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Evaluating the Ventilation of a 40-Foot Two-Pass Extended Cut

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

cfm	cubic foot (feet) per minute	psi	pound(s) per square inch
ft	foot (feet)	s	second(s)
gpm	gallon(s) per minute	%	percent
in	inch(es)	°	degree(s)
min	minute(s)		

EVALUATING THE VENTILATION OF A 40-FOOT TWO-PASS EXTENDED CUT

By Edward D. Thimons,[1] Charles D. Taylor,[2] and Jeanne A. Zimmer[3]

ABSTRACT

Methane concentrations at a continuous mining machine coal face are affected by the quantity of fresh intake air reaching the face. During the mining of the box cut on a 40-ft two-pass extended-cut face, the continuous miner is always located at the point of deepest penetration, and operation of the machine-mounted dust scrubber and the water spray system improve the flow of fresh air to the face of the box cut. However, after the continuous miner leaves the box cut to begin the cutting of the 40-ft slab, little is known about how much ventilation air reaches the face of the box cut during the slab cut. The Pittsburgh Research Laboratory of the National Institute for Occupational Safety and Health conducted a study to answer this question. Tests were run to determine how much ventilation air reaches the face of the box cut, with the continuous miner at three locations in the 40-ft two-pass extended-cut mining sequence. These three locations were at the end of the 40-ft box cut, at the start of the 40-ft slab cut, and 20 ft into the slab cut.

During these tests, methane gas was released at the face of the 40-ft box cut to simulate methane liberation underground. Methane concentrations measured 1 ft from the roof and face of the box cut were used to estimate face airflow quantities at fresh air flow rates of 10,000 and 4,000 cfm, scrubber flow rates of 0, 4,000 and 10,000 cfm, and water spray pressures of 0 and 120 psi. A blowing ventilation curtain setback position of 50 ft was used during these tests.

With the continuous miner operating at the face of the 40-ft box cut, and the blowing ventilation curtain maintained at 50 ft, at least 50% of the available fresh air was delivered to the face when the scrubber and water spray system were operating. The operation of the scrubber was essential to providing this quantity of air to the face for all test conditions, while the operation of the water sprays was significant only at the lower fresh air flow rate of 4,000 cfm.

With the continuous miner operating at the start of the 40-ft slab and the blowing ventilation curtain remaining at 50 ft, fresh airflow to the face of the 40-ft box cut was significantly reduced—in some cases to <10% of the available fresh air. Operation of the scrubber and/or the water sprays resulted in no significant improvement in the ventilation at the face of the box cut. When the continuous miner advanced 20 ft into the slab cut, an improvement was achieved in the quantity of air reaching the face of the box cut, with the quantity increasing by 100% or more of what it was for similar conditions at the start of the 40-ft slab.

To improve ventilation to the face of the 40-ft box cut when the continuous miner was starting the 40-ft slab cut, and operating at 20 ft into the slab cut, the blowing ventilation curtain was advanced from its 50-ft setback location to locations 40 ft and then 28 ft from the face. With the continuous miner at the start of the 40-ft slab, extending the curtain 10 ft resulted in increases in fresh air to the face of the box cut of 53% to 159% depending on the fresh air flow rate. The additional 12-ft extension resulted in increases of 270% to 626%.

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INTRODUCTION

About one-half of all mechanized mining units in the United States use extended cutting, advancing more than 20 ft past the last row of bolts. Most of the approvals for extended cuts are for cutting depths of approximately 40 ft. Unless a full-face mining machine is used, the mining sequence is alternated between box and slab cuts. Deep cuts of this length can be taken as two 40-ft cuts, four 20-ft cuts, or by using some other cutting sequence combination.

Most extended-cut mining sections provide intake air to the face by means of a blowing ventilation curtain and have continuous miners equipped with machine-mounted dust scrubbers. The dust scrubbers help to move fresh air to the immediate face area and to remove the methane-laden air from the face area to the rear of the continuous miner. Properly oriented water sprays, which are used on all continuous miners for dust control, can also improve face airflow. Past studies [Taylor et al. 1997; Volkwein and Wellman 1989] have demonstrated how operation of scrubbers and water sprays improve face ventilation during extended-cut mining.

Little is known about what happens to the ventilation of the 40-ft box cut when the continuous miner backs out of the box cut to begin the slab cut. This issue is of particular concern when a two-pass 40-ft cut is taken because, at the start of the slab cut, the continuous miner is located 40 ft from the point of deepest penetration, the face of the box cut.

To gain some understanding of the ventilation of the box cut on a two-pass 40-ft extended cut, researchers at the National Institute for Occupational Safety and Health's Pittsburgh Research Laboratory (PRL) undertook a full-scale study. Tests were conducted to determine how the location of the mining machine and other operating conditions affect the quantity of fresh intake air reaching the box-cut face during a 40-ft two-pass extended-cut mining sequence. In general, the effective dilution and removal of methane gas from the mining face depends on the quantity of intake air reaching the face. Two series of tests were conducted in the PRL methane test gallery to determine—

- How much fresh intake air reaches the box-cut face during various phases of the extended-cut mining sequence;
- How the amount of fresh intake air reaching the box-cut face is affected by operating conditions; and
- How airflow to the box-cut face can be increased.

TEST FACILITY

TEST GALLERY CONFIGURATION

The PRL methane test gallery (figure 1) was configured to simulate a 16.5-ft-wide, 7-ft-high entry during the mining of a 40-ft two-pass extended cut. As shown in the figure, intake air is drawn into the gallery by an exhaust fan, and the return air exits the building behind a wall constructed on the right side of the entry. A blowing ventilation curtain, attached to a wood frame constructed 2 ft from the left rib of the entry, directs intake air toward the face. Intake airflow was measured at the inby end of the curtain with a vane anemometer. Two regulator doors were adjusted to provide either 10,000 or 4,000 cfm of fresh intake air.

