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A SECOND CASE STUDY OF FIELD TEST RESULTS FOR COMPARISON OF ROOF BOLTER DRY COLLECTION SYSTEM WITH WET COLLECTION SYSTEM

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ABSTRACT

Silicosis is an occupational respiratory disease that roof bolter operators are susceptible. It is caused by over-exposure to respirable quartz dust (RCS), and has no cure and may ultimately be fatal. The only method of prevention of silicosis is by preventing exposure to RCS. The wet box collection system is a newly developed dust collection system for roof bolting machines; a modification of the existing dry box collection system utilizing water to saturate the material that is collected by the dust collection system. Testing was conducted for three days on a dual boom roof bolter with the wet box installed on the left side and the dry box installed on the right side. Sampling, using the coal mine dust personal sampling unit (CMDPSU), during cleaning of the collector boxes demonstrated that using the wet box dust collection system instead of the dry box dust collection system can reduce RCS exposures during cleaning of the collector boxes by 71% (day 1), 82% (day 2), and 88% (day 3). In addition, the quartz content of samples collected during cleaning of the wet box were 0.0%, while the quartz content of the samples collected when cleaning the dry box was 4.6%, 10.3%, and 7.4%.

KEYWORDS: Respirable dust, Roof bolter, Coal, Silica dust

INTRODUCTION

Respirable quartz (silica) dust is a health hazard to which roof bolter operators can be exposed. Overexposure to respirable quartz dust can result in the incidence of silicosis—an occupational respiratory disease that has no cure and may ultimately be fatal—which can only be prevented by eliminating exposure to respirable quartz dust [Lara 2020]. Sources of exposure to respirable coal mine dust for roof bolting occupations include frequent maintenance and cleaning of the vacuum dust collection system [Goodman and Organiscak, 2003]. The Mine Safety and Health Administration (MSHA) set the respirable coal mine dust standard at 1.5 mg/m^3; this is the maximum allowable respirable coal mine dust for a full working shift in the active workings [Code of Federal Regulations, 30 CFR 70.100, 2017]. If respirable quartz greater than 100 micrograms per cubic meter equivalent concentration is encountered in the atmosphere, then the coal mine respirable dust standard is reduced to 10 divided by the percentage of silica from sampling [Code of Federal Regulations, 30 CFR 70.101, 2017]. This standard can be significantly lower than the 1.5 mg/m^3 respirable coal mine dust standard.

Roof bolter machines typically use a dry vacuum dust collection system that collects the cutting material when drilling the roof bolt holes in the mine roof in underground coal mining. A few operations use a wet drilling system where water is used to flush the cutting material from the bolt holes. However, the dry vacuum dust collection system is more common. These systems are used to aid in the prevention of exposures of roof bolter operators to respirable quartz dust.

Recently, a modification was made to the dry collector system to convert it to a wet collector system. This system was originally developed at the Deserado Mine located in Rangely, CO [Reed et al. 2019]. The system at the Deserado Mine was tested by researchers from the National Institute for Occupational Safety and Health (NIOSH). However, even though some of the data was compromised, researchers were able to conclude that using a wet box collection system could provide dust reductions of up to 60% during cleaning over the dry box collection system [Reed et al. 2019].

The wet collector system uses a vacuum system to pull material from the vertical roof bolt hole but incorporates a #2 continuous miner spray located inside the dust box at the bottom with its orientation directed towards the inlet. The flow through the nozzle is rated at 2.4 liters (0.63 gpm) at 0.7 MPa (100 psi). Random checks of the water flow meter throughout the study indicated the waterflow was consistently 3.8 liters/min (1.0 gpm) when the water was turned on. The conversion to the wet collector system removes the pre-cleaner and the cyclones inside the dust box. The wet material (sludge) then empties through a drain in the bottom of the box onto the mine floor.

Emptying the collector box is controlled by a rotary valve at the drain location, and this action is performed when drilling and roof bolting is completed. The rotary valve is opened and closed using a control lever located at the roof bolter operator's working position. The final filter is a specially designed filter that is water resistant and is still used to prevent respirable dust from leaving the dust box through the exhaust. During operation, the wet collector dust box is opened and hosed clean after roof bolting 12.2 m (40 ft) of entry or at least after every shift.

The mine's management requested NIOSH to test the wet system in conjunction with the dry collection system and to compare the dust concentrations encountered when operating and when cleaning out each system to determine their performance for dust control.

TEST LOCATION

Field testing occurred on a roof bolting machine in a longwall three-entry development section at the West Elk Mine in Colorado. The mine used a ventilation tubing setup with an exhausting face ventilation arrangement. The entries were numbered 1 through 3, with entry #1 as the intake and entry #3 as the return. Each entry had ventilation tubing exhausting air from the entry using three separate ventilation fans (one for each entry) that were located in the return entry #3 (Figure 1).

The roof bolting machine was a J.H. Fletcher dual boom crawler high seam bolter with inside controls with the rib bolting option (model #: CHDDR, serial #: 91-102). The roof bolter machine had J.H. Fletcher's dry collection system installed on the intake (right) side of the roof bolter. The dust material was collected inside the physical dimensions of the dry box instead of using bags to collect it. The return (left) side of the machine had J.H. Fletcher's new wet box collection system installed. Testing of these systems occurred simultaneously over three working shifts. Figure 2 shows the inside of the wet box and the dry box, both in a clean condition (i.e., no dust inside the boxes).

