tailgate side, with some air traveling right behind the shield line. On the face, part of the air enters the gob in front of the shearer (path of least resistance) and comes back on the face inby the shearer. For the flow in the gob, air enters the shield legs on the headgate side of the face and travels from the front of the gob toward the back bleeder entries. In the bleederless configuration, air traveled along the length of the face from the headgate to the tailgate. Similar to the bleeder system, a portion of air traveled behind the shield line. However, both the data and smoke visualization showed that in this case, some air came back on the face near the mid-face region. A similar phenomenon of more than one pathway of air and movement from the gob to the face has also been observed in a recent field study we conducted [2]. Such movement of air in the gob's void space may have severe mine safety implications, as the coalbed methane can get mixed with air and come back on the face on the tailgate side.

As the void space behind the shields increases, airflow on the face decreased and airflow in the gob increased significantly. For 4.57 m (15 ft) of void space behind the shields, airflow decreased on the face for both bleeder and bleederless scenarios. In addition, velocities as high as 0.85 m/s (167 fpm) were recorded in the gob. For 9.14 m (30 ft) of void space, the airflow on the face decreased further, leading to very low air quantities on the tailgate side of the face. The air velocities recorded in the gob were 0.31 to 0.41 m/s (60 to 80 fpm) for the bleeder configuration and 0.61 m/s (120 fpm) for the bleederless configuration (Fig. 2). In the rare scenario with 13.7 m (45 ft) of void space behind the shields, a major portion of the airflow moved into the gob from the face. In this case, for both ventilation configurations, there was a high degree of air recirculation and eddy formation in the gob. The results suggest that if there is a large volume of void space behind the shields, it can be very difficult to ventilate the face with either a bleeder or bleederless ventilation system. The air leakage from the face through the shields is pronounced, and the void space creates a low-resistance pathway of flow that can potentially cause both gas and spontaneous combustion problems. The study showed that caving characteristics have a significant impact on the ventilation of a longwall panel. ■

Disclaimer

The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Mention of any company or product does not constitute endorsement by NIOSH.

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Performance of a new fan silencer prototype for auxiliary ventilation

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Keywords: Health, Safety, Mine ventilation, Auxiliary fan, Noise-induced hearing loss (NIHL)

To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

Noise-induced hearing loss (NIHL) is prevalent in mechanized underground mines. Federal regulations are often not complied with effectively. Miners are also prone to ignoring administrative guidelines and/or personal protective equipment for hearing conservation. As a result, quality of life among experienced miners plummets while occupational risks increase at workplaces. This research focused on auxiliary fans used in underground mines. These fans work at high rotational speed and generate extremely high levels of noise in close proximity to miners. Silencers used are often of little effect due to poor maintenance. A new silencer is tried in the laboratory with the objective of easy maintenance and resulting reduction of noise exposure for miners.

Background

Sound levels in active underground mine workings us-

Fig. 1 Ring-style silencer and silencer extension with repackable section.

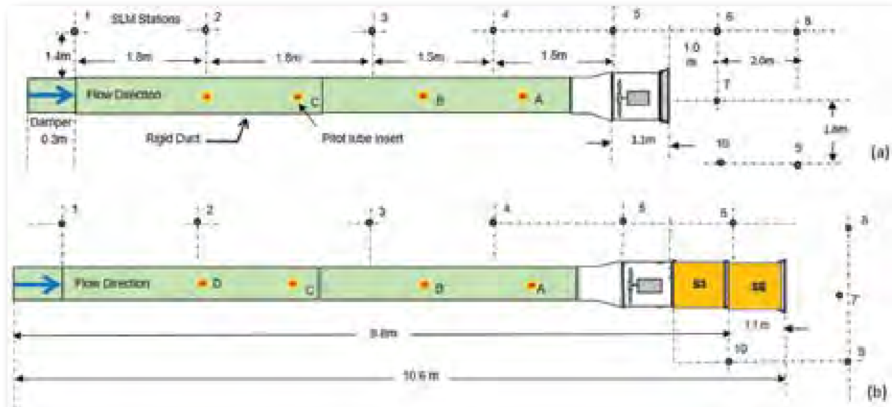

Fig. 2 Laboratory test layout for noise testing: (a) fan only and (b) with silencer and extension.