A full-scale model continuous mining machine with dust scrubber and water spray system was employed in this testing (figure 2). Eleven hollow cone water sprays mounted on top of the boom were directed 10° clockwise to the right of a line perpendicular to the face. Three additional hollow cone sprays were mounted on the left front of the miner chassis. Two of these sprays were also directed 10° to the right and one about 20° to the left of a line perpendicular to the face aimed toward the left corner of the face. When the water spray system was employed, water pressure and flow rate were kept constant at 120 psi and 22 gpm.

The scrubber system (figure 2) included inlets on each side of the mining machine approximately 11 ft from the mining face, near the boom hinge point of the machine. Two fans in the scrubber ducting moved air from the two inlets to the exhaust port at the right rear of the continuous miner. Both fans were needed to obtain a scrubber flow rate of 10,000 cfm; only one was required for the 4,000-cfm flow rate. Orifice plates in the scrubber ducting were used to set the flow at 10,000 or 4,000 cfm. Scrubber flow rate was measured about 5 ft downstream from each fan using a Pitot tube and Magnehelic gauge (10-point equal area traverse). When the scrubber was operating, scrubber and intake flow quantities were equal.

A 4-ft-wide box was built from floor to roof on the right side of the entry to simulate an uncut slab of coal. The slab was either 40 or 20 ft long to simulate the start of the 40-ft slab cut or 20 ft into the slab cut.

METHANE RELEASE

Methane gas supplied by a commercial gas line was released through four perforated horizontal pipes located across the box-cut face, equally spaced from floor to roof. This resulted in a uniform release of methane across the entire face and simulated methane liberation at the face of the box cut.

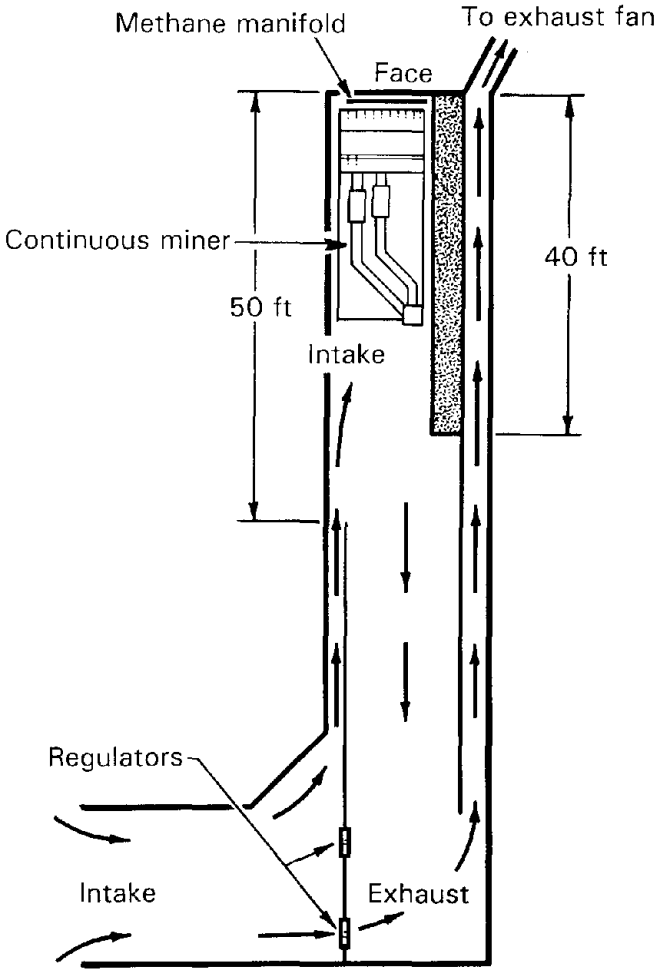

Figure 1.—Full-scale surface mine test gallery.

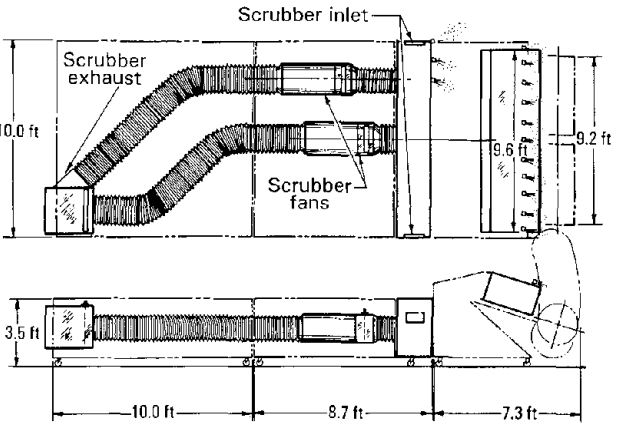

Figure 2.—Full-scale model continuous miner with dust scrubber and water spray system.

Each 12-ft-long pipe was located 18 in from the box-cut face. For all tests, the methane gas flow rate through the manifold at the end of the box cut was set at 5 cfm using a rotameter. The 5-cfm flow rate provided methane concentrations in the gallery that could easily be recorded by the methane monitoring instrumentation.

METHANE MONITORING

Bacharach methane monitors concurrently monitored methane at the three face locations shown on figure 3. Data from each methanometer were downloaded every 2 s to a personal computer via a Metrabyte A/S conversion board and then to a Lotus spreadsheet for analysis.

Monitors were calibrated using 1% calibration gas at the start of each test series. Zero settings on the monitors were checked daily.

TEST PLAN

The testing consisted of two series of experiments in the full-scale gallery. In the first series of tests, the blowing ventilation curtain was maintained at a 50-ft setback at all times. This series of tests was run to determine how the amount of fresh air reaching the box-cut face was impacted by the position of the continuous miner in the cutting sequence, the amount of fresh air supplied, the operation of the scrubber, and the operation of the water spray system.

The continuous miner was sequentially positioned at three locations in the mining cycle of a two-pass 40-ft extended cut (figure 3): the completion of the 40-ft box cut, the start of the 40-ft slab cut, and 20 ft into the slab cut. At each of these positions, testing was done by setting the blowing ventilation curtain airflow at either 10,000 or 4,000 cfm. For each of these curtain flows, the scrubber flow was matched at either 10,000 or 4,000 cfm, or the scrubber was turned off. Also, for each of the two curtain airflows, the water sprays were either operated at a pressure of 120 psi for a total water flow rate of 22 gpm, or they were turned off.

