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ABSTRACT: This paper discusses how careful evaluation of the geomechanical properties of gob can be applied to gob degasification techniques in order to improve gas production and quality. It further describes the “best practices” for each method that may increase methane capture and purity. In both the commonly used methods, the cross-measure boreholes and vertical gob wells, the factors affecting gas purity and capture efficiency are geologic and reservoir conditions, appropriate borehole siting, orientation and spacing, and borehole integrity. The best practices for the techniques that might improve gas production and/or quality include appropriate siting of the boreholes to maintain integrity, proper borehole inclination, adequacy of well spacing, and targeting stress relief zones. An important implementation with significant potential improvement is continuous monitoring of the gas flow rates, quality and system pressure.

1 INTRODUCTION

A gob, or gob area, is the region of fractured geologic material from overlying strata that settles into mined out areas after coal recovery. The overlying material relaxes after longwall mining operations have passed by, as shown on Figure 1, or after pillar removal in room and pillar mining method, as shown on Figure 2. The majority of methane emission into any mine working occurs as a result of destressing the overlying and underlying strata during mining. The amount of gas released from the gob areas into the mine depends on the method of mining, proximity of over and/or underlying gas bearing strata, gas content of the working and nearby seams, and geologic and reservoir characteristics.

The primary motive for gas recovery from the gob is to reduce methane emissions into mine workings and provide a safe environment for coal exploitation activities. The gas is recovered in some cases for commercial use although much of the gas emitted from gobs discharges to the atmosphere, either directly from the recovery system, or through the ventilation systems.

Gob degasification, the most common methane drainage technique practiced worldwide, takes place after the gob forms. However, gob gas recovery systems often produce gas with low methane concentrations. While some of the poor recovery results

from focusing attention to minimizing emissions into the mine, there is potential at many mines to increase recovery ratios (percent of total emissions) and decrease dilution levels by adopting improved degasification and collection systems, and modifying some of the operating techniques.

This paper first describes the three primary methods of longwall gob degasification techniques. It then presents a discussion of “best practices” for each method during the design, installation and operation phases to improve the recovery and purity of the recovered gas.

2 GOB GAS RECOVERY TECHNIQUES

The three gob degasification techniques used worldwide are the cross-measure boreholes, vertical gob wells, and superjacent method where degasification takes place from overlying galleries and boreholes. These are illustrated in Figure 3. This section presents a brief description of each of these practices and conditions suitable for their application.

2.1 *Cross-Measure Boreholes*

2.1.1 *Description and Application*

Cross-measure degasification of longwall gob regions is suited to all longwall operations. In this technique, small diameter boreholes (50 to 100 mm diameter) are drilled at angles from gateroad entries

Longwall Gob Fracture Zone

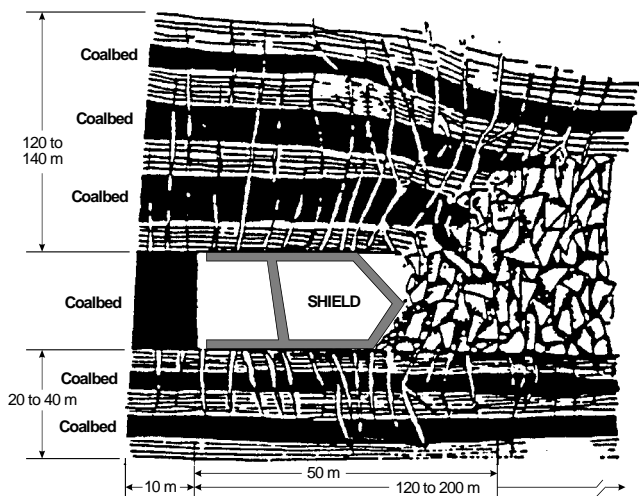


Figure 1. Side view of the effects of longwall mining on adjacent strata (Cervik, 1979).

