Development and application of reservoir models for the evaluation and optimization of longwall methane control systems

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ABSTRACT: Methane explosions have historically been one of the major causes of fatalities and injuries in underground coal mining operations. Advanced numerical models and predictive modeling approaches have the potential to offer optimized methane control solutions for general mine planning purposes and to address specific methane-related operational problems. This paper describes the development of reservoir models for the longwall mining environment and their application for investigating the influence of various completion design parameters on the methane drainage effectiveness of gob gas ventholes. The influence of increasing longwall panel width on the effectiveness of current gob gas venthole completion and placement strategies in the Pittsburgh Coalbed were evaluated and optimized designs developed to capture the expected increase in methane emissions on the larger panel.

1 INTRODUCTION

Comprehensive assessments of the need for additional methane control capacity beyond ventilation often require both an empirical and theoretical approach for an adequate or timely control of increased methane emission levels. Thus, the prediction of methane emissions and optimization of methane control systems prior to starting a new mining operation will be a major improvement towards eliminating the explosions in the underground workplace.

During longwall mining, the caving of immediate strata and stress relief create horizontal fractures along bedding planes and vertical fractures in the strata overlying the caved zone. These fractures provide an extensive pathway for gas migration from the surrounding coalbeds and other gas bearing strata into the longwall mining environment (Fig. 1).

The thickness of the fractured zone can vary up to 100 times the height of the mined coalbed (Palchik 2003). The fractured and caved rock mass left behind the advancing longwall face is generally referred to collectively as "gob" (Fig. 1). The methane that originates and accumulates in the gob above the mined-out longwall panel is the main source of potential gas emissions during longwall mining.

Gob gas extraction in the Northeastern U.S. is almost exclusively accomplished using ventholes that are drilled from the surface to within a short distance [typically 10-15 m (30-45 ft)] of the coalbed being mined (Diamond 1994). Commonly, the bottom section of the well casing [generally about 60 m (200 ft)] is slotted. The gob gas ventholes generally become productive only when the mining-induced fractures are created as mining advances under the venthole (Diamond 1994).

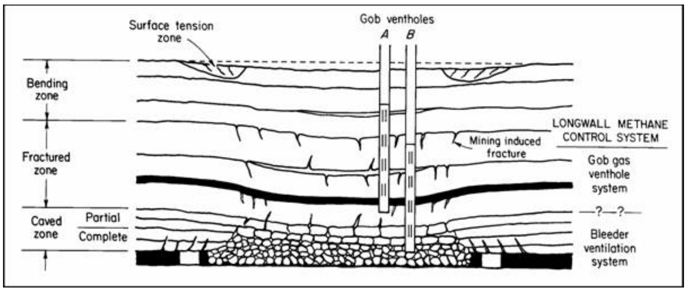

Figure 1 Schematic cross-section view of subsided strata zones and methane control system influence zones above mined-out longwall panel (Mucho et al. 2000).

Numerical models offer effective capabilities for predicting methane emissions, and designing drainage systems accordingly. There have been reported studies using computational fluid dynamics (CFD), boundary element and finite element modeling (FEM) techniques to better characterize the parameters for gas emission prediction [Ren & Edwards (2002), Lunarzewski (1998), Tomita et al. (2003)].

Reservoir simulators developed over the years can represent the complex reservoir flow mechanisms in coalbeds (King & Ertekin 1991). However, a comprehensive reservoir model capable of realistically representing various aspects of mining operations and production from gob gas ventholes has not previously existed. In one study, Zuber (1997) modeled the face and rib emissions during development mining. Karacan et al. (in prep., 2005) and Esterhuizen & Karacan (2005) have developed "dynamic" reservoir models that include the subsided strata above the mined panel during longwall mining to evaluate methane emissions and various gob gas venthole design factors for their impact on gas drainage efficiencies.

2 MODEL DEVELOPMENT

The models summarized in this paper were developed for mine sites operating in the Pittsburgh Coalbed in the Southwestern Pennsylvania section of the Northern Appalachian Basin. The reservoir models were constructed using Computer Modeling Group's (2003) GEM compositional reservoir simulator.

2.1 *General description of the mine sites*

Overburden depths in the area range between 152 and 274 m (500 and 900 ft). Longwall panels in the old mining districts of this mine were around 253 m (830 ft) wide and were increased to 305 m (1000 ft). In the new districts, the panel widths were originally 430 m (1250 ft); however, the first 480 m (1450 ft) wide panel is currently being mined. Thus, all the panels, particularly the recent ones, are supercritical, which results in a more complete caving of the overburden strata into the mine void.