Each test included the release of the gas into the gallery for a period of 10 min. The first 5 min was needed to ensure that the methane levels in the gallery reached a steady-state condition. Methane concentration data obtained over the final 5 min were used to determine the average methane levels at the box-cut face for each test condition.

Methane was monitored at three locations in the box-cut face (figure 3). These locations were evenly spaced across the box-cut face, 1 ft outby the methane release manifold and 1 ft from the roof. The average methane concentration at the box-cut face was considered to be the average of these three

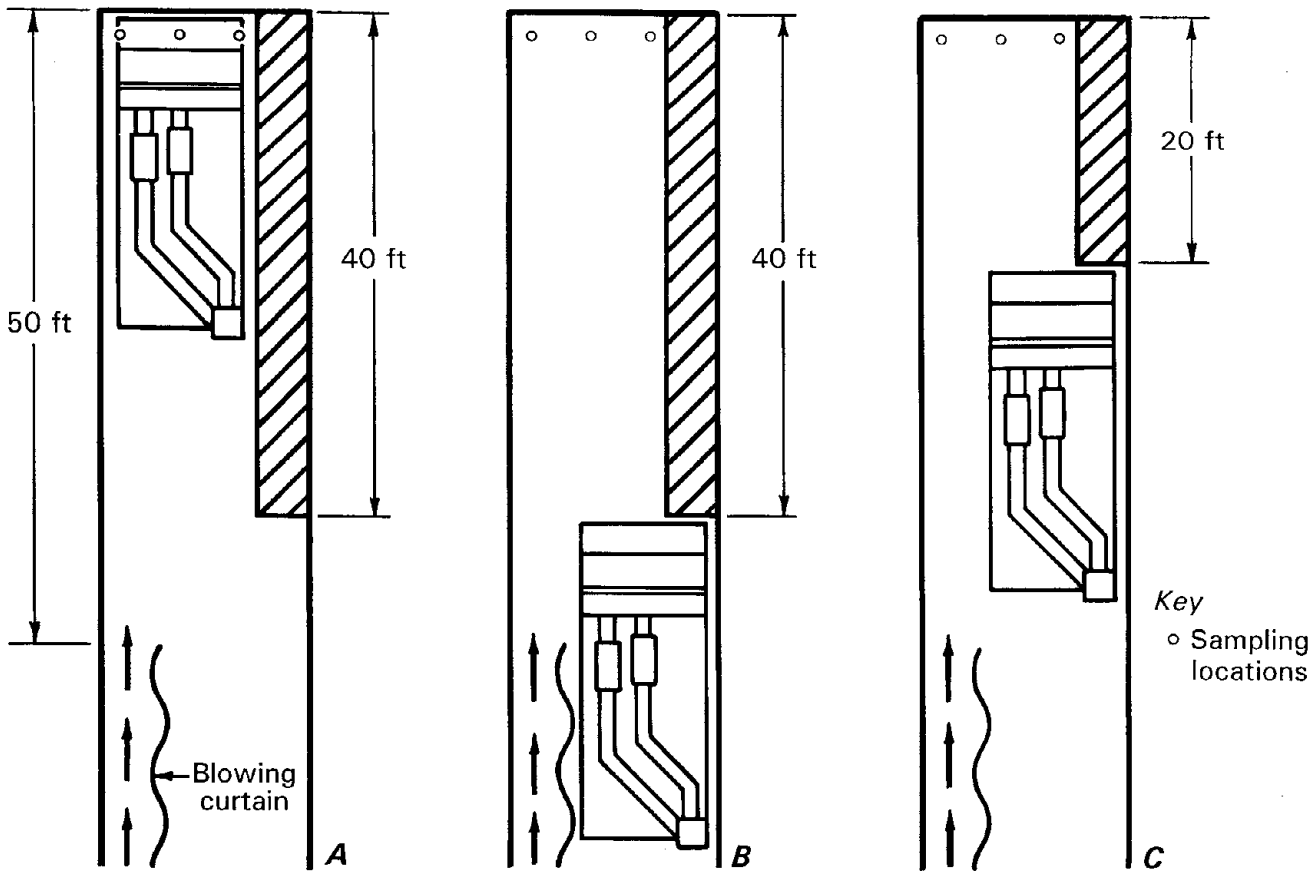

Figure 3.—Continuous miner at three locations in cutting sequence: *A*, face of 40-ft box; *B*, start of 40-ft slab; *C*, 20 ft into slab.

readings. Each test was repeated one time, and the average of the two tests was used to calculate the resulting test findings.

As the discussion of the results of the first series of tests will later show, little ventilation air was reaching the box-cut face when the continuous miner was located at the start of the 40-ft slab cut, with some improvement as the continuous miner advanced 20 ft into the slab cut. For this reason, a second series of tests was run to determine how advancing the blowing ventilation curtain toward the box-cut face impacted box-cut ventilation while the slab was being cut.

During the second series of tests, the continuous miner was located either at the start of the 40-ft slab cut or 20 ft into the slab cut. Again, blowing ventilation curtain flow rates of 10,000 and 4,000 cfm were used. Scrubber flow was always matched to the blowing curtain flow at either 10,000 or 4,000 cfm, and the water spray system was always operated at 120-psi pressure and a total flow rate of 22 gpm. The blowing ventilation curtain was varied at setbacks of 50, 40, and 28 ft for all test conditions. The 40-ft curtain represented an advance of the curtain during the slab cut to the last row of bolts, while the 28-ft curtain would require the use of a 12-ft extensible curtain beyond the last row of bolts. Figure 4 shows these brattice setbacks with the continuous miner at the two test locations.

As in the first series of tests, all tests were repeated once and an average methane face concentration was calculated for each set of tests. This information was used, as explained in the following section, to determine how much of the available fresh air from the blowing curtain was reaching the box-cut face for each test condition.

