CDC NIOSH Workplace Safety and Health

Technology News

No. 523 Milestones in Mining Safety and Health Technology February 2007

Evaluation of Dust Collector Bags for Reducing Dust Exposure of Roof Bolter Operators

Objective

To evaluate the effectiveness of dust collector bags for reducing dust liberation from a roof bolter dust collection system.

Background

Respirable dust exposure in underground coal mines during the roof bolting process continues to be a problem for roof bolter operators. During 2000–2004, Mine Safety and Health Administration (MSHA) inspectors collected nearly 5,000 respirable dust samples for roof bolting occupations. Of these samples, 20% exceeded a respirable silica dust concentration of 100 $\mu g/m^3$, a level that MSHA considers excessive. From these data, it is clear that roof bolter occupations exhibit a continued risk for overexposure to respirable silica dust.

Most roof bolting machines use an MSHA-accepted (30 CFR 33) vacuum dust collection system to capture dust as holes are drilled. A vacuum pump on the machine draws the dust through the bit and drill steel into an enclosed dustbox. The box has several compartments and functions as a rough size classifier, allowing the coarser dust sizes to settle out of the airstream first in the large compartment (about 95% of all the dust entering the box). The dust that passes through the large compartment is routed through cyclones and then into the filter chamber for deposition on a paper canister filter. The filtered air flows through the vacuum pump, a noise-reducing muffler, and then is exhausted into the mine environment. The dustbox and filter are usually cleaned on a preselected schedule to avoid overfilling the box and/or overloading the filter. Normally the dustbox is emptied at the end of every cut. As the filter accumulates fine particles of dust, resistance increases and flow through the system decreases, requiring removal and cleaning of the filter, usually after several cuts.

The majority of the dust is collected in the main (large) chamber of the collector. This dust is removed from the collector box by opening the door and pulling a "rake" toward the opening to drag the dust out, allowing it to dump onto the mine floor. Operator exposure occurs when this dust is entrained into the air as it falls from the box to the floor. Another source of exposure is from the canister filter. Dust that is too fine to be captured in the main and subsequent dustbox chambers passes through to the filter. Typically, filters are cleaned by shaking or tapping against the rubber tire of the bolter or a hard surface. This method of cleaning often creates a respirable dust cloud that contaminates the breathing area of the operators. The operator must take care not to damage the filter, filter seal, or dustbox door seal during the cleaning cycle, as dust not captured by the filter or that bypasses the filter seal is exhausted into the mine air. In addition, care must be taken to stay upwind of the dustbox during cleaning.

Approach

A laboratory study was conducted to evaluate the use of vacuum bags in the dust collector for improving dust capture efficiency. A Fletcher® dust collector box, typical of many found on underground bolters, and a model AP–228 dustbag were configured in the lab to simulate roof bolter drilling dust collection. The bags are MSHA-accepted for retrofit in Fletcher® dustboxes. Testing was performed with and without the bag installed. Airflow through the box was provided by a vacuum pump rated at 60 cfm at 20 inches Hg. Dust was fed into the box using an AccuRate bulk dust feeder with a 2¼-in screw.

Fifty pounds of ground limestone, similar in size distribution to dust collected from bolter dust collectors in use, was used as feed material for each test. The bags and canister filter were weighed after each test to determine the dust capture inside the box. Dust concentrations in the exhaust were recorded continuously in a 6-in-diam pipe using a RAM–1 instantaneous dust monitor. Aerodynamic particle sizes were measured in the exhaust using a TSI Aerodynamic Particle Sizer (APS). A laptop computer was interfaced with the APS and data acquired using the available TSI software. Aerosol was drawn isokinetically into the diluter at 5 L/min through a 4-ft length of 0.31-in ID conductive tubing. Particle sizes were measured in the 6-in-diam pipe, roughly 8 ft away from the entry of the 2-in hose into the PVC pipe. Vacuum pressures within the box and across the filter were also recorded continuously during each test. A total of 60 tests were conducted (30 with the bag installed and 30 without).

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Figure 1.—Condition of main chamber before test (top), after test without bag (center), and after test with bag (bottom – note retrofit kit installed).

Results

The laboratory dust collector tests showed that 99.6% of the test dust fed into the collector was captured by the dustbags. Figure 1 shows the condition of the main chamber before and after testing. Total weight gain on the canister filter was over

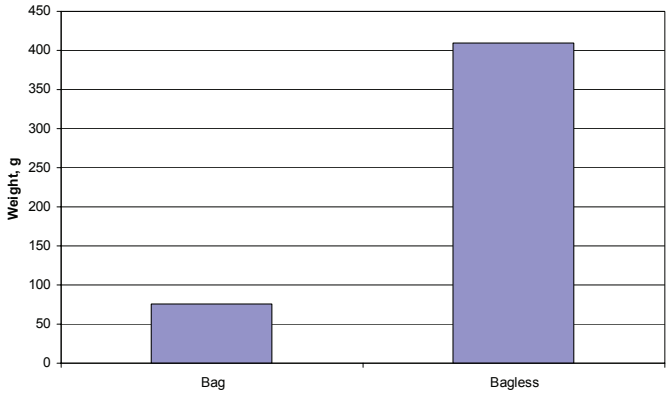

Figure 2.—Comparison of total weight gain on canister filter after 30 tests for each condition.

five times greater without use of the bag (Figure 2). The RAM–1 unit showed respirable dust levels in the collector exhaust to be over two times higher when tests were conducted without the bags in place. The APS showed that the number of total dust particles emitted from the exhaust was two times greater when the tests were conducted without the bags. Since nearly all the dust is contained in the bag, operator exposure is improved when emptying the collector box's main chamber. Filter loading is greatly decreased when using the bags, enabling longer periods of drilling without filter removal/cleaning. Pressure drop across the filter for all tests ranged from 3.0 to 3.3 in w.g. when the bag was used and from 4.0 to 8.4 in w.g. without the bag. Filtered air emitted from the collector has less respirable dust and fewer total dust particles when the bags are used. These results show that benefits from use of the bags are realized in all areas of operator exposure. In order to use these bags in underground coal mines, the dustbags must be accepted by MSHA as an optional item for the specific dust collection system and machine model (30 CFR 33). In addition, the collector must be equipped with a predump option and must have a retrofit kit installed inside the collector to connect to the bag.

For More Information

For more information on roof bolter dust collector bags, contact Jeffrey M. Listak (412–386–5082, JListak@cdc.gov) or Timothy W. Beck (412–386–4776, TBeck@cdc.gov), NIOSH Pittsburgh Research Laboratory, P.O. Box 18070, Pittsburgh, PA 15236–0070.

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

Mention of any company name or product does not constitute endorsement by the National Institute for Occupational Safety and Health.

DHHS (NIOSH) Publication No. 2007–119