A generalized stratigraphic section for the study area is shown in Figure 2. Several coalbeds with a combined thickness of almost 3 m (10 ft) are present in the 26 m (85 ft) of strata immediately above the Pittsburgh Coalbed. Within this interval, the thickest coalbed is the Sewickley, which is about 25 m (75 ft) above the Pittsburgh Coalbed. Between these two major coalbeds, there are comparably thin Pittsburgh rider coals and the discontinuous Redstone Coalbed, which are contained in the caved zone after panel extraction (Fig. 1). The gas emissions associated with the caved zone report to the bleeder ventilation system (Mucho et al. 2000). In some parts of the study area a sandstone paleochannel replaces the shale unit usually present above the Pittsburgh Coalbed. The thickness of the paleochannel varies between 0-13 m (0-40 ft). Regionally, the Sewickley Coalbed may split into two separate benches, and its height above the Pittsburgh Coalbed may vary. Gas contained in the fractured zone (Fig. 1), in particular, gas in the Sewickley Coalbed, primarily reports to the gob gas ventholes, if they are present and operational (Mucho et al. 2000).

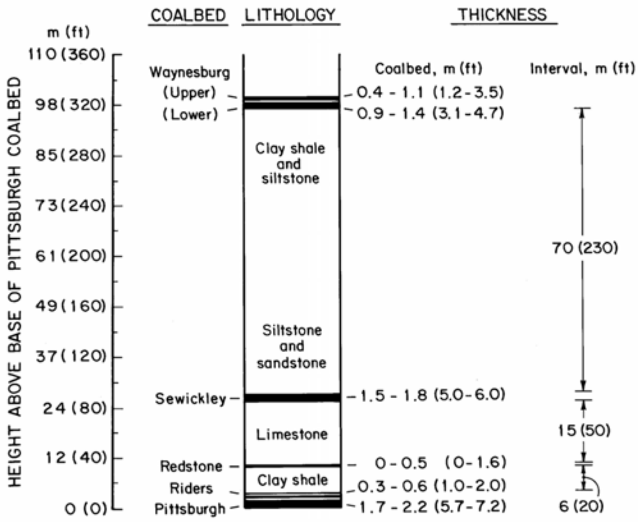

Figure 2. A generalized stratigraphic section of the strata above the Pittsburgh Coalbed in the study area (Mucho et al. 2000).

2.2 *Grid model generation for longwall sites*

In order to model the longwall mining process and analyze the associated methane control systems, a three-dimensional grid model of the mine site has to be created. The horizontal dimension of the grid models were usually determined based on the problem type and the total area of interest. The number of vertical layers and their thicknesses were based on generalized stratigraphic sections for the mine site.

The Pittsburgh Coalbed (mining) layer was constructed differently from the other layers in the grid model to host both the mined and unmined Pittsburgh Coalbed, and the entries surrounding the longwall panels. An example showing this structure for one of the study sites is given in Figure 3.

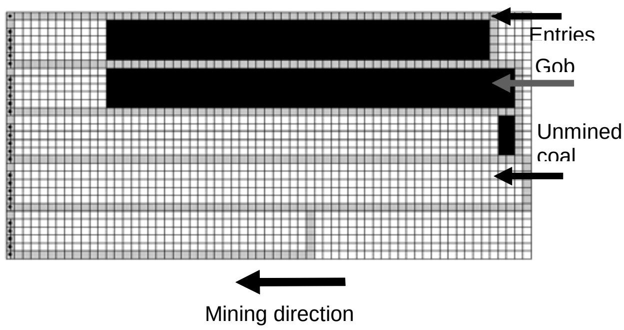

Figure 3. Pittsburgh Coalbed layer as represented in the models.

2.3 *Gob gas ventholes and the pseudo-ventilation system*

A simplified version of the ventilation system was incorporated into the model. For each panel, a set of wells injecting air into the entries with a rate constraint of 1700 m^3/min (60,000 cfm) represented the air intake part of the ventilation system. The exhausting bleeder fan at the top of a 1.8-m (6-ft) diameter air shaft was modeled with a large-diameter vertical well on the tailgate side of the panel and operated with a bottom-hole pressure constraint of 1.36 KPa (0.2 psia) negative pressure.