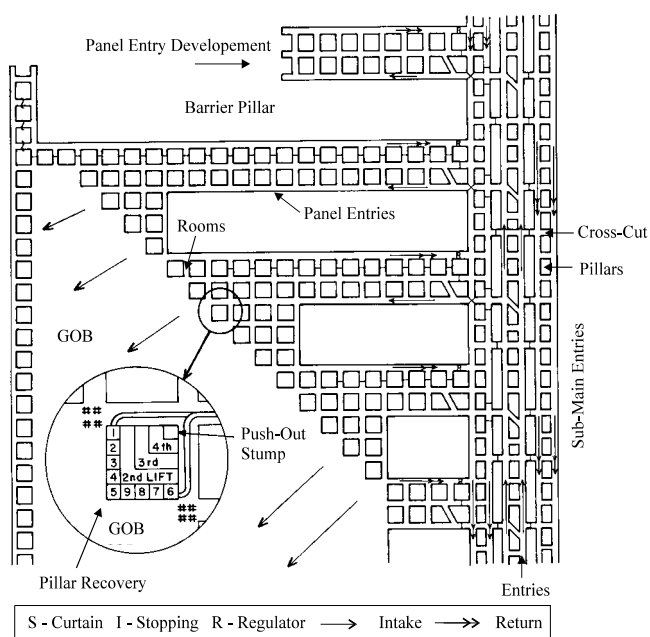


Figure 2. Plan view of a typical room and pillar mining panel in the U.S. (Stefanko, 1983).

up into overlying or down into underlying strata, in advance of the longwall face, as shown in Figure 4. In extremely gassy conditions, boreholes are placed from the intake as well as return entries surrounding the panel. Site specific conditions dictate the angle, length, and spacing of the boreholes. In order to maximize the connectivity with the gob and minimize inflow of mine air into the degasification system, a pipe is inserted and sealed (commonly known as a standpipe) into the initial borehole length. Cross-measure boreholes connect to a gas collection manifold that is normally under suction induced by a vacuum pump. Although suction (negative pressure) is the primary means of controlling the gas flow rate from cross-measure boreholes, it results in dilution with air, if not done carefully.

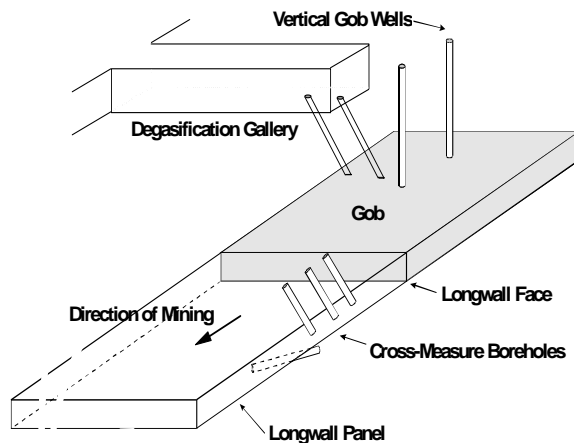


Figure 3. Schematic showing the different gob gas recovery methods.

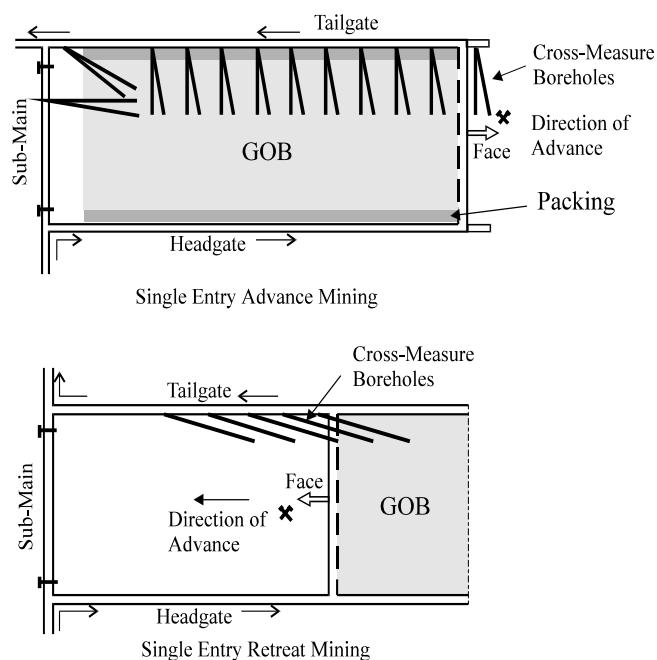


Figure 4. Cross-measure boreholes for longwall gob gas recovery for advancing and retreating operations.