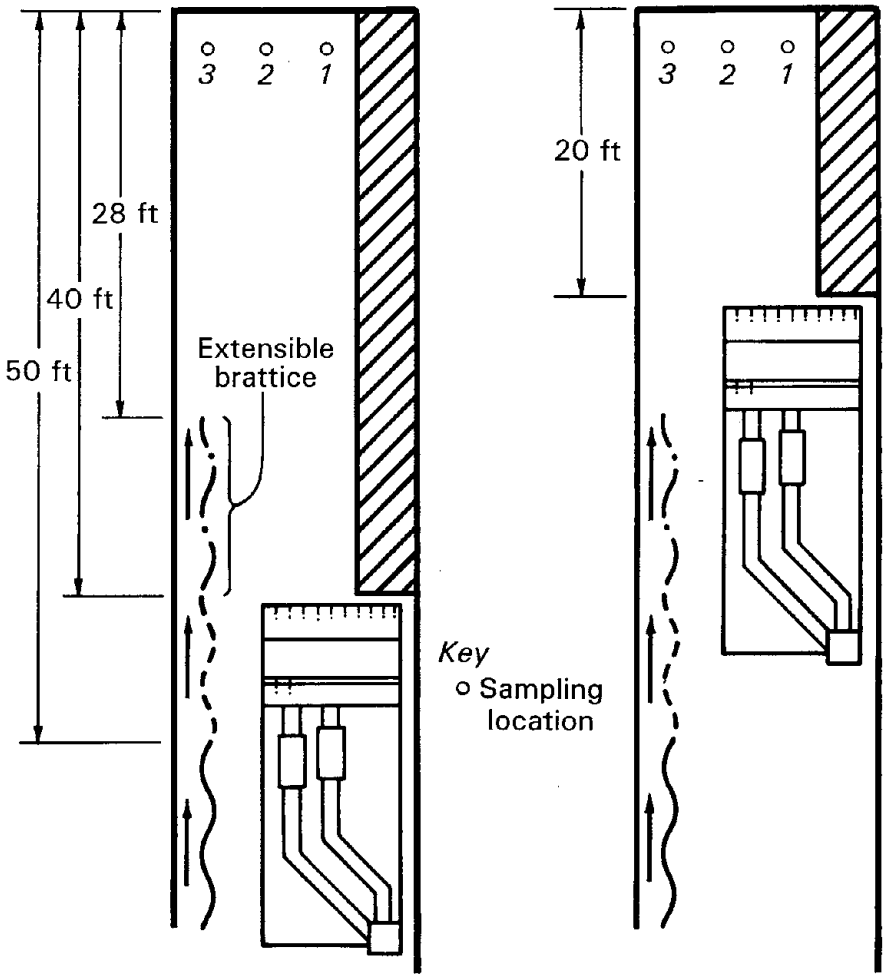

Figure 4.—Second test series continuous miner locations with three brattice setback distances.

CALCULATION OF VENTILATION AIR REACHING BOX-CUT FACE

It is possible to calculate the quantity of intake air reaching the box-cut face (F_v) if the following three quantities can be measured or calculated:

- The percentage of methane concentration at the face (C_f). In this research, this percentage was the average of three sampling locations at the face of the box cut. Throughout all of the tests, this average ranged from 0.1% to 1.2%.
- The average percentage of methane concentration in the immediate face return (C_r). This percentage is the methane concentration that would occur if all methane liberated at the face were thoroughly mixed with all of the available intake airflow. In this research, this percentage was calculated by dividing the face methane liberation rate (5 cfm) by the total available intake airflow measured at the end of the blowing ventilation curtain (either 10,000 or 4,000 cfm), then multiplying by 100.
- The total available intake airflow (Q) measured at end of the blowing curtain, either 10,000 or 4,000 cfm.

Once these quantities are measured, the quantity of air reaching the box-cut face is then calculated with the following equation:

$$F_v = \frac{C_r}{C_f} * Q$$

This methodology was used to calculate the volume of ventilation air reaching the box-cut face for each test condition.

RESULTS

FIRST TEST SERIES

In this test series, the blowing ventilation curtain remained fixed at a 50-ft setback. The curtain flow rate was either 10,000 or 4,000 cfm, the scrubber flow was either set to match the curtain flow or the scrubber was turned off, and the water spray system was either set at 120 psi (22 gpm total water flow) or was turned off. These conditions were varied with the continuous miner in one of three positions in the two-pass, 40-ft extended cut. These three positions were at the completion of the 40-ft box cut, at the start of the 40-ft slab cut, and 20 ft into the slab cut. Tables 1 and 2 show the results of these tests at curtain flow rates of 10,000 and 4,000 cfm, respectively.

Table 1.—Airflow to box-cut face for 10,000-cfm curtain with 50-ft setback

Machine location	Scrubber flow, cfm	Water sprays, psi	Box-cut ventilation, cfm
Box-cut face	10,000	0	6,250
Start of 40-ft slab	10,000	0	435
20 ft into slab cut	10,000	0	1,471
Box-cut face	10,000	120	5,556
Start of 40-ft slab	10,000	120	549
20 ft into slab cut	10,000	120	1,852
Box-cut face	0	0	538
Start of 40-ft slab	0	0	435
20 ft into slab cut	0	0	1,136
Box-cut face	0	120	1,282
Start of 40-ft slab	0	120	630
20 ft into slab cut	0	120	1,923

Table 2.—Airflow to box-cut face for 4,000-cfm curtain with 50-ft setback

Machine location	Scrubber flow, cfm	Water sprays, psi	Box-cut ventilation, cfm
Box-cut face	4,000	0	800
Start of 40-ft slab	4,000	0	538
20 ft into slab cut	4,000	0	870
Box-cut face	4,000	120	2,286
Start of 40-ft slab	4,000	120	583
20 ft into slab cut	4,000	120	1,111
Box-cut face	0	0	552
Start of 40-ft slab	0	0	505
20 ft into slab cut	0	0	494
Box-cut face	0	120	1,500
Start of 40-ft slab	0	120	776
20 ft into slab cut	0	120	1,625

From tables 1 and 2 and from figures 5 and 6, it can be seen that at the completion of the 40-ft box cut with the scrubber and water sprays operating approximately 50% of the available blowing curtain air arrives at the box-cut face. This is true for curtain flows of either 10,000 or 4,000 cfm. When the scrubber and water sprays are turned off, however, the airflow at the box-cut face drops significantly. For the 10,000-cfm curtain flow, it drops to 538 cfm (5% of the available curtain air); for the 4,000-cfm curtain, it drops to 552 cfm (14% of the available curtain air).