The locations of gob gas ventholes in the model were determined based on their locations on the study panels, and they were configured based on their actual reported completion data. The ventholes are usually drilled to within about 12-13 m (40-45 ft) of the top of the Pittsburgh Coalbed at this mine site, and 17.8-cm (7-in) casing, with 61 m (200 ft) of slotted pipe on the bottom is installed as shown for Venthole A, Figure 1. However, in some case, the ventholes were drilled closer to the mining horizon and into the caved zone (Venthole B, Fig. 1), which affects their performance, as will be discussed in the following sections.

2.4 *Geomechanical calculations for strata response and permeability changes*

The geomechanical, fast lagrangian analysis of continua (FLAC) model (Ithasca Consulting Group, Inc. 2000) was used to evaluate the effects of longwall mining on the surrounding rock mass and to calculate mining-related permeability changes.

Calculation of permeability changes was accomplished using the final stress and rock failure distributions from the FLAC model runs, and employing empirical relations [Ren & Edwards (2002), Lowndes et al. (2002)]. Details of the model development, permeability calculations, and geomechanical analysis are given in Esterhuizen & Karacan (2005).

2.5 *Simulation and model-calibration strategy*

During longwall mining, the strata disturbances and the onset of production in successive gob gas ventholes move along with the face, This leads to a moving-boundary problem in modeling, which was addressed with "restart" models. Each model restart run was performed so that it would progress up to either the next venthole location or to a defined location on the panel for the distance and time characterizing the intervening face movement (Karacan et al. in prep.). The reservoir-parameter changes were incorporated into the model as the face was advanced between restarts during calibration and prediction runs.

3 MODEL APPLICATIONS

Figures 4 and 5 show the two grid models constructed for this study. In both figures, only the coalbeds are depicted to improve the visualization. The models were calibrated by matching the measured gas production rates, methane concentrations in the produced gas stream, and the flowing bottom-hole pressures.

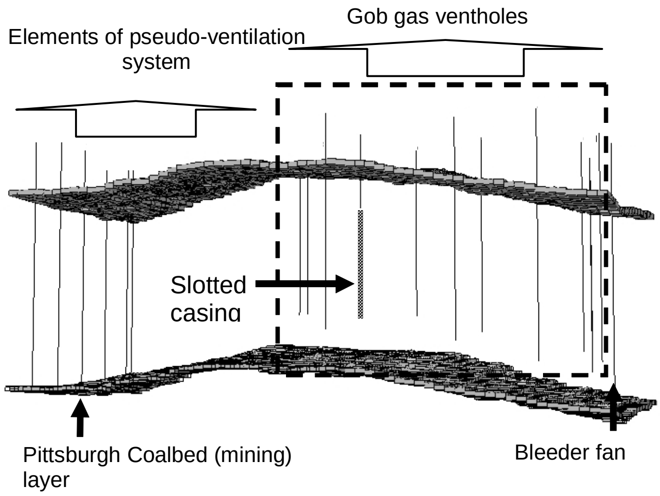

Figure 4. Study mine Case-1, grid model of a multi-panel mining site, Pittsburgh Coalbed.

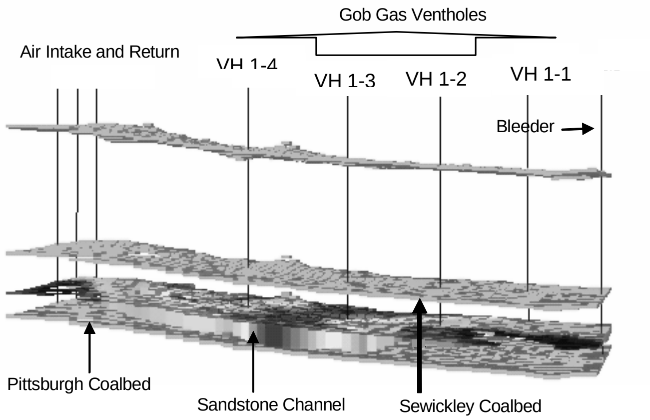

Figure 5. Study mine Case-2, grid model of a new mining district, Pittsburgh Coalbed.

Case-1 (Fig. 4) was developed for a previous, multi-panel mining district, and was used to evaluate the influence of various gob gas venthole completion parameters on methane capture. The grid model shown in Figure 5 (Case-2) was developed for the new mining district that started with 381 m (1250 ft)-wide panels, but would be switching to 442 m (1450 ft)-wide panels. The focus of the Case-2 study was to estimate the increase in expected methane emissions and to investigate alternative gob gas venthole completion and placement scenarios on the larger panel.

