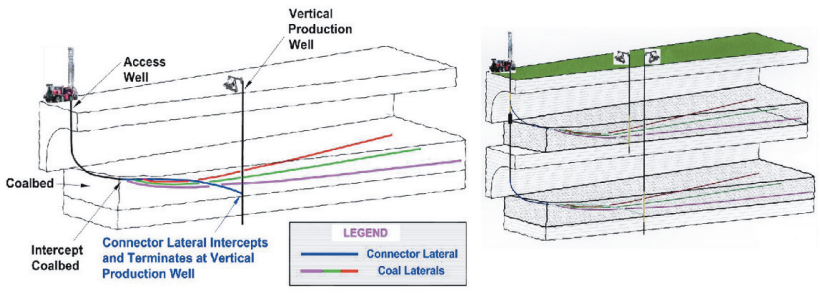

Figure 3. TDI's coalbed methane wells targeting the coal being longwall mined (left) and upper coal (right).

the firm has directionally drilled 203 in-mine boreholes for degasification and other applications. Implementing its in-mine coal seam horizontal directional drilling procedures and experience, combined with patented under-balanced dual well drilling methodology, TDI developed the capability to directionally drill surface coalbed methane (CBM) horizontal wells to degasify coal seams years in advance of mining (Figure 1).

Many coal basins throughout the world consist of numerous stacked coal seams separated by various types of rock. As the longwall is mined, the longwall gob is created. This consists of a caved zone, a fractured zone and bending or subsidence zone. If the coal(s) above the longwall (referred to as the upper coal) are within the fractured zone and contain methane, they are often the primary source(s) of longwall gob gas (Figure 2).

Ideally, it is most effective to degasify the upper coal in advance of mining to eliminate or significantly reduce future longwall production delays caused by gob gas. Evaluating the degasification time before longwall mining begins, in order to effectively degasify the upper coal, depends on its gas reservoir characteristics. These characteristics include, but are not limited to:

- Gas reservoir pressure.
- Gas content.
- Gas permeability.

These characteristics are factored into the design of the horizontal degasification strategy, which primarily comes down to the number of – and spacing between – in-mine horizontal boreholes or surface CBM coal laterals.

Drilling surface CBM horizontal wells years in advance of mining will result in more effective degasification of the upper coal seams. This helps to eliminate or significantly reduce longwall gob gas problems compared to in-mine boreholes, which typically have a much shorter productive life. TDI has successfully proven the effectiveness of degasifying the coal seam above the longwall – and the coal seam being longwall mined – using surface CBM horizontal wells in advance of mining (Figure 3).

However, in the US – and perhaps even more prevalent in other countries – surface access to directionally drill surface CBM horizontal wells targeting coal seams is not always available. Furthermore, other technical obstacles, such as drilling through mined-out coal seams above the current longwall, create numerous difficulties. The mine operator can either choose to dilute the longwall gob gas with ventilation, which might result in longwall production delays, or drill horizontal

boreholes, which target the upper coal(s) from inside the mine.

Case study

A longwall mine operator experienced the degasification (and dewatering) benefits of surface CBM horizontal wells, which targeted the coal being mined by the longwall and the upper coal nominally 26 m (85 ft) above the coal being longwall mined. These targeted areas had been previously proven to be the primary source of the mine operator's longwall gob gas. However, technical obstacles prevented horizontal degasification of the upper coal before longwall mining in their entire longwall district. Consequently, TDI was contracted to infill drill in-mine degasification boreholes, targeting the upper coal in advance of longwall mining where surface CBM horizontal wells could not be drilled (Figure 4).

