Technology News

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Translucent Face Partition Reduces Longwall Workers' Dust Exposure

Objective

Create two air splits along the longwall face to isolate the shearer-generated dust to the immediate face area, maintaining a cleaner split of air in the workers' walkway.

Approach

Previous U.S. Bureau of Mines (USBM) studies have shown that an extended face-conveyor spillplate barrier can create two air splits effectively, but it proved to be impractical because the workers could not see the face area and a reliable radio remote control was not yet available for the shearing machines. The USBM's current approach to air splitting consists of using a polyester mesh partition to overcome the visibility problems of a solid barrier. A permeable mesh partition is expected to provide adequate air-splitting capabilities as long as the pressure differential between the face and worker walkway is minimal. New, reliable, radio remote shearer-control technology supplemented the development of this air-splitting technology.

Laboratory Test Results

Experiments at the USBM's Lake Lynn Laboratory near Fairchance, PA, were conducted to determine the feasibility of maintaining two parallel splits of air with several different sizes of a permeable polyester mesh and to select an optimum mesh size for underground application. The meshes tested had 6.35-mm (1/4-in), 3.18-mm (1/8-in), and 1.59-mm (1/16-in) opening sizes, exhibiting open areas of 83.7, 52.5, and 30.0 pct, respectively. Each mesh size was evaluated to separate a 152.4-m-long (500-ft-long) entry into two parallel splits of airflow. Both baseline (no mesh) and mesh tests were conducted over a range of typical air velocities (1.02-4.06 m/s [200-800 ft/min]) used at longwalls. Dust was released on one side of the entry, and dust sampling was conducted along 30.5-m (100-ft) intervals on both sides of the entry.

Results showed that effective air splitting can be achieved with the 3.18-mm (1/8-in) and 1.59-mm (1/16-in) mesh opening sizes. Notable dust reductions were measured on the one side of the entry opposite the dust feed source with the mesh partition. Average dust reductions at 30.5 m (100 ft) and 71.0 m (200 ft) downstream of the source for the various air velocities were 58 and 36 pct, respectively, for the 3.18-mm (1/8-in) mesh, and 79 and 55 pct, respectively, for the 1.59-mm (1/16-in) mesh. At the higher air velocities (3.05 m/s and 4.06 m/s [600 ft/min and 800 ft/min]), marginal differences were observed between the 3.18-mm (1/8-in) and 1.59-mm (1/16-in) mesh sizes.

Underground Test Results

Underground testing of the mesh partition was conducted at a longwall operation to verify its effectiveness as a control technique. A cooperative effort was conducted with the mine to incorporate the mesh into its operation.

The mine extracted a highly volatile group B bituminous coal from a seam with a historically low rate of methane emission, notably reducing any potential methane buildup areas while testing the mesh partition. The 3.18-mm (1/8-in) mesh was selected for this study because the experimental results showed that this size material provided nearly the same air-splitting effectiveness with the mine's higher face air velocity as the 1.59-mm (1/16-in) mesh, while providing 75 pct more open area for improved worker visibility. The mesh partition was hung continuously from rods secured to the light fixture bolts on the underside of each shield canopy. Between each shield, amber latex tubing was attached to the end of each bar to provide the flexibility for continuously hanging the mesh. Additional mesh material was folded between the shields to allow for support movement.

During this study, fire-retardant polyester mesh material was used that was tested and classified as a low-risk fire hazard, "Class A," as defined by the ASTM E-162 test, "Standard Method Test for Surface Flammability of Materials Using a Radiant Heat Source." Cap lamps were mounted temporarily and focused at the shearer drums to provide some face-side backlighting to improve operator visibility through the mesh.

Underground dust sampling of this operation verified that the mesh partition can be an effective air splitting method by reducing the dust concentrations downstream of the shearer. Mobile dust sampling was conducted 15.2 m (50 ft) upstream, 30.5 m (100 ft) downstream, and 71.0 m (200 ft) downstream of the shearer with and without the mesh. During the head-to-tail cut pass, dust levels were reduced with the mesh by 52 and 43 pct at 30.5 m (100 ft) and 71.0 m (200 ft) downstream of the shearer, respectively. These results were very similar to the Lake Lynn Laboratory tests. However, during the tail-to-head cleanup pass, negligible dust reductions were achieved downstream of the shearer. Part of the mesh surface during this pass was not always parallel to the airflow since supports were advanced between the shearer and downwind sampling locations. The mesh was perpendicular to the airflow where the supports were being advanced, which probably caused dusty air to pass through the mesh. Thus, the mesh material must be parallel to the airflow to be effective. Airflow measurements taken over the face conveyor and in the worker walkway indicated that the mesh curtain had minimal effect on the face ventilation characteristics of this operation.

Longwall Application Challenges

For the mesh partition to work effectively, several operational issues must be addressed. The mesh partition concept was found to separate effectively one split of ventilation into two separate splits provided the mesh was parallel to the airflow. Improved application methods must be developed to reduce the significant bends in the mesh (perpendicular to the airflow) created by support movement during the USBM's underground study. One possible technique to curtail these significant mesh deviations is to hang the mesh from cable supported by heavy-duty, self-adjusting, "pogo-stick-type" poles secured to the face conveyor. This system would eliminate the mesh orientation dependence on shield movement and would subject the mesh to milder orientation deviations of less than 5 degrees.

Poor visibility of the face area through the mesh also was encountered underground by the shearer operators. The cap lamps mounted to the shearer did not provide adequate backlighting necessary for suitable worker visibility. This lack of visibility through the mesh can probably be resolved by providing higher intensity lights powered by the shearer and/or additional shield-mounted lights on the face side of the mesh.

Since the mesh restricts the intermixing of the face and walkway airflows, dust and/or methane produced at the face or workway area will be subjected to less dilution and diffusion. Application of this concept at gassy longwalls could possibly lead to higher than normal methane levels at the face or in the walkway depending on its origin (such as the face, floor, or gob). Thus, more methane monitoring and caution must be used when applying this concept in gassy mines.

For More Information

Further details or additional information about this development may be obtained by contacting the principal investigator for this project:

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