3.1 *Case-1, Evaluation of gob gas venthole completion parameters*

3.1.1 *Effect of slotted-casing diameter*

The standard casing diameter for the gob gas ventholes in the study area was 17.8 cm (7 in). The effects of different slotted-casing diameters [25.4 cm (10 in) and 10.2 cm (4 in)] on methane production were evaluated. The length of the slotted casing and its setting depth above the top of the Pittsburgh Coalbed were held constant at their original design values, 61 m (200 ft) and 12 m (40 ft), respectively.

The modeling results given in Table 1 for the simulated mining period (910 days) predict that the cumulative methane production using the 25.4 cm (10 in) casing will increase 4.9%, as compared to the 17.8 cm (7 in) standard diameter casing. The amount of methane produced with the 10.2 cm (4 in) casing was about 6.7% less than that produced with the 17.8 cm (7 in) diameter casing. However, the amount of mine air produced with the 10 in casing was 12.3% more, which resulted in a lower predicted methane concentration. Conversely, the amount of mine air produced with the 10.2 cm (4 in) diameter casing was 15.2% less, as compared to the standard casing, which resulted in higher methane concentrations.

The predicted increase in cumulative methane production with the larger diameter wellbore was due to the increase in the open-to-flow area of the wellbore. Also, with larger diameter wellbores, the calculated pressure losses were less compared to smaller diameter wellbores. The predicted reduction in methane concentration with the 25.4 cm (10 in) diameter casing is most likely the result of more mine air being captured due to an expanded pressure sink and associated depletion radius created by the production of gas from the larger diameter casing. However, since the total predicted gas production (methane and air) was higher for the 25.4 cm (10 in) diameter casing, it still resulted in higher cumulative methane production, even though the methane concentration was less.

Table 1. Predicted effect of casing diameter on cumulative methane and total gas production for 910 days of simulated mining.

Casing diameter inch	Cum. CH_4, MMscf	ΔCH_4 compared to 7-in casing, %	Cum. Gas (CH_4 + Air) MMscf	ΔAir compared to 7-in casing, %
4	391.8	-6.7	609.4	-15.2
7	419.8	-	676.5	-
10	440.1	+4.9	728.4	+12.3

3.1.2 *Effect of slotted casing length*

To evaluate the influence of the length of the completion interval on gob gas venthole performance, the length of the slotted casing section was changed in the model to 30.5 m (100 ft) and to 76.2 m (250 ft), as compared to the original 61 m (200 ft) length. The casing diameter was kept at 17.8 cm (7 in), and the setting depth of 12 m (40 ft) above the top of the Pittsburgh Coalbed was maintained. The modeling results predict that the cumulative methane production will increase with increases in slotted casing length (Fig. 6). The methane production with 76.2-m (250-ft) of slotted casing was 459.4 MMscf, as compared to 391.8 MMscf with the standard 61-m (200-ft) of slotted casing. This difference corresponds to a 9.5% increase in methane capture from the four panels modeled in Case-1 (Fig. 4). However, when the slotted casing length was shortened to 30.5 m (100 ft), the predicted methane production decreased to 314.7 MMscf, which was about 25% less than what was captured with 61 m (200 ft) of slotted casing.

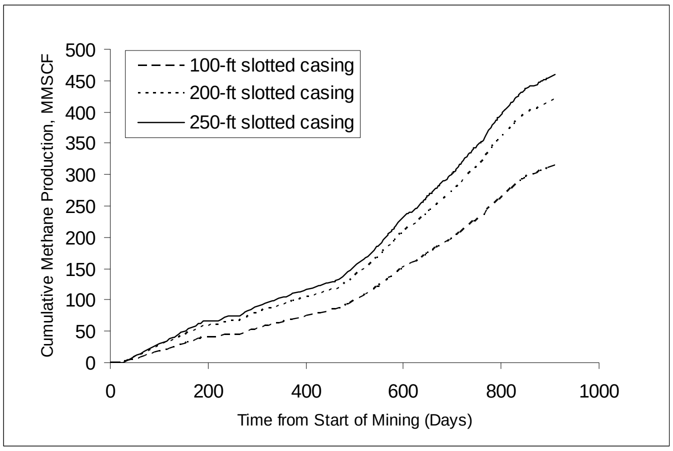

Figure 6. Simulated cumulative methane production from ventholes with varying lengths of slotted casing.