To overcome the technical challenges of drilling in-mine boreholes, TDI used its permissible UDR rig, which is equipped with 150 hp, 258 kN (58 000 lb) of thrust/pullback, as well as two triplex high-pressure water pumps, which are able to deliver 452 l/min. (120 gal./min.) at up to 75 Bar (1100 psi). This facilitated drilling a 152 mm (6 in.) dia. directional borehole through unstable rock lithology to intercept the upper coal seam. The directional borehole was then cased with 102 mm (4 in.) inner dia. casing to isolate the unstable rock layers and provide an integral long-term connection to the upper coal seam during drilling and afterwards for methane production, in advance of, and during, longwall mining. To date, over 18 km (60 000 ft) of in-mine horizontal degasification boreholes have been drilled. These target the upper coal seam, thereby removing methane before and during longwall mining.

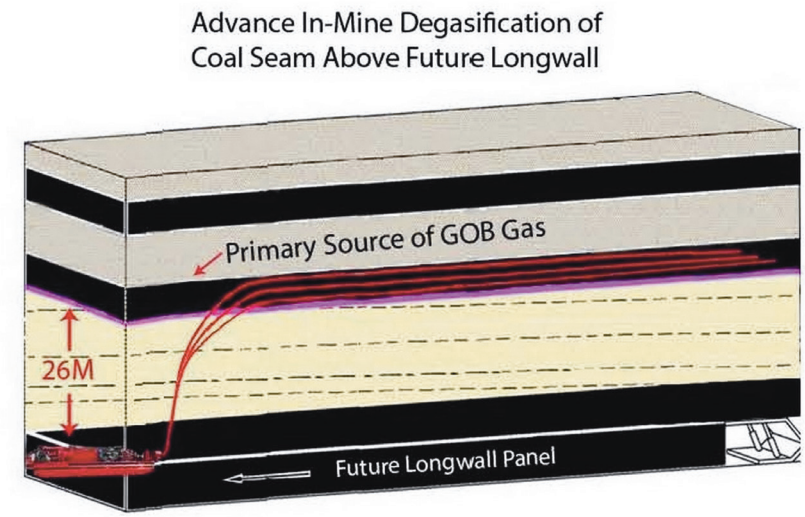

Figure 4. In-mine horizontal degasification of upper coal seam above longwall.

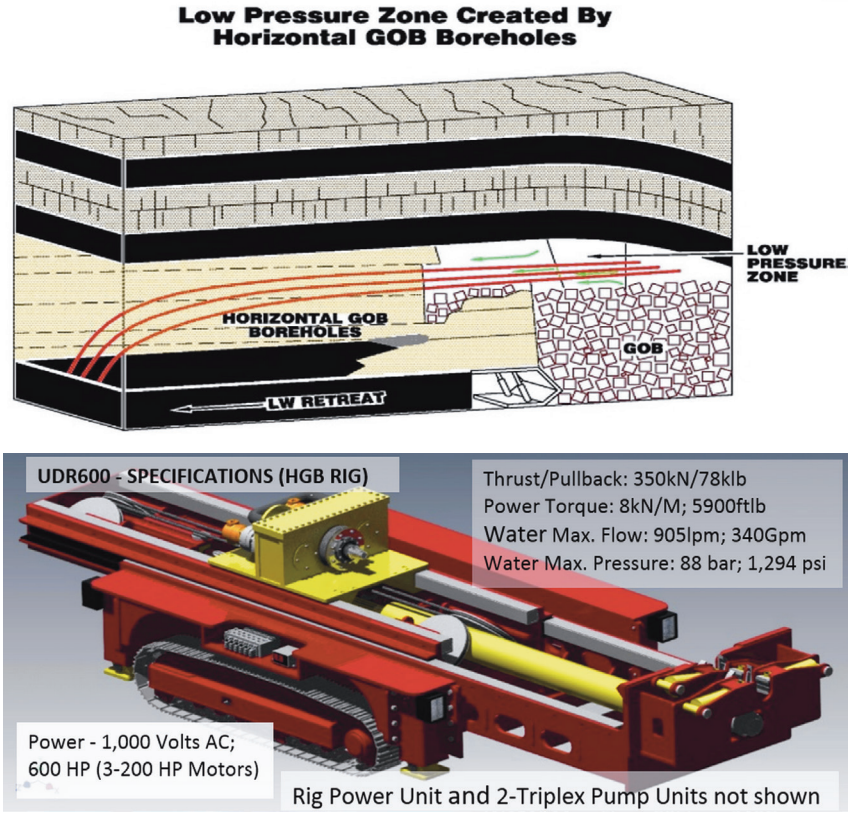

Figure 5. In-mine horizontal gob boreholes (top) drilled with TDI's UDR600 high-capacity rig (bottom).

