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Technology News

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Floor Heaters Can Increase Operator's Dust Exposure in Enclosed Cabs

Objective

To reduce equipment operator exposure to respirable dust in enclosed cabs by examining the effectiveness of retrofitting air pressurization and filtration systems on existing cabs.

Background

Many types of heavy equipment are used in mining, construction, and agriculture. Most have enclosed cabs to protect the equipment operator from excessive dust and noise exposure. When the equipment is new, controls are normally implemented into the cab to keep these exposures at acceptable levels. However, as this equipment becomes older, many components of the enclosure deteriorate, such as gaskets and seals. This causes the effectiveness of the enclosed cab to be greatly reduced. Once this occurs, the equipment operator's dust exposure can increase to hazardous levels. In surface mining operations, elevated exposures to crystalline silica have caused an excessive incidence of silicosis.

Approach

A cooperative research study with a mining operation and a cab filtration company was conducted to evaluate the effectiveness of retrofitting an older surface drill with two controls to lower the drill operator's respirable dust exposure. These two controls were:

(1) A good air filtering and pressurization system to ensure that clean air was delivered into the enclosed cab. Ideally, the incoming air filter should be 99% efficient in removing particles with an aerodynamic diameter of 0.3 μm or greater from the airflow.

(2) Sufficiently sealing the cab to develop a positive static pressure and ensure that dust was not leaking into the cab. This was done by plugging all holes and cracks and maintaining good gaskets and seals. To prevent wind from forcing contaminated air through holes in the cab, the cab's static pressure must be greater than the wind's velocity pressure.

During the course of this research, it was found that a floor heater fan used in the drill during the winter months greatly increased the operator's respirable dust exposure.

Problem Identification

Four days of background dust levels were measured as a baseline for this research. These baseline measurements were taken in May 2000 when air temperatures ranged from 60° to 70° F. When this was completed, the two controls were implemented. The first control was to install an improved air filtering and pressurization system on the enclosed cab. This was composed of a two-stage prefilter, a blower, then the respirator-medium secondary filter. Since the secondary filter was on the positive side of the fan, all air delivered into the enclosed cab had to pass through this secondary filter. After the filtering system was installed, the cab was pressurized to a static pressure of 0.01 inches of water (w.g.), which is still very minimal. The second control was to seal the cab. New door gaskets were installed, and all cracks and holes in the shell of the enclosure were plugged. This increased the cab pressurization to approximately 0.1 inches w.g.

With these changes implemented and everything working properly, the identical dust analysis was repeated to determine the effect on the drill operator's dust exposure. The posttesting dust measurements consisted of 2.5 days of testing in November 1999 and 2 days of testing in January 2000. Since this testing took place in winter conditions with low outside air temperature, the cab had to be heated. The heater unit used in this enclosed cab was a radiator heater located near the floor (figure 1). This is a very common type of heater used in many types of heavy equipment.

Figure 2 shows the respirable dust levels inside the enclosed cab for both pretesting (baseline) and posttesting (with floor heater in cab). NIOSH anticipated that in the posttests, dust levels would decrease because of the improvements made to the cab. Instead, respirable dust levels increased from 0.04 mg/m^3 during pretesting to 0.68 mg/m^3 during posttesting. NIOSH hypothesized that the floor heater in the cab was the primary cause of this dust increase. It was believed that dust was generated from the drill operator's boots

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grinding and stirring up material on the floor and from dust being blown off of the operator's clothing.

The drill was taken into the shop, and testing was done with optical particle counters to evaluate whether the floor heater was the significant source of dust contamination to the drill operator. Initially, the first test was to monitor particle levels with only the air filtration and pressurization system operating (figure 3, test 1). Next, the recirculation system was operated, which also provides air conditioning to the cab in the summer months (test 2). The recirculated air in this second ventilation system was not filtered. Finally, both systems were operated along with the floor heater (test 3). Once this test series was completed, another series was repeated, with the particle-counting instruments switched from outside to inside the cab to minimize the effects of any instrument biases.

The results confirmed that the floor heater was the dust source. Inside cab concentrations averaged 0.01 mg/m^3 for test 1, 0.03 mg/m^3 for test 2, and 0.26 mg/m^3 for test 3 when the floor heater was operating. The concentrations for test 3 were a ninefold increase over those for test 2 and a 27-fold increase over those for test 1. Figure 3 also indicates that respirable dust levels inside the cab were higher than those outside the cab when the floor heater was used.