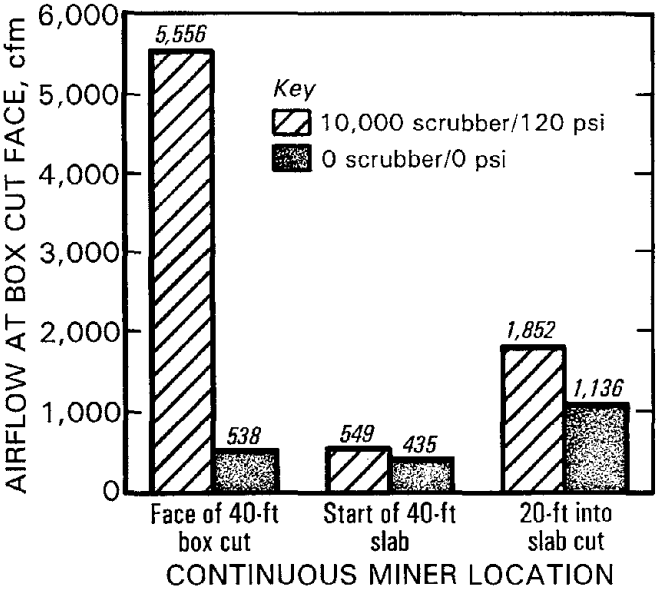

Figure 5.—Airflow to box-cut face for 10,000-cfm curtain with 50-ft setback.

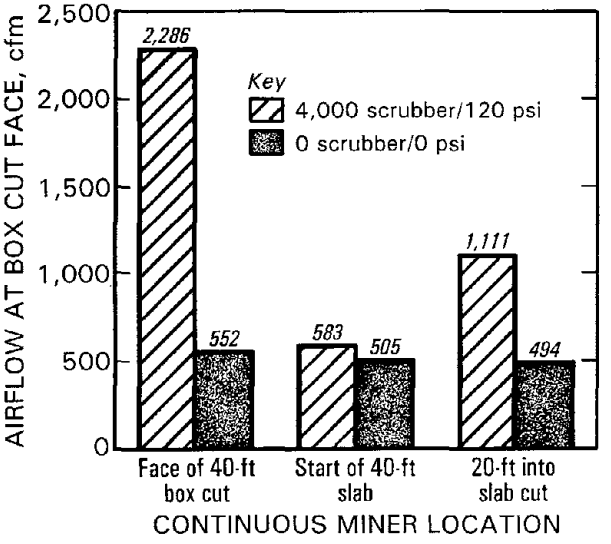

Figure 6.—Airflow to box-cut face for 4,000-cfm curtain with 50-ft setback.

For both 10,000- and 4,000-cfm curtain flow rates, continuous miner positioned to start the 40-ft slab cut, the airflow arriving at the face of the box cut remains between 4% and 15% regardless of scrubber or water spray operating conditions. As the miner advances 20 ft into the slab cut, an improvement occurs in the ventilation at the box-cut face, particularly with the use of the scrubber and water sprays. With the scrubber and water sprays operating, 19% to 28% of the air arrives at the face of the box cut.

Figure 7 compares a 10,000-cfm blowing ventilation curtain to a 4,000-cfm blowing ventilation curtain in relation to the ventilation provided to the box-cut face with the scrubber flow rate matched to the curtain flow, and with the water sprays operating. With the continuous miner at the box-cut face and 20 ft into the slab cut, more air is provided to the box-cut face with the 10,000-cfm curtain. However, with the miner at the start of the 40-ft slab, there is no advantage to the higher curtain flow in terms of airflow to the face of the box cut. In fact, the 4,000-cfm curtain actually provides slightly more air to the box-cut face.

Figures 8 and 9 show the effect of the operation of the scrubber on the amount of air reaching the face of the 40-ft box cut for curtain flows of 10,000 and 4,000 cfm, respectively. In all of these tests, the water spray system was operated at 120 psi and a total water flow rate of 22 gpm and the curtain setback was at 50 ft. The scrubber system was either turned off or was matched to the curtain flow rate.

For the 10,000-cfm blowing ventilation curtain (figure 8), the operation of the scrubber has a major effect on the airflow reaching the face of the 40-ft box cut when the continuous miner is at the box-cut face. The scrubber's operation at 10,000 cfm increases the amount of air reaching the face of the box cut from 1,282 to 5,556 cfm (a 333% increase). However, when the continuous miner is at the start of the 40-ft slab cut or 20 ft into the slab cut, the operation of the scrubber at 10,000 cfm has no impact on the amount of air reaching the face of the box cut. In fact, there is a very slight decrease with the scrubber operating under these test conditions.

For the 4,000-cfm blowing curtain (figure 9), the operation of the scrubber has some benefit when the continuous miner is at the face of the 40-ft box cut, increasing the airflow from 1,625 to 2,286 cfm when the scrubber is operating (a 41% increase). With the continuous miner at the start of the 40-ft slab cut or 20 ft into the slab cut, the operation of the 4,000-cfm scrubber actually decreases the amount of fresh air reaching the 40-ft box-cut face (about a 25% decrease in both cases).

Figures 10 and 11 show the effect of the water spray system on the amount of air reaching the face of the 40-ft box cut for curtain flow rates of 10,000 and 4,000 cfm, respectively. For these tests, the scrubber flow was matched to the curtain flow and the curtain was maintained at a setback distance of 50 ft. For each test condition, the water spray system was either operated at a pressure of 120 psi and a total water flow rate of 22 gpm or the water spray system was not operated.