In-mine boreholes

Targeting low permeability coal seams above the longwall

In Poland, Russia, China and elsewhere, coal seams in the longwall gob's fractured zone contain high gas contents of greater than 8 m^3/t (282 ft^3/t), relatively low permeability of less than 1 mD and high gas reservoir pressure. Effective degasification of these upper coal seams in advance of mining can require drilling years in advance due to their low permeability, even with a close spacing between in-mine boreholes or surface CBM coal laterals. When longwall mining occurs and the longwall gob is created, significant volumes of methane from these upper coals can be liberated into the mine ventilation system, thereby causing longwall production delays. In order to effectively capture methane liberations during longwall mining with in-mine horizontal boreholes or surface CBM horizontal laterals, a minimum of a 152 mm (6 in.) dia. for borehole lengths of over 1000 m (3280 ft) can be required to pull methane under partial vacuum at flow

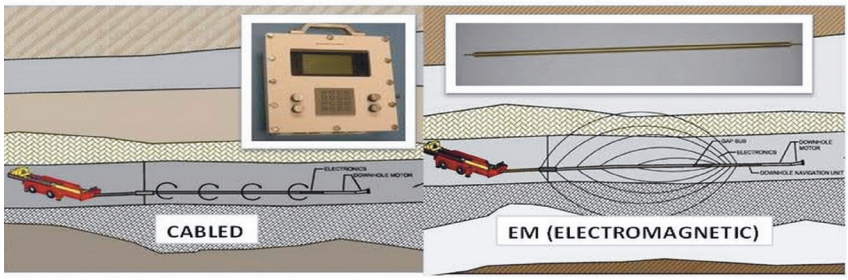

Figure 6. MagneStar™ Cabled MWD (left) and MagneStar™ EM MWD (right) steering systems, including photo of uphole unit (left) and downhole unit (right) of both systems.

Figure 7. Polymer gel mixing/pumping unit used to plug in-mine boreholes and CBM coal laterals. Plugging with polymer gel summary (top left), mixing polymer gel (top right), monitoring downhole gel pumping pressure (bottom left) and sampling mixed polymer gel per batch (bottom right).

rates of greater than 28 000 m^3/d (1 million ft^3/d).

TDI has designed a high-powered rig, called the UDR600, which is capable of directionally drilling in-mine horizontal degasification boreholes of 152 mm (6 in.) dia. in order to target upper coals above the longwall boreholes to depths of 2 km (6560 ft) (Figure 5).

Get steering

The cabled permissible steering system consists of a downhole unit and an operator controlled uphole unit (Figure 6). The system provides all the data required to enable a directional driller to steer to a desired horizontal borehole plan or desired well plan.

The electronics system of the downhole unit are contained in an explosion proof (XP) housing, called the instrument tube. This conforms to Mine Safety and Health Administration (MSHA) XP requirements. The orientation sensor package measures the borehole or well azimuth, pitch (inclination), roll, temperature, battery voltage and numerous diagnostic measurements to ensure proper downhole operation. The directional gamma sensor measures the natural gamma radiation in American Petroleum Institute (API) units in a focused window, which assists the directional driller in determining the lithology that was drilled about 3 m (10 ft) behind the drill bit. A communication link provides real-time data transmission via the coaxial pipe assembly in the drill pipe connected between the uphole unit and the downhole unit. The downhole unit replaceable battery pack provides continuous downhole operation for a minimum of 20 days.