3.1.3 *Effect of slotted-casing setting depth*

The effect of casing setting depth (distance from the top of the mining layer) on gas production was investigated by modeling alternative completion depths of 19.8 m (65 ft), 7.6 m (25 ft) and 4.6 m (15 ft), as compared to the original, 12 m (40 ft) depth. In these alternative cases, the 7.6 m (25 ft) completion depth generally corresponded to a close proximity to the caved zone, which was modeled as 7.3 m (24 ft) above the Pittsburgh Coalbed for the Case-1 study site, and the 4.6 m (15 ft) depth corresponded to circumstances where the venthole was drilled into the caved zone. The 19.8 m (65 ft) completion depth corresponds stratigraphically to a depth slightly below the Sewickley Coalbed (Fig. 2). For these scenarios, the casing diameter and slotted casing lengths were kept at their original design values, 17.8 cm (7 in) and 61 m (200 ft), respectively.

Raising the slotted casing setting depth to 19.8 m (65 ft), as compared to 12 m (40 ft), above the Pittsburgh Coalbed resulted in a 4% predicted cumulative methane production increase. The predicted cumulative methane production declined by about 5% and 29% when the casing was set to within 7.3 m (25 ft) and 4.6 m (15 ft) of the top of the mining layer, respectively. In the 15 ft setting depth scenario, the lower slots of the casing were in the caved zone influenced by the mine ventilation system where flow resistance was small. Therefore, the ventholes pulled 74% more mine air, as compared to the operator's standard ~12 m (~40 ft) setting depth. Since most of the produced gas was mine air at the 4.6 m (15 ft), the average methane concentration in the cumulative produced gas at the end of mining was about 40%, as opposed to 60-70% average methane concentration calculated for other depths (Fig. 7).

A real-world example of the gas quality consequences of completing gob gas ventholes into the caved zone is illustrated with measured gas concentration data from two ventholes continuously monitored in the Case-2 study area (Fig. 8). For this site, the height of the caved zone was estimated to be ~12 m (~40 ft), higher than the Case-1 site shown in Figure 4, due to the presence of the sandstone paleochannel. The first venthole on the study panel (1-1, Fig. 5) was completed to a depth of 14.3 m (47 ft) above the top of the Pittsburgh Coalbed, generally within the standard depth range for the mine site. However, the second venthole drilled on the study panel (1-2, Fig. 5) was inadvertently drilled deeper to a depth of 10.6 m (35 ft) above the top of the Pittsburgh Coalbed, which is in the caved zone. As shown in Figure 8, the methane concentration in the produced gas from the venthole completed into the caved zone averaged about 30% less than that of the standard completion depth above the caved zone due to the increased production of mine ventilation air. It should be noted that even though the estimated caved zone height for which the predictions for the influence of different casing setting-depths were made (Case-1) is slightly different than that at the Case-2 study site where these actual field production data were measured, a similar methane concentration decrease (25-30%) was predicted for the venthole penetrating into caved zone for the Case-1 study (Fig. 7).

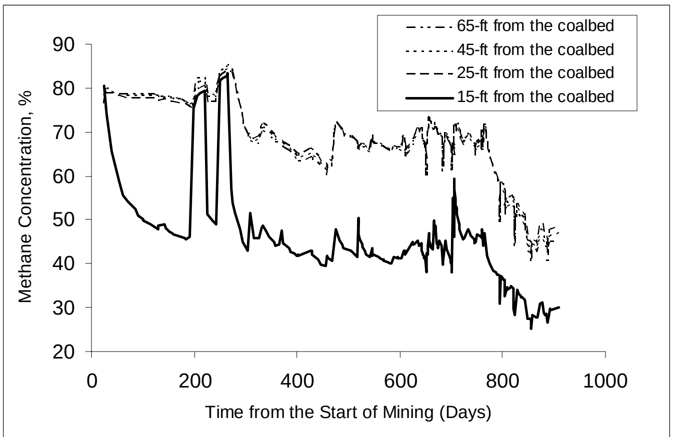

Figure 7. Simulated methane concentrations from ventholes completed to varying depths above the Pittsburgh Coalbed.