For the 10,000-cfm blowing ventilation curtain (figure 10), use of the water spray system results in a slight decrease in air reaching the box-cut face when the continuous miner is at the face of the box cut (an 11% decrease). Some increase in airflow to the end of the box cut occurs with the water spray system operating and the miner at the start of the 40-ft slab and 20 ft into the slab cut (about 26% at both locations). However, at the start of the 40-ft slab cut, the airflow reaching the face of the box cut, even with the water spray system and scrubber operating is still only 549 cfm (<6% of the available 10,000 cfm of curtain air).

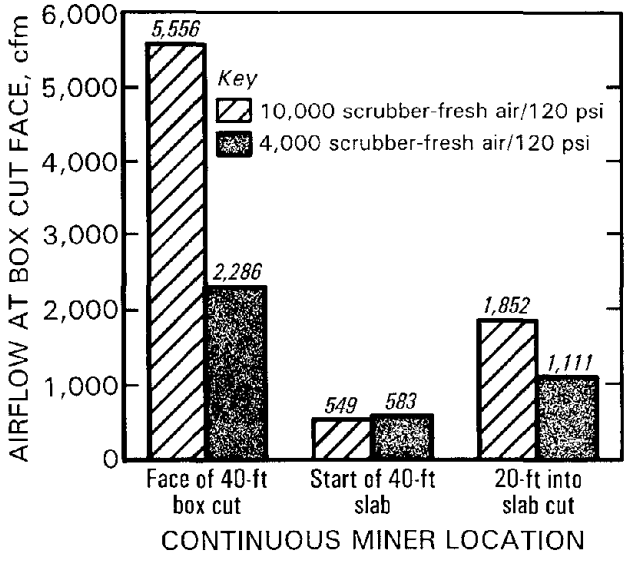

Figure 7.—Scrubber/fresh airflow effect.

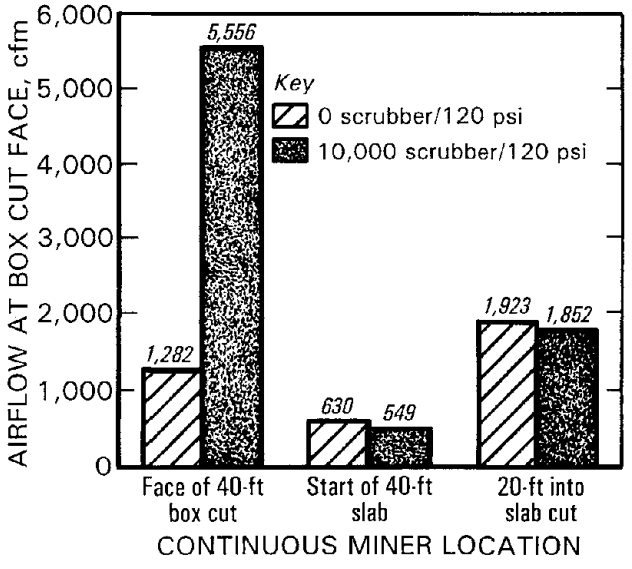

Figure 8.—Impact of scrubber at 10,000-cfm curtain flow with 50-ft setback.

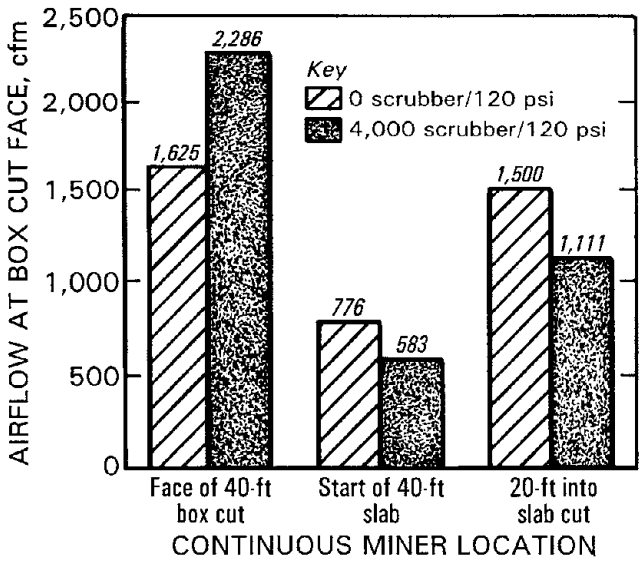

Figure 9.—Impact of scrubber at 4,000-cfm curtain flow with 50-ft setback.

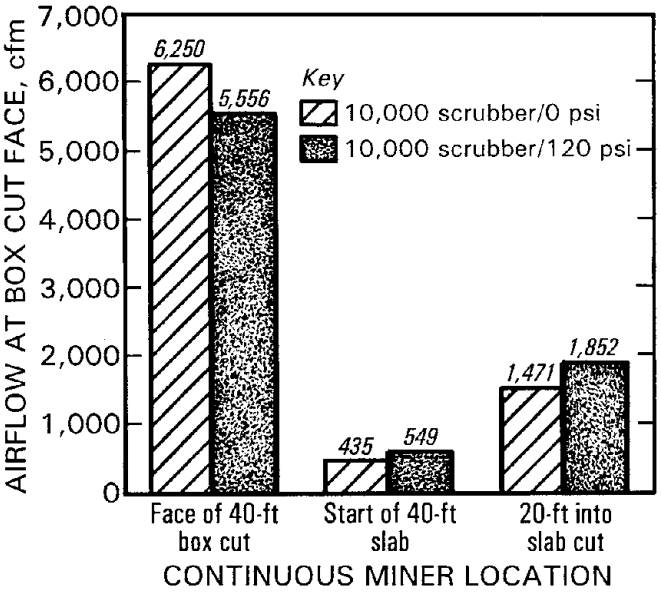

Figure 10.—Impact of water spray system at 10,000-cfm curtain flow with 50-ft setback.