ing auxiliary fans can reach up to 121 dB(A), or A-weighted decibels. Use of silencers seldom ensures permissible exposure level (PEL). Overexposure of noise induces permanent hearing loss. A research project funded by the U.S. National Institute for Occupational Safety and Health (NIOSH) and field studies at six coal and noncoal mines revalidated these findings.

The University of Utah undertook laboratory studies to reduce fan noise at the source. A new silencer prototype with varying noise-dampening materials was designed and tested. The silencer and associated extension can be repacked with different dampening materials and in various configurations. The tests demonstrated a maximum sound level attenuation of about 14 dB(A) at the fan discharge. A properly designed silencer offers lesser resistance and thereby better fan performance and lower energy cost. The repackable silencer is more likely to be maintained properly. Lowering of noise level is achieved in audible frequencies (4,000 to 8,000 Hz), which are important in A-weighting.

In hard rock mines, auxiliary fans are used in blower configuration to ventilate development headings and large production stopes, and to ventilate areas such as underground maintenance workshops, crushers and conveyor transfer points. Typical duct diameters in hard rock mines vary from 0.91 to 1.21 m. In coal mines, auxiliary fans are used in exhaust configuration with rigid ducts 0.61 to 0.76 m in diameter to ventilate working faces in gateroads and main entry developments.

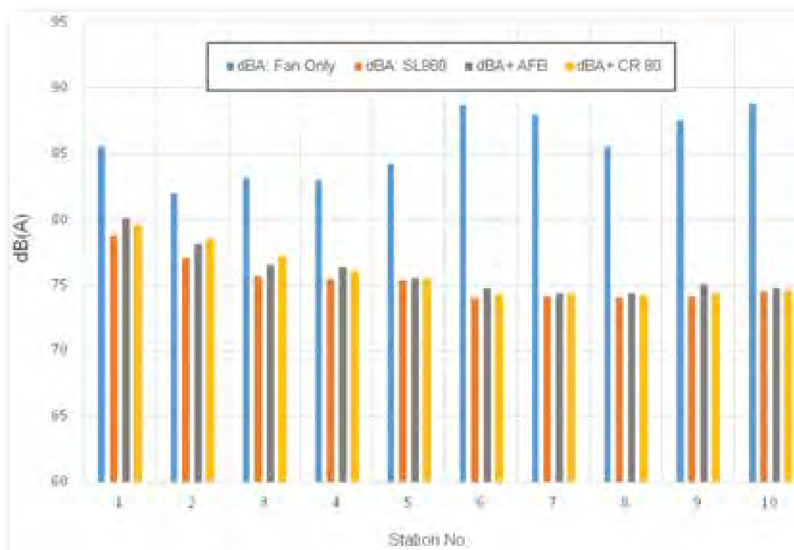

Fig. 3 Comparison of sound levels for four fan-silencer configurations.