The operator controlled uphole unit includes an LCD display, microprocessor board, four switches, keypad, communications link and rechargeable battery. The data provided to the operator includes, but is not limited to:

- Azimuth (0 – 360°).
- Pitch or inclination (+/- 90°).
- Toolface (0 – 360°) or roll.
- Deviation from the start of the borehole (left, right, up and down, or in elevation or co-ordinates).
- Measured borehole depth.
- Downtrack and vertical section.
- Sidetracking or branching.
- Comparison of as-built to the designed wellplan.

Additional features of the uphole unit include magnetic declination compensation and built-in diagnostics, which importantly alert the operator of uphole and downhole performance metrics. The uphole unit's internal battery provides 10 days of operation between charges.

The process of operating the system begins with inserting the downhole unit into the non-magnetic survey collar. The collar is integrated with the drill string and downhole motor. The uphole unit is directly connected to the drill pipe at the rig. As each drill pipe joint is added to the drill string – or alternatively while directional drilling – the operator can press the survey button, which captures a set of the continuous stream of downhole borehole survey data. This data is transmitted in real-time from the downhole unit and it is stored uphole. The operator evaluates the borehole navigation data and makes directional corrections to the borehole, as required, to maintain the desired course and elevation. This directional survey and steering process continues until the borehole is completed. As-built borehole or well survey positional processed data is continuously compared

to the designed well plan and archived in the uphole unit for later download and analysis.

TDI's MagneStar MWD™ EM (electromagnetic) steering system is, for the most part, a replica of the MagneStar MWD™ Cabled system. The key difference is that, in the new system, the transmission of borehole survey data occurs via the drill pipe and the earth, eliminating the costly coaxial cable assembly in the drill pipe. The MagneStar MWD EM survey system has been field tested with additional borehole tests planned. TDI's launch of the MagneStar MWD EM survey system is scheduled for 3Q15. Both the MagneStar MWD Cabled and EM survey systems can be used for in-mine permissible boreholes, as well as shallow surface horizontal wells to vertical depths of about 1000 m (3280 ft).

Plugging holes

MSHA requires mine operators that use either in-mine degasification boreholes or surface CBM horizontal well coal laterals to describe what material will be used to seal or plug the boreholes in their mine-through plan. TDI and its partner, Concrete Construction Materials (CCM), developed and continually refine their proprietary mix of polymer gel chemicals with water specifically tailored to the water chemistry, coal seam methane reservoir properties and other specific factors of the boreholes or coal laterals. To date, 119 594 m (658 540 ft) of in-mine degasification boreholes and CBM well coal laterals have been plugged with 3.26 million l (864 540 gal.) of polymer gel and water mix (Figure 7). TDI estimates several thousand mining intercepts of boreholes and CBM well coal laterals plugged with polymer gel have been experienced safely without serious incident.

Conclusion

Comprehensive longwall degasification has been achieved by implementing TDI's directional drilling of in-mine boreholes and surface CBM well coal laterals. This has been achieved by targeting the source of longwall gob gas: i.e., the longwall and upper coal seams. In a number of cases, TDI used its UDR underground rig to drill upper coal degasification boreholes. Borehole lengths greater than 1219 m (4000 ft) have been drilled to degasify the upper coal seam in advance of – and during – longwall mining, where CBM wells could not be drilled. TDI has designed a 600 hp underground horizontal rig, called the UDR600, to drill in-mine horizontal gob boreholes to target upper coal seams or rock strata above the longwall for degasification in advance of, and/or, during longwall mining.

TDI has developed and launched its permissible MagneStar MWD™ Cabled Survey System designed to conform to MSHA permissibility standards. The company is finalising the next evolution of this system called the MagneStar MWD™ EM Survey System, which will not require the coaxial cable assembly in the drill pipe, scheduled for launch later this year. Both systems can be used in-mine and on surface directional wells to vertical depths of about 1000 m (3280 ft). Lastly, TDI and CCM have plugged 119 594 m (658 540 ft) of in-mine degasification boreholes and CBM well coal laterals with 3.26 million l (864 540 gal.) of its proprietary mix of polymer gel chemicals, resulting in thousands of safe mining intercepts without incident. WC