For the 4,000-cfm blowing ventilation curtain (figure 11), with the continuous miner at the face of the 40-ft box cut, the airflow to the box-cut face is greatly impacted by the operation of the water spray system. When the spray system is turned on, the airflow to the face of the box cut increases from 800 to 2,286 cfm (an increase of 186%). With the continuous miner at the start of the 40-ft slab cut and 20 ft into the slab cut, the impact of the water spray system on the quantity of air reaching the face of the box cut is not significant (with increases of 8%

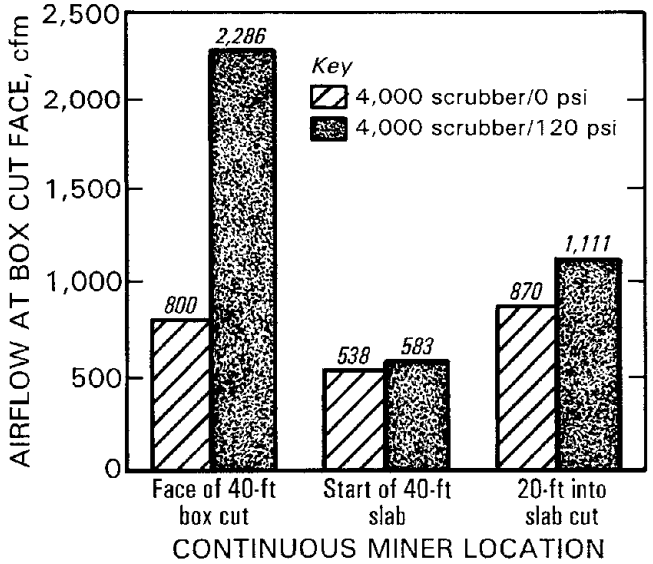

Figure 11.—Impact of water spray system at 4,000-cfm curtain flow with 50-ft setback.

and 27%, respectively). Note that the airflow to the face of the box cut is still very low when the continuous miner is at the start of the 40-ft slab cut, regardless of water spray system operation (about 14% of the available curtain flow with the water spray system operating).

SECOND TEST SERIES

In the second test series, the curtain setback distance was varied. For each test configuration, the setback distance was set at 50, 40, and 28 ft from the inby end of the box cut. The blowing ventilation curtain flow rate was established at either 10,000 or 4,000 cfm, and the scrubber flow rate was set to match the blowing ventilation curtain flow rate. For all tests, the water spray system was operated at 120 psi and 22 gpm total water flow rate. All testing was done with the continuous miner located either at the start of the 40-ft slab cut or 20 ft into the slab cut. Tables 3 and 4 show the results of these tests at curtain flow rates of 10,000 and 4,000 cfm, respectively.

Table 3.—Airflow to box-cut face as 10,000-cfm curtain is advanced

Machine location	Curtain setback, ft	Scrubber flow, cfm	Water sprays, psi	Box-cut ventilation, cfm
Start of 40-ft slab . .	50	10,000	120	459
Start of 40-ft slab . .	40	10,000	120	1,190
Start of 40-ft slab . .	28	10,000	120	3,333
20 ft into slab cut . .	50	10,000	120	2,273
20 ft into slab cut . .	40	10,000	120	2,500
20 ft into slab cut . .	28	10,000	120	3,505

Table 4.—Airflow to box-cut face as 4,000-cfm curtain is advanced

Machine location	Curtain setback, ft	Scrubber flow, cfm	Water sprays, psi	Box-cut ventilation, cfm
Start of 40-ft slab . .	50	4,000	120	419
Start of 40-ft slab . .	40	4,000	120	640
Start of 40-ft slab . .	28	4,000	120	1,551
20 ft into slab cut . .	50	4,000	120	2,000
20 ft into slab cut . .	40	4,000	120	2,600
20 ft into slab cut . .	28	4,000	120	3,368

Figures 12 and 13 show the impact of advancing the blowing ventilation curtain inby on the quantity of fresh air reaching the box-cut face for a 10,000- and 4,000-cfm curtain, respectively. For the 10,000-cfm curtain (figure 12), with the continuous miner at the start of the 40-ft slab cut, advancing the curtain from a 50-ft setback to a 40-ft setback results in a 159% increase in the airflow reaching the face of the box cut. Advancing the curtain from a 50-ft setback to a 28-ft setback by means of an extensible curtain results in a substantial increase in airflow reaching the box-cut face, from 459 to 3,333 cfm (an increase of 626%). One-third of the available fresh air reaches the face of the box cut at the 28-ft setback. With the continuous miner 20 ft into the slab cut, advancing the curtain from a 50-ft setback to a 40-ft setback results in only a slight increase in airflow to the box-cut face, but advancing it to the 28-ft setback results in a 54% increase in the airflow to the box-cut face.

For the 4,000-cfm curtain (figure 13), the findings are similar to those for the 10,000-cfm curtain. With the continuous miner positioned at the start of the 40-ft slab cut, advancing the curtain from a 50-ft setback to a 40-ft setback results in an increase in airflow to the box-cut face of 53%. Advancing the curtain from a 50-ft setback to a 28-ft setback using an extensible curtain results in an increase in airflow reaching the face of the box cut from 419 to 1,551 cfm (an increase of 270%). At the 28-ft setback position, more than one-third of the available fresh air (39%) now reaches the box-cut face. With the continuous miner 20 ft into the slab cut, advancing the curtain from a 50-ft setback to a 40-ft and then to a 28-ft setback results in increases in airflow to the face of the box cut of 30% and 68%, respectively.