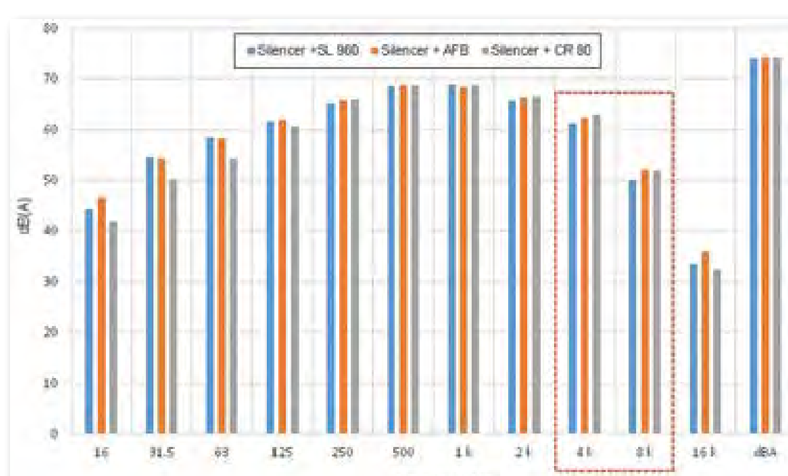

Fig. 4 Comparison of sound levels for different frequency bands for samples collected at station 7. The red box shows the frequencies at which hearing loss begins.

Sometimes, rock dusters are added at the discharge end to dust the roof, ribs and floor.

Laboratory model at the University of Utah

An auxiliary ventilation system model was set up in exhaust configuration. The system includes a 7.5-kW axial flow fan, a silencer, 0.51-m-diameter ductwork and a damper. The fan is installed with a fiberglass ductwork attached to its inlet and a ring-style silencer at its outlet. The inlet is equipped with a damper to simulate ducts of longer length and a variable-frequency drive to change the fan speed between 0 and 1,800 rpm (60 Hz).

The laboratory model included a prototype silencer consisting of two sections: a modified ring-style silencer and a repackable silencer in which the sound-absorbing material can be retrieved and replaced (Fig. 1). The auxiliary ventilation system model was tested at the maximum fan speed of 1,800 rpm with the inlet duct damper wide open. Then, the tests were repeated after the damper cross-sectional area was reduced by 25-percent increments to simulate longer ducts. The testing setup and sampling points are shown in Fig. 2.

Four cases of fan performance and sound attenuation tests are presented: (1) fan system without silencer or extension, (2) fan system with a new ring-style silencer and extension with ProRox SL960, (3) fan system with a new ring-style silencer and extension with ROXUL AFB and (4) fan system with a new ring-style silencer and extension with ROXUL CR 80. Insulation material in the ring-style silencer itself was unchanged (SL960).

Analysis of results

Figure 3 shows a comparison of average sound levels for the four tests presented in this study. These were developed based on average sound levels. Based on this figure, it can be concluded that utilization of these silencers reduced the noise level by about 7 dB(A) at station 1, near the system inlet, and by about 14 dB(A) at station 7, at the system discharge. A close look at the histograms shows that the silencer with SL 960 insulation material provides better protection than the other materials.

Figure 4 shows sound-level histograms for the last three tests when the sound-level monitor was held at station 7. Based on these histograms it can be concluded that the three insulation materials have practically the same noise-absorbing characteristics. A closer look, however, shows that CR 80 outperforms the other materials in the low frequency bands. Figure 4 also shows the equivalent sound levels in dB(A) for the frequencies at which humans can hear the best. A comparison of sound levels in the 4,000 to 8,000 Hz range (red box) reveals that SL 960 outperforms AFB and CR 80 by about 2 dB(A).

Among other findings, this study found that, compared to the base case (test 1), utilization of the ring-style silencers reduced the fan capacity by about 5 percent and increased the fan pressure by about 8 percent, regardless of the type of material used. This is explained by the additional resistance to airflow caused by the pod-type silencers. ■

References

A list of references is available in the full article.

Evaluation of post-blast re-entry times based on gas monitoring of return air

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Keywords: Ventilation, Blasting, Re-entry time, Gas monitoring, Contaminant spread

To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

Blasting is the main method of production in many noncoal underground mining operations, producing multiple toxic gases. The U.S. Mine Safety and Health Administration (MSHA) requires mine operators to measure the level of toxic gases in mines as frequently as necessary to ensure they are below regulatory safety limits. The current practice uses portable gas monitors to check the concentrations of toxic gases after a fixed post-blast time. This paper studies the application of a gas-monitoring system in the return entry of a limestone mine to determine a safe re-entry time. The study shows that