The cross-measure technique of longwall gob degasification is the dominant method used in Europe and the C.I.S. where mostly advance longwall mining is practiced in multiple dipping coal seams, normally deeper than 600 m. Several US mines have tested cross-measure boreholes (Cervik & King, 1983) and found them effective where vertical gob wells could not be implemented because of surface constraints or other conditions.

2.1.2 Factors Impacting Cross-Measure Borehole Performance

The objective of cross-measure gob degasification is to provide a continuous low-pressure zone above the mined coalbed in order to minimize the emission of methane into the mine openings. The continuous low

pressure zone not only promotes downward migration of gas from overlying fractured strata, but also upward migration of mine ventilation air and gas released from the rubble zone in the gob. Methane capture efficiencies, defined as the ratio of the gas captured by the degasification system to that emitted into the ventilation system plus that captured, range from 20% to 70% with the cross-measure borehole technique (McPherson, 1993). Lower gas purities are typical with this system because of the connectivity between boreholes and the ventilation system. The important factors affecting gas purity and capture efficiency of the cross-measure borehole technique are as follows:

1. **Geologic and Reservoir Conditions:** Although predictive techniques account for these conditions and assist the design work (McPherson, 1993; Lunarawski, 1995), most system parameters reach optimization only through trial and error during implementation. Cross-measure boreholes are most productive when targeted at the highest overlying or the lowest underlying source seam. These can be coalbeds, shales with high organic contents, or pervious sandstones overlain (or underlain) by impermeable shale beds. Fractures generated by longwall mining break up the impervious layers increasing the permeability of naturally tight strata, sometimes by order(s) of magnitude. These fractures can extend to source beds 200 or more meters above the mined seam during longwall mining (Cervik & King, 1983). Since the objective of the cross-measure system is to extend the borehole into the fractured region of the gob where the strata remains reasonably intact (above the rubble zone), the geomechanical characteristics of the strata and the impact of mining are important in estimating the location of that region.

2. **Borehole Siting:** The cross-measure borehole collar location and its integrity is critical to its performance, and recovered gas quality. As lithostatic stresses redistribute to side abutments, fractures propagate along the mine roof and significantly impact cross-measure borehole performance by serving as conduits for mine ventilation air. If connectivity exists between the borehole and the mine ventilation system, wellhead suction pressure will tend to draw in air from the mine ventilation system, rather than gas from the gob, resulting in poor gas quality. Often, extensive standpipe configurations and perforated casing have been resorted to in order to maintain borehole integrity.

3. **Borehole Orientation:** Borehole orientation pertains to the vertical angle, horizontal angle, and the penetration distance into the gob.

- **Vertical Angle:** A borehole should be angled so that its furthest extent is situated in the fractured zone above the rubble after the gob is formed. If the borehole extends only to the rubble zone, it will be more prone to drawing mine ventilation

air, thus impairing its effectiveness and gas quality. The upper limit of vertical inclination depends on the width of the longwall panel, depth below surface, thickness of the mined seam, site specific geomechanical properties of the strata, drilling space available, and limitations of the drilling equipment.

- **Horizontal Angle:** Typical cross-measure boreholes in retreating longwalls angle toward the faceline on the horizontal plane. Studies have shown that most of the gob gas emits from the newly fractured strata and stress relaxation zone behind the faceline. The boreholes should, therefore, be angled to intercept this zone with the holes' furthest point of projection.
- **Borehole Penetration:** Cross-measure system tests along return gateroads have shown that a borehole's horizontal projection over the longwall rib does not need to be very long. In fact, 30 m horizontal projection was sufficient to obtain capture efficiencies of 70 percent with this system during tests in the US. (Garcia & Cervik, 1985).

4. **Borehole Locations Along Panels:** The mine ventilation system has a direct influence on gas accumulation in the gob because gas migrates toward the low pressure side of the gob adjacent to the return airway (typically the tailgate entry in the US). Cross-measure boreholes developed from the return entry normally provide sufficient reduction of gas emissions from the gob into the workings. In very gassy conditions, boreholes are required from both sides of the panel.