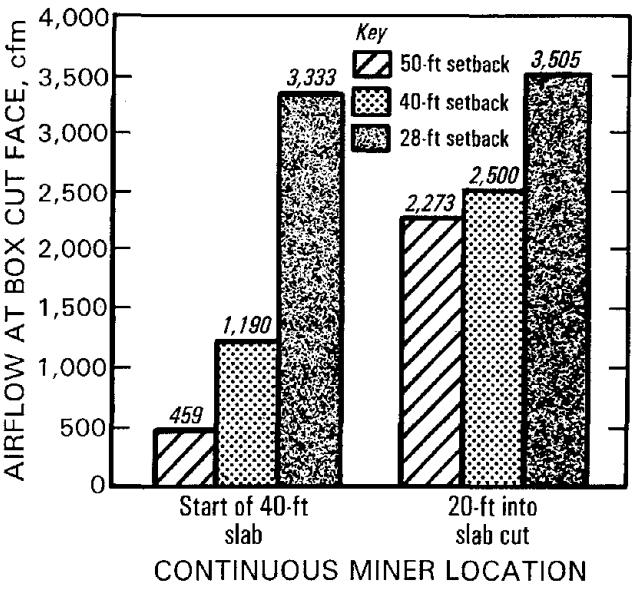

Figure 12.—Brattice setback effect for 10,000-cfm curtain/ scrubber flow and 120-psi water pressure.

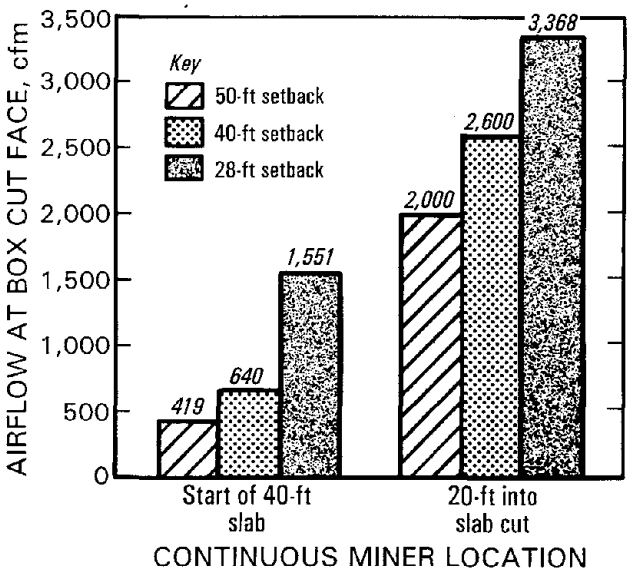

Figure 13.—Brattice setback effect for 4,000-cfm curtain/ scrubber flow and 120-psi water pressure.

CONCLUSIONS

Providing adequate fresh air to a coal mine face is crucial for effective methane control. This study was concerned with the ventilation of the box cut during a 40-ft two-pass extended cut. Testing was done with both 10,000- and 4,000-cfm blowing ventilation curtains. Scrubber system airflows were matched to the blowing ventilation curtain air volumes, or the scrubber was turned off. The water spray system was either operated at 120 psi and 22 gpm, or it was shut off. For the first series of tests, the continuous miner was located at one of three locations in the cutting sequence: at the face of the 40-ft box cut, at the start of the 40-ft slab cut, and 20 ft into the slab cut. For the second test series, the continuous miner was located at the start of the 40-ft slab and 20 ft into the slab.

The first series of tests was done with the blowing ventilation curtain at a 50-ft setback. For both 10,000- and 4,000-cfm blowing ventilation curtains, as the continuous miner

completes the 40-ft box cut, with the scrubber and water spray systems operating, at least 50% of the available curtain air reaches the face of the box cut. When the scrubber and water spray systems are turned off, the airflow reaching the face of the box cut drops significantly to 5% of the available air for the 10,000-cfm curtain and 14% of the available air for the 4,000-cfm curtain.

For both 10,000- and 4,000-cfm flow rates, when the continuous miner is located at the start of the 40-ft slab cut, the airflow to the face of the 40-ft box cut is low (about 4% and 15%, respectively) regardless of scrubber and water spray system operation. When the miner advances 20 ft into the slab cut, the ventilation to the face of the box cut improves, particularly when the scrubber and water spray systems are operating. For a 10,000-cfm blowing ventilation curtain, 19% of the available air reaches the box-cut face; for a 4,000-cfm blowing ventilation curtain, 28% of the available air reaches the box-cut face.

A comparison was made of the quantity of air reaching the face of the 40-ft box cut as a function of the blowing ventilation curtain flow rate. This comparison was made with the water spray system operating and the scrubber flow rate matched to the curtain flow rate. When the continuous miner is at the face of the box cut and 20 ft into the slab cut, more air is provided to the face of the box cut with the 10,000-cfm curtain than with the 4,000-cfm curtain. When the continuous miner is at the start of the 40-ft slab cut, there is no advantage to the higher curtain flow rate in terms of the quantity of air reaching the 40-ft box-cut face. As noted earlier, the operation of the scrubber and water spray systems has no significant impact on the air reaching the box-cut face when the continuous miner is at the start of the 40-ft slab cut.

The second series of tests analyzed the quantity of air reaching the face of the 40-ft box cut with the continuous miner at the start of the 40-ft slab cut and 20 ft into the slab cut. The quantity of air was analyzed as a function of blowing ventilation curtain setback distance. For these tests, the scrubber flow rate was matched to the blowing ventilation curtain flow rate and the water spray system was operated continuously. Three curtain setback distances—50, 40, and 28 ft from the inby end of the 40-ft box cut—were tested.

For a 10,000-cfm blowing ventilation curtain, when the continuous miner is located at the start of the 40-ft slab cut, advancing the curtain from 50 to 40 ft and then to 28 ft results in increases in airflow to the face of the box cut of 159% and 626%, respectively. With the miner 20 ft into the slab cut, only a small increase in airflow to the face of the box cut results for a 40-ft curtain setback, and a 54% increase results when the curtain is advanced to a 28-ft setback.

For the 4,000-cfm blowing ventilation curtain, with the continuous miner at the start of the 40-ft slab cut, advancing the curtain from 50 to 40 ft and then to 28 ft results in increases in airflow to the face of the box cut of 53% and 270%, respectively. With the miner 20 ft into the slab cut, advancing the curtain to a 40-ft setback increases airflow to the box-cut face by 30%, while advancing it to a 28-ft setback increases airflow to the box-cut face by 68%.

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