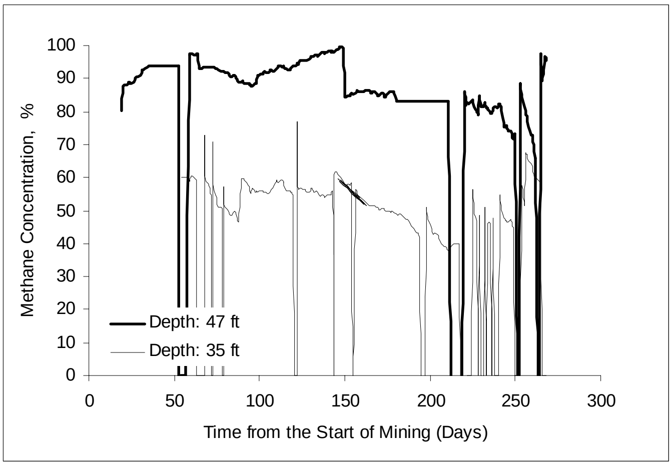

Figure 8. Actual methane concentrations measured from two gob gas ventholes completed to different depths.

3.2 *Case-2, Evaluation of longwall panel width on gob gas venthole performance*

The first two longwall panels in the new mining district at the study mine site were 381 m (1250 ft) wide with a length of approximately 3350 m (11,000 ft). However, starting with the third panel, the panel widths were to be increased by 61 m (200 ft) to 442 m (1450 ft). Due to the uncertainty of the methane emission consequences associated with mining of the larger panel, the area in question (Fig. 5) was modeled to estimate the expected increase in gas flow and to investigate methane control options. The question to be answered was whether the current number and configurations of gob gas ventholes would adequately control the projected increase in gob gas on the larger longwall panels (Karacan et al. 2005).

3.2.1 *Evaluation of the increase in methane emissions due to the mining of a wider longwall panel*

Modeling the increase in panel width from 381 m (1250 ft) to 442 m (1450 ft) results in about 47 MMscf of additional methane liberation from the coal mined on the longwall face and 137 MMscf from the overlying disturbed strata over the 268 days of mining simulated for this study. Depending on the availability of additional gob gas drainage capacity, some of the additional 137 MMscf of methane originating in the overlying strata may report to the ventilation system. This would represent the potential of up to about 355 cfm of additional methane entering the underground workplace.

3.2.2 *Analysis of expanding panel width from 381 m (1250 ft) to 442 m (1450 ft) with the four actual ventholes in operation*

The four actual gob gas ventholes on the first panel in this new mining district at the study mine site were drilled to varying depths [14, 11, 9, and 12 m (47, 35, 30, and 40 ft)] above the top of the Pittsburgh Coalbed, and, therefore, two of the ventholes were completed into or at the top of the caved zone, as opposed to the preferred ~12 m (~40 ft) distance. For this analysis, the results of simulation runs for the 381 m (1250 ft) wide panel with the four actual gob gas ventholes were compared to the results when the panel width was increased to 442 m (1450 ft), using the same venthole placement [91 m (300 ft) from the tailgate side of the panel], completion, and production histories (Fig. 9).

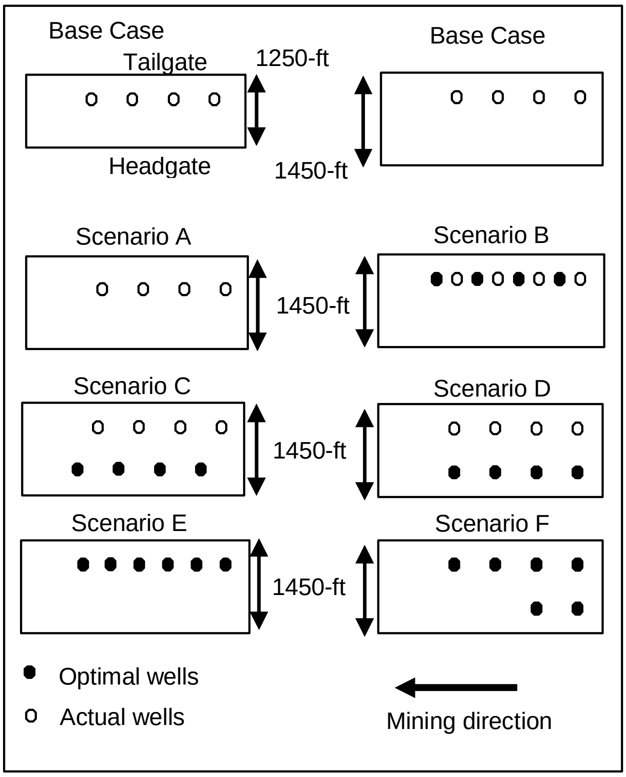

Figure 9. A schematic representation of gob gas venthole configurations for the simulation of methane control options on wider longwall panels.