5. **Borehole Spacing:** In order to produce a continuous low-pressure zone over the gob using the cross-measure system, boreholes need to be spaced such that their influence zones overlap slightly. If boreholes are too far apart, then the accumulated gas between boreholes will tend to migrate towards the nearest mine entry. If the boreholes are spaced too close together, they may promote migration of mine ventilating air into the gob, reducing the recovered gas quality. Borehole spacing of 60 to 75 m proved effective in US tests (Garcia & Cervik, 1985).

2.2 Vertical Gob Wells

2.2.1 Description and Application

The predominant gob degasification technique applied in the US uses vertical wells developed in advance of mining from the surface, typically at depths less than 600 m. As with all gob degasification techniques, the methane quality and quantity produced from these wells vary, depending on site specific geological, reservoir, mining, degasification and ventilation practices at the mine.

The usual practice is to drill large diameter (up to 300 mm) vertical gob wells in advance of mining to within 10 to 30 m above the working coal seam. The

wells are cased and cemented to a point just above the uppermost coal seam or gas bearing strata believed capable of liberating gas as a result of the longwall mining operation. The lower portion of the well is left open or completed with slotted casing.

In general, the highest gas production occurs at the beginning and end of the longwall panel. Therefore, it is a common practice to concentrate gob wells along the front of the panel and space them at increasing intervals along the panel. Subject to surface constraints, the current practice is to place vertical gob wells off center of the long axis of the panel in an attempt to target tension zones and avoid the zone of highest overburden compaction.

A vacuum is applied to the gob wellhead to enhance production. At some mining operations, such as the Jim Walter Resources mines in Alabama, where overlying gas bearing strata of high gas content are present, and where gob permeabilities are very high, excellent production rates and high gas qualities are maintained with suction and proper monitoring and control. In this case, the gas produced is of pipeline quality and is commercialized.

This technique is capable of degasifying longwall gobs developed in retreat and in advance. However, experience using the technique with advancing operations is limited (Thakur, 1985). Vertical gob wells are also used in the C.I.S. countries and China when subsurface degasification measures are inadequate, and surface access is available.

Vertical gob wells are difficult to apply to mines developed under urban areas, mines overlain with rugged topography, and where surface right-of-way is limited. There must be sufficient space to drill each well in its correct location and for surface infrastructure that supports the well sites.

2.2.2 *Factors Impacting System Performance of Vertical Gob Wells*

Vertical gob wells, when used in favorable geologic and reservoir setting, have claimed high methane capture efficiencies. Mining operations with overlying gas-bearing strata exhibiting high gob permeabilities have been able to obtain high gas purities with this system. As with all gob gas recovery methods, intrusion of mine ventilation air is common because of the connectivity between the borehole and ventilation system. The important factors that impact gas capture efficiency and gas purity are as follows:

1. **Geologic and Reservoir Conditions:** Gob gas production characteristics depend upon overlying and underlying strata and the extent of fracturing and separation as a result of mining. The fractures serve to conduct gas that may otherwise be impeded by low permeable or impermeable measures. Anticipated characteristics of the gob must be considered in the design of a vertical gob well installation and completion plan. Gob wells must be designed to re-

main competent after under-mining, with the ability to collect gas from fractures or strata separations that occur at significant distances above the mined seam. In some cases, inflows of gas have been observed from strata separations as high as 100 m above the mined seam (Mazza & Mlinar, 1977).

Water bearing strata pose further concerns, as these must be isolated from the well and mine workings by proper well casing cementation. In some cases, significant water inflow is unavoidable and may worsen after mining because of increased conductivity exhibited by fractured strata (Diamond, 1995).

2. **Mining Factors:** Gob well performance records indicate that well productivity is linked to the dynamic creation of the gob and is dependent on the volume of coal extracted. At many US operations, gob gas production rates depend on the longwall face advance rate. A two to three fold increase in gob gas production rate with increased longwall face productivity has been reported. However, data in a region where panels advance at various rates (and with varying number of gob wells per panel) show that cumulative gas recoveries for each panel are similar (Diamond, 1995).