The perspective on enclosed cabs has always been to provide clean air into the enclosure and maintain pressurization to keep dust from coming into the cab from outside. The floor heater problem identified in this research adds a new perspective to providing dust protection to the operator in the enclosed cab. The floor heater is a serious problem because the floor is the dirtiest part of the cab, since the operator brings a significant amount of dirt into the cab floor on his or her work boots. Then, as the operator moves his or her feet around in the cab, dust is created, which is then blown throughout the enclosure by the fan on the floor heater. The fan on the floor heater also tends to stir up dust that may be on the drill operator's clothes.

Recommendations

Because of the significant increase in dust levels with the floor heaters, NIOSH recommends that they not be used in their present location. If needed, they should be repositioned to a higher area in the enclosure where they are less prone to pick up dust from the floor and the operator's clothes. The best solution would probably be to implement a heating and air-conditioning unit into the clean air and pressurization system.

In addition to removing cab heaters from the floor, this study identified two ways to minimize the problem of dust generation inside of cabs. First, use a highly efficient recirculation filtration system to capture dust that is generated by the operator or other sources inside the cab. Second, practice good housekeeping by keeping the floor and other internal cab surfaces as clean as possible. Also, keep the operator's clothing and boots as clean as possible.

For More Information

For more information about controlling dust levels in enclosed cabs, contact Andrew B. Cecala or John A. Organiscak, NIOSH Pittsburgh Research Laboratory, Cochrans Mill Rd., P.O. Box 18070, Pittsburgh, PA 15236-0070, phone: (412) 386-6677 or (412) 386-6675; fax (412) 386-4917; e-mail: **aic1@cdc.gov** or **jdo3@cdc.gov**; or William A. Heitbrink, NIOSH Division of Applied Research and Technology, 4676 Columbia Parkway, Cincinnati, OH 45226, phone: (513) 841-4376; fax: (513) 841-4506; e-mail: **wah2@cdc.gov**.

To receive additional information about occupational safety and health problems, call **1-800-35-NIOSH (1-800-356-4674)**, or visit the NIOSH Web site at www.cdc.gov/niosh

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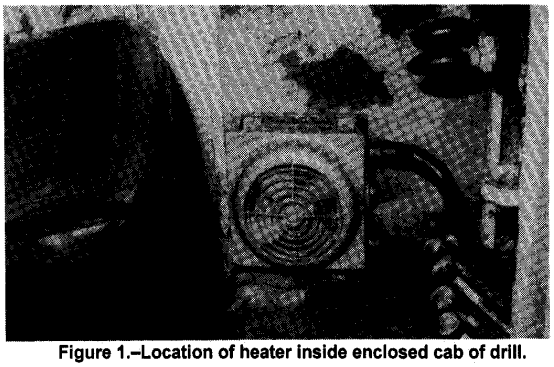

Figure 1.–Location of heater inside enclosed cab of drill.

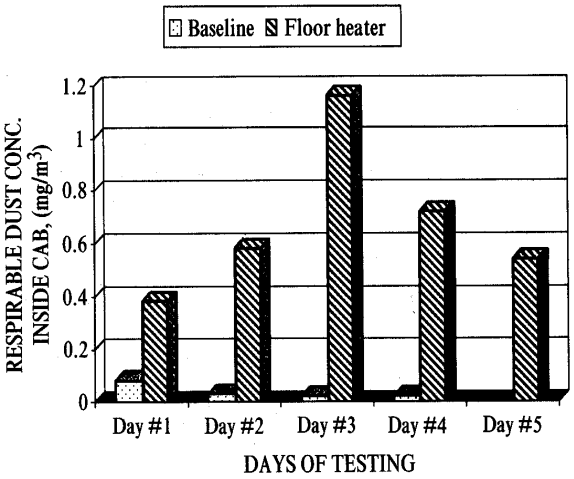

Figure 2.—Drill operator's respirable dust exposure with and without floor heater.

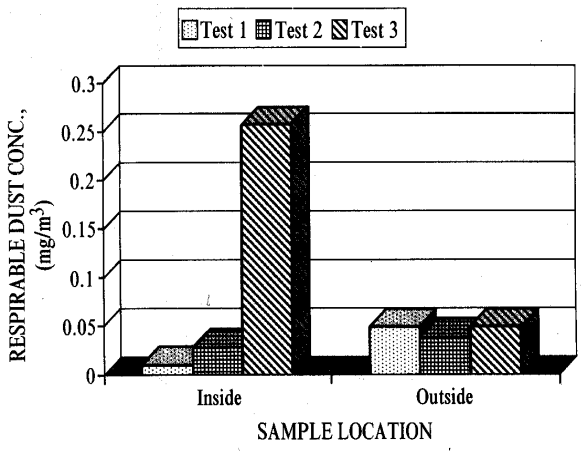

Figure 3.—Shop testing to determine increase in drill operator's respirable dust exposure with floor heater.