The performance of the four individual gob gas ventholes on the simulated wider panel was very similar to those on the original panels since the wellbore flow model is not dependent on panel width and due to the similar reservoir permeability, irrespective of the panel width as confirmed by the FLAC computations (Karacan et al. 2005). Since the performance (gas production potential) of individual gob gas ventholes is not influenced significantly with an increased panel width, the additional 137 MMscf (355 cfm) of methane released from the overlying strata as a result of mining the larger panel will potentially enter the underground workplace, if additional methane drainage capacity is not provided. Thus, the constructed model (Fig. 5) was used to evaluate multiple scenarios to optimize the number and locations of the gob gas ventholes on the wider panel and to minimize the volume of additional methane entering the ventilation system.

3.2.3 *Alternative gob gas venthole placement scenarios and performance analysis for a 442 m (1450 ft) wide panel*

The simulated alternative gob gas venthole placement and completion scenarios investigated for this study, as shown in Figure 9, were: (A) moving the four actual ventholes (as drilled and completed on the first panel in the Case-2 study area) to locations 152 m (500 ft) from tailgate side, i.e. 61 m (200 ft) closer to the centerline of the panel than on the first panel; (B) adding four optimal (continuously operating with 2.7 psi suction pressure and completed to 12 m (40 ft) above the Pittsburgh Coalbed) infill ventholes located between each actual venthole; (C) adding four optimal ventholes located 90 m (300 ft) from the gateroads on the headgate side of the panel, positioned diagonally to the actual ventholes; and (D) adding four optimal ventholes located 90 m (300 ft) from the gateroads on the headgate side and positioned directly opposite the actual ventholes on the tailgate.

Simulation runs showed that the optimal gob gas ventholes produced gas that is 85-90% methane through the entire mining period, as compared to the 65-70% range for the actual wells during most of their production history (due to close proximity of two of the holes to the caved zone). Optimal wells were also predicted to produce about 50% more methane than the actual wells.

The data presented in Table 2 compare the cumulative methane production volumes from each of the gob gas venthole configuration scenarios shown in Figure 9. The lowest predicted cumulative methane production (Case A) is obtained when the four ventholes with the actual completions are located 152 m (500 ft) from the tailgate entry of the 442 m (1450 ft) panel. This configuration produces 0.37×10^6 m^3 (13 MMscf) less methane compared to the base case production from the 381 m (1250 ft) panel, thus illustrating the importance of near-margin venthole placement (Diamond et al. 1994).

The highest predicted cumulative methane production is achieved when additional optimal infill ventholes are used (Table 2). Case D, with four actual ventholes on the tailgate side of the panel and four additional optimal headgate ventholes located directly across from the tailgate holes produces 3.91×10^6 m^3 (138 MMscf) more methane compared to the four actual ventholes on the 381 m (1250 ft) panel base case. Case C, with four actual ventholes on the tailgate side of the panel and four additional optimal ventholes located on the headgate side of the panel (but diagonal to the tailgate ventholes) is the next highest incremental producer of methane at 3.37×10^6 m^3 (119 MMscf). While Cases C and D are similar, Case D is probably the higher producer because the tailgate and headgate ventholes are closer to each other (since they are directly opposite each other on the panel) and are intercepted by mining at the same time. This scenario results in a quicker overlap of the venthole drainage radiuses, which enhances gas desorption from the overlying coalbeds associated with the subsided strata. Also, when headgate and tailgate ventholes are intercepted at the same time, the headgate ventholes start producing earlier and stay on production longer, as compared to the diagonal location in Case C, resulting in more methane production.

One of the main considerations in gob gas venthole design and operation is to locate and drill the ventholes optimally and operate them continuously to minimize the number of ventholes while maximizing the production. Thus, Cases E and F were simulated to determine the minimum number of optimal ventholes that will produce the same maximum amount of methane as in the highest-producer configuration (Case D). In Case E, six optimal ventholes were placed along the tailgate side of the panel, and in Case F, two of the optimal ventholes were placed on the headgate side directly opposite the first two ventholes on the tailgate side (Fig. 9).

Table 2. Cumulative predicted methane production differences from gob gas ventholes on a 442 m (1450 ft) wide panel.