A typical gob well usually attains a peak production rate as the face undermines the well, and then declines exponentially until stabilizing at a much lower rate that depends on the mining advance rate. Peak performance typically occurs when the face approaches within about 6 m (horizontally) of the gob well, after which peak production may last for several days. Studies of gob wells have indicated that between 40 to 55 percent of the total gas recovered from vertical gob wells flows after mining of the entire panel (Diamond, 1995). This result is site specific and dependent upon the geologic and reservoir characteristics of the neighboring strata and gob permeability.

Gob well performance research also links longwall panel size and seam height to gas production characteristics. Gob fracture development is much greater after mining of a large volume of coal. Furthermore, extraction of a thin coal seam tends to produce gobs with lower fracture permeability and a lower gas yield. In fact, results of several studies indicate that gob wells associated with thin seams are more conducive to intrusion of mine ventilation air, particularly if subjected to a vacuum at the wellhead (Mazza & Mlinar, 1977).

3. **Well Siting:** Adjacent well performance often dictates vertical well locations. An optimal location should be selected for the first well on a panel. Its production record should then be evaluated to help locate the succeeding wells. Based on production data, the succeeding gob wells are concentrated near the start of longwall panels and the adjacent wells are placed at increasing spacing along the panel as mining progresses. To successfully apply vertical

gob wells, it is important to ensure that there is flexibility to decide upon the exact well locations shortly before drilling.

Production figures show that wells positioned at the start and end of panels produce the most gas. This occurs because these wells intercept the strata within the zone of tension between the barrier pillar (at the start and end of the panels) and the two adjacent pillar lines. Because of the aspect ratio (the ratio of length over width) of the longwall panel, the tension zones at the ends of the panel are typically much greater than those alongside the pillar lines paralleling the panel. It is in the tension zones where the fractures generated by longwall mining activity tend to maintain their aperture, and where gob permeabilities are the highest.

4. Well Completion: A high performance gob well must maintain wellbore integrity as well as connectivity with the fracture zone. Gob well completion concerns include vertical placement of the well within the gob, maintaining borehole integrity and productivity after under-mining, and isolating water-bearing horizons.

Vertical placement of the gob wells in advance of mining is relatively easy, but maintaining the integrity of the well after formation of the gob is more difficult. In the US, C.I.S. countries, and China, where vertical gob wells are employed, slotted casing is used to maintain hole stability in the gob's fracture zone. The slotted casing is installed so that it extends from the highest producing source seam or stratigraphic separation to just above the lowest point of the well. The remaining wellbore is left uncased. Where there are stratigraphic horizons with weak geomechanical characteristics, modifications to completion techniques are necessary. For example, the slotted casing may need to extend above these horizons to avoid blockage or casing collapse, both of which inhibit gas production.

It is a common practice to line gob wells from the wellhead down to the slotted casing with solid steel cemented in place. The intention is to provide well stability in the upper horizons and to isolate any intercepted water-bearing strata from the well, the gob, and the mine.

2.3 Superjacent Techniques

2.3.1 Description and Application

Some gassy, deep underground operations in Eastern Europe, the C.I.S., and China recover methane using the superjacent techniques. The principal task in this technique is to prepare long drainage boreholes or galleries in advance of mining, in overlying or underlying strata (rock or coal). In some cases, small diameter, short boreholes are developed extending from the galleries into strata overlying the gob. Operators either construct seals in the galleries with connections to an underground gas collection

system, or directly tie the boreholes into the gas collection system.

Overlying galleries serve as useful platforms for targeting the fractured zones over longwall gobs. Figure 5 illustrates two superjacent gob drainage techniques used in Eastern European mines. Figure 6 illustrates the application of superjacent horizontal boreholes for initial pre-mining degasification of an underlying coalbed and subsequent use for gob degasification implemented in Australia. These are 70 to 90 mm diameter boreholes directionally controlled to lengths in excess of 1000 m.

Superjacent gob degasification techniques are a viable alternative to cross-measure boreholes and vertical gob wells when these methods are not effective at controlling gob gas emissions, or where surface access does not permit their use. Unless there are existing upper working levels, the superjacent gallery system is prohibitively costly to implement and used only in extreme circumstances. Therefore, the technique (from galleries) is more common in multi-level mining regions where existing mine workings can support these developments.

For some mining operations, directionally drilled superjacent boreholes may prove less costly to implement and easier to operate than cross-measure boreholes, or a system involving superjacent galleries, particularly if the galleries are developed solely for the purposes of degasification.

2.3.2 Factors Impacting Degasification Performance using Superjacent Methods

The objective of gob degasification using the superjacent technique is to provide more immediate and independent access to overlying strata that will fracture as a result of longwall mining. The system enables placing galleries and/or boreholes from non-production areas that are free of equipment and production related inconveniences. It also facilitates placement of boreholes in advance of the mining face for both advancing and retreating systems. Generally, superjacent methods result in methane capture efficiencies of up to 80 percent. For Chinese operations, efficiencies as high as 90 percent with superjacent galleries have been reported (Liu & Bai, 1997). As with the first two methods, gob gas drainage capture efficiency and gas purity for superjacent systems are impacted by the following factors:

1. Geologic and Reservoir Conditions: The geomechanical characteristics of the overlying and underlying strata, the fracture characteristics of the gob as it forms, the resulting gob permeability, and proximity of source seams to the mined horizon must be considered. Additional geological factors to consider include collected water from upper strata and drilling fluids which can inhibit gas production, particularly for boreholes developed to target seams below superjacent galleries. Similar to cross-measure bore-

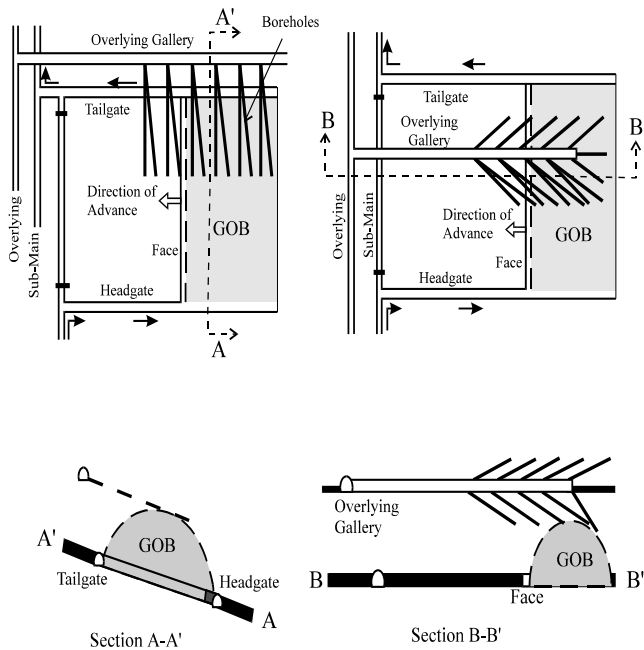


Figure 5. Degasification of gob areas using superjacent method in Eastern Europe (Wisniewski, 1994).

holes developed below the working horizon, these holes may not produce gas until the water migrates through fractures that will develop during mining. With longer horizontal superjacent boreholes, as shown on Figure 6, deviations in borehole trajectory can produce water collection areas impeding gas flow.

2. Gallery and/or Borehole Integrity: Superjacent galleries, boreholes drilled from these galleries, and long superjacent boreholes, are susceptible to integrity problems. However, they are not plagued by fractures in the vicinity of the standpipe and collar that typically affect cross-measure boreholes. Boreholes drilled from galleries and long superjacent boreholes generally originate from competent stratigraphic horizons, and enable recovering higher quality gas than with cross-measure boreholes.

3. Borehole Orientation, Size and Spacing: When developing superjacent boreholes, the contributing source seams are targeted and the holes are positioned away from the gob rubble zone to take advantage of the fracture network created by longwall mining. Borehole orientation, size, and spacing requirements depend on the height of the target location relative to the mined seam, anticipated gob gas volumes, available suction pressures, and the mine ventilation system.

- Orientation: The superjacent boreholes are oriented to reach the lowest known source seams, and positioned in the fractured zone, not the rubble, when the gob is formed. Borehole orientation designs consider the stress relief zone behind the face, the less consolidated regions along the perimeter of the gob, and gas migration resulting from mine ventilation pressures.