Venthole placement scenario ID	Cummulative methane production difference compared to 381 m (1250 ft) base case, MMscf
442m (1450-ft) Base Case	- 0.9
A	- 13
B	113
C	119
D	138
E	86
F	134

The predicted methane production performance of venthole configurations E and F using six optimal gob gas ventholes were compared to the performance of Case D, the highest predicted methane producer [3.91×10^6 m^3 (138 MMscf)] in the previous simulations. Table 2 shows that Case E, where six optimal ventholes were located along the tailgate side of the panel, produced about 2.44×10^6 m^3 (86 MMscf) more methane than the 381 m (1250 ft) base case, whereas Case F, with two of the optimal wells on the headgate side, produced 3.79×10^6 m^3 (134 MMscf) more methane. Thus, the six optimal ventholes of Case F produced almost as much methane as the eight (four actual and four optimal) ventholes of Case D. The predicted performance differences between Case E and F are due to the location of the ventholes and to the length of time they stay on production.

3.2.4 *Evaluation of the impact of gob gas venthole configurations on controlling ventilation system methane on a wider face*

Table 3 presents the predicted amount of uncaptured methane that will be available for flow to the ventilation system on a 442 m (1450 ft) wide panel with the various gob gas venthole configurations that have been simulated relative to the gob gas produced volume for the 381 m (1250 ft) base case panel. The greatest amount of uncaptured methane available for potential flow from the overlying disturbed strata to the ventilation system [4.19×10^6 m^3 or 0.179 m^3/s (148 MMscf or 380 cfm)] is Case A, where the gob gas ventholes are placed an additional 61 m (200 ft) towards the center line of the panel. The minimum amount of uncaptured methane on the wider panel occurs with Case D (-1 MMscf) when the four actual tailgate ventholes are supplemented with four optimal headgate ventholes. The minimal uncaptured methane flow into the ventilation system for Case D (eight ventholes) is comparable to the 0.85×10^6 m^3 (3 MMscf) of uncaptured methane for Case F, where only six optimal ventholes are used.

Table 3. Predicted uncaptured methane volumes potentially available for flow for simulated gob gas venthole configurations on the 442 m (1450 ft) wide panel.

Venthole placement scenario ID	Cummulative uncaptured methane volume compared to the 1250 ft base case, MMscf (cfm)
442 m (1450-ft) Base Case	137 (355)
A	148 (380)
B	25 (65)
C	17 (44)
D	-1 (-)
E	50 (130)
F	3 (10)

4 SUMMARY

Comprehensive "dynamic" reservoir models for simulating gas flows associated with the longwall mining environment have been developed. The models were constructed based on reservoir parameter data available for the study site and through history matching techniques for those parameters that were not easily obtainable. Simulating the mining component of the model, and updating the changing reservoir parameters due to strata disturbance, were addressed with the use of "restart" models, which were configured based on a schedule built from the actual longwall face advance and gob gas venthole interception times.

Theoretical results indicated that, while keeping the other completion parameters constant, increasing the casing diameter increased cumulative methane production from subsided strata. However, a marginal decrease in the produced methane concentration was evident, possibly due to increased mine-air extraction. It was demonstrated that longer slotted casing lengths produced more gob gas, and thus more methane, depending on the geology and the presence of gas bearing strata in the horizons adjacent to the extra slotted casing length. Most importantly, it was demonstrated that casing setting depth played an important role relative to the methane concentration in produced gas stream and the volume of methane captured. Modeling results showed that when the setting depth was within the estimated caved zone, the methane concentration in the produced gas decreased by about 30%. Conversely, raising the casing setting depth into the fractured zone above the caved zone increased methane production.

The models were also used to predict the methane emission consequences of mining a wider longwall panel in the Pittsburgh Coalbed. It is predicted that increasing the panel width from 381 m (1250 ft) to 442 m (1450 ft) would result in about 3.88×10^6 m^3 (137 MMscf) from the overlying disturbed strata, resulting in an average of about 0.167 m^3/s (355 cfm) of additional methane potentially entering the ventilation system over the 268 days of simulated mining for this study. The importance of completing and operating the ventholes optimally to increase their methane control capability was also demonstrated. The model simulations predicted that six optimally completed, placed, and operated ventholes could produce the same amount of methane on the wider panel as eight non-optimal wells would produce.

Reservoir modeling has been shown to be a viable approach for evaluating methane emission and control issues in the longwall mining environment. This approach is far superior to the traditional trial-and-error methods, and has the capability of addressing unexpected methane emission problems as they evolve.

5 DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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