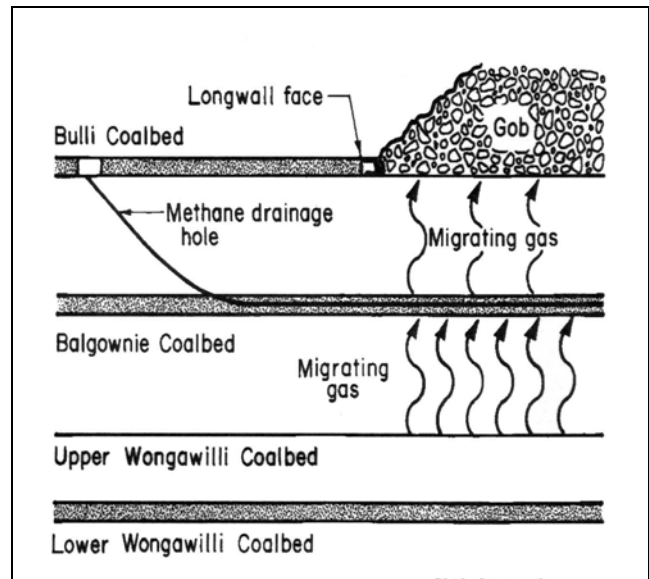


Figure 6. Superjacent borehole drilled into an underlying coalbed in Australia (Diamond, 1993).

- Borehole Spacing and Size: To develop a continuous low pressure zone over the gob, superjacent boreholes are developed at appropriate sizes and spacing so that borehole influence zones overlap slightly. As with the cross-measure system, if boreholes are insufficiently sized and spaced apart, gob gases will tend to migrate to the mine entry. If boreholes are over-designed and too close together, they may promote migration of mine ventilating air into the gob.

3 PRACTICES FOR ENHANCED GOB GAS RECOVERY

3.1 Best Practices in Cross-Measure Borehole Technique

This section presents low cost practices for the cross-measure borehole technique that would improve gas production and/or quality of the recovered gas.

1. Site Boreholes to Maintain Integrity: With re-treating longwall systems, where multiple entries are used, it is recommended that the borehole be initiated over the immediate adjacent pillar line to provide additional protection from the nearby fractured environment. Crosscuts should be avoided as they are susceptible to fracturing after the face passes. With advancing systems, additional roof supports, such as substantial packing walls, arches, etc., should be installed at the immediate borehole location to assist in protecting the initial length of the boreholes. The practice results in improved borehole stability, thus preventing intrusion of air and improving the gas quality.

2. Grout Borehole Collars: A grout annuli of 20 mm are effective in the cross-measure borehole technique (Garcia & Cervik, 1985). The grout should be pumped into the standpipe and extruded through the annuli, or fed directly into the packed off annulus with a system of grout supply and air relief tubing. The practice results in a significant improvement in the integrity of the borehole near the collar and prevention of intrusion of mine air. In the case of advancing systems, where the life of a degasification borehole is much longer, the practice would also serve to increase the productive life of the well.

3. Increase Vertical Angle: Studies indicate that boreholes at higher vertical angles have a longer productive life and tend to produce purer methane. However, for every gob, there is an optimum angle, and exceeding it will impair its performance. This optimum must be determined by modeling if practical, or by field trials.

4. Increase Horizontal Angle: For retreating systems, particularly ones with single entry gateroads, the boreholes must be angled towards the faceline to intercept the relaxation zone. For advancing systems, cross-measure boreholes may be driven at less acute angles to the faceline. The "relaxed" zone has higher permeability, and in the case of retreating systems where the life of the well is somewhat limited, the practice results in higher gas production.

5. Shorten Horizontal Projection: The horizontal projection of cross-measure boreholes need not be extensive to be effective. Researchers suggest that shorter holes may be as productive as ones with long horizontal projection. Implementing this practice may, in fact, result in some cost saving (relates to reduced hole length) without any loss in gas production rates.

6. Test Adequacy of Well Spacing and Suction Pressure: The adequacy of borehole spacing must be tested by shutting-in adjacent boreholes and observing gas quality changes and impacts on methane concentrations in the district return. This test assists in determining optimum borehole spacing and suction pressure, the two most important factors impacting gas production rates and gas quality with cross-measure boreholes.

7. Decrease Borehole Spacing at Ends of Panels: Studies have shown that decreasing borehole spacing near the start and ends of new panels (or adding new boreholes to an existing configuration) to accommodate the gas generated in these large tension zones significantly improve the production of gas. Since the tension zones are more fractured, the permeability is greater, and higher gas flow rates and capture efficiencies are achievable. Studies indicate that panel ends contribute to approximately 35 percent of total gob gas recovered by methane drainage systems (Diamond, 1995).

3.2 *Best Practices in Vertical Gob Well Technique*

1. Install Wells in Advance of Mining: Success with vertical wells drilled into gobs developed after longwall mining has been very low (Li et al, 1997). Better conditions have been encountered when gob wells are drilled and completed in advance of mining.

2. Target Stress Relief Zones: Gob wells located within the tension zones produce gas at higher flow rates and for greater durations than wells positioned along the centerline of panels. Test results have shown that offset wells produce 30 to 55 percent more gas than centerline wells on a cumulative basis.

3. Experiment with Shorter Completions: It has been noted that shorter completions, 30 m above the mined seam for example, produce as effectively as completions that are much closer to the mined seam.

4. Use Surface and Slotted Casing: Wells that are completed mostly "open hole", and extend into the rubble zone, commonly encounter water problems or shear after under-mining which limits the productive life of the well. Proper surface casing to isolate surface water bearing zones avoids water accumulation, while slotted casing minimizes the potential of shearing and a short productive life.

3.3 *Best Practices in Superjacent Technique*

1. Target Stress Relief Zones: As discussed previously, margin zones, where the overlying strata remains in tension after under-mining prevalent at the ends and along the sides of longwall panels produce more gas than consolidated regions within the center of the gob. Superjacent boreholes and galleries should target these high permeability zones to improve gas production rates. Proper implementation of this practice includes determining the extent of these zones, either through modeling, field experimentation, or analysis of ground subsidence data.

2. Develop Fewer, Larger Diameter Boreholes from Galleries: Fewer, further spaced, larger diameter boreholes (75 - 100 mm) developed from superjacent galleries may recover more gas than smaller diameter closely spaced holes. The Weymouth formula should be used to assist in selecting the optimum borehole diameter (i.e. the capacity increases as a function of the diameter raised to the exponent of 2.667) for any given production rate and pressure differential (anticipated gob gas pressure minus inlet suction pressure). Applying this practice results in less drilling, fewer wellhead connections, minimized leakage, and improved system operation and control. The benefit of the practice is an improvement in gas production rate and quality, and ease of maintenance.

3. Maximize Use of Directional Steering Capability to Minimize Water Problems and Increase Bore-

hole Surface Areas with Superjacent Boreholes: Because of the steering capability of directional drilling equipment, a multitude of deviated, tangential boreholes can be developed from a single initial superjacent borehole. Once the main borehole has reached the desired horizontal level, horizontal boreholes in a general downgrade direction should be developed, and deviated holes should be developed in order to enlarge the zone of reduced pressure over the gob. This practice increases the extent of the low pressure horizon over the gob, and mitigates water accumulation problems which may impair gas production with this technique.

4 SUMMARY

This paper has considered the important factors in applying gob degasification techniques to increase gob gas production and improve recovered gas quality. The significance of evaluating the geological, reservoir and geomechanical properties of gob, overlying and underlying strata, and their importance in identifying optimum borehole/well location, orientation, inclination, length, integrity and longevity, etc. have been discussed. Specific, effective, low cost practices that can improve the productivity and gas quality recovered from existing systems have been presented. The practices cover a wide range, including assessment of gob properties, borehole (well) siting or placement considerations, borehole integrity, and directional drilling.

Since gas quality, gas flow rate, and system pressure are the three characteristics of gob gas drainage systems, these should be monitored carefully and continuously. In fact, monitoring throughout the life of a degasification system is another important practice that can make a significant difference in gas production and quality. Continuous monitoring, though more costly requiring transmission to a central location for data analysis and system surveillance, might prove to be an asset for large scale commercial operations that are concerned with gas quality. Finally, the potential of directional drilling to displace costly in-mine gob degasification systems and improve recovery efficiency and increase recovered gas quality can not possibly be overemphasized.

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