Sampling method

Both gravimetric and instantaneous samplers were used for testing to determine the wet box collector system's ability for respirable dust control. The gravimetric sampler, also known as the coal mine dust personal sampling unit, consisted of an ELF Escort pump operating at 2.0 L/min, a 10-mm Dorr-Oliver cyclone, and a 37-mm 5-µm PVC filter in a coal cassette. The instantaneous sampler was the pDR-1000. Sampling packages, comprised of two gravimetric samplers and one instantaneous sampler, sampled respirable dust at different locations in the roof bolter entry. Figure 1 shows the locations of the sampling packages.

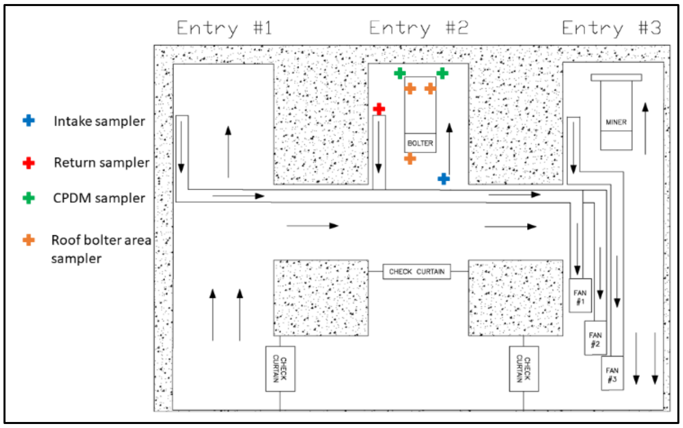

Figure 1. Locations of sampling packages for testing the dry dust collector and the wet dust collector. Entry #1 is intake and Entry #3 is return.

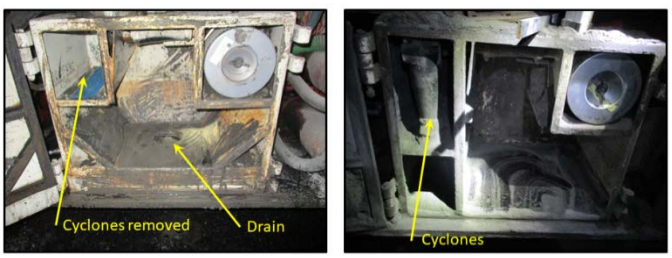

Figure 2. Inside view of the wet box (left) and the dry box (right).

The intake sampler (blue) was located in the intake of the roof bolting entry. The return sampler (red) was located in front of the exhaust tubing. This sampler was moved as the exhaust tubing was advanced. Additional sampling packages (orange) were placed near or as close to the roof bolter operators on the left/return and right/intake side of the bolter. Another was located behind the roof bolter machine in the dust collector exhaust flow. Finally, each operator was outfitted with a continuous personal dust monitor (CPDM). This allowed determination of respirable dust levels at the roof bolter operator position during operation.

For sampling collector box cleanout/inspection activities, sampling vests consisting of four gravimetric samplers and a pDr-1000 were used by operators, one vest worn for each dust box (wet and dry). One set of two filters was changed out for each cleanout, and the other set of filters was used the entire day sampling all cleanouts. The operator conducting the cleanout/inspection of the dust collector boxes wore a vest during this operation, with the samplers turned on prior to donning the vest. Once completed, the vests were removed from the operators, the samplers were turned off, and the vests were stored in a clean location, either inside a pelican case or in intake air, until their next use.

Testing

Prior to bolting each entry, a vacuum pressure measurement was taken at each bolter head using a J.H. Fletcher pressure gauge to ensure the dust collection system was operating properly. Throughout testing the dust collector vacuum pressure was stable at 17.0–19.0 in. Hg for both sides of the roof bolter, which was above the rated minimum vacuum pressure on the roof bolter plate.

The roof bolter dust collector wet box also had pressure gauges installed for the inlet and outlet of the wet box. Typical operating pressure differentials ranged from 1.0 to 7.0 in. Hg during the study. Higher pressure differentials (>10.0 in. Hg) were encountered at the end of the study, but this was due to the operator neglecting to shut off the water to the wet box during a roof bolter machine idle time. During this instance, the box had filled with water resulting in the inlet being plugged, which required material removal from the box. J.H. Fletcher representatives stated that the wet box final filter has been redesigned so that water should not negatively impact its filtration ability.

Ventilation measurements to determine airflow quantity and velocity into the bolting machine entry were recorded for each entry. The operators were expected to follow their normal ventilation plan. Additionally, new dust collector filters were in place at the beginning of testing. Table 1 shows the ventilation information gathered during the study.

Table 1. Entry locations during testing with corresponding face ventilation information.

Date	Entry	Width (cm)	Height (cm)	Airflow Quantity (cfm)	Mean Entry Air Velocity (fpm)
8-Oct	Entry 2 Right	643	284	14,570	0.4
8-Oct	Entry 1	625	305	14,570	0.4
8-Oct	Entry 2 Right	549	307	14,570	0.4
9-Oct	Entry 1	625	279	17,600	0.5
9-Oct	Entry 2	559	302	17,100	0.5
9-Oct	Entry 2	615	274	17,100	1.5
10-Oct	Entry 1	706	292	16,660	0.4
10-Oct	Entry 3	551	320	18,070	0.5
10-Oct	Entry 1	704	292	16,640	0.4
10-Oct	Entry 1	627	328	16,640	0.4

Once the samplers were set up, testing began. The roof bolter operators completed their normal tasks. The sampler for the collector exhaust advanced with the roof bolter machine. Time studies were conducted on the roof bolter machine monitoring bolter operation.

Respirable dust sampling was conducted during dust box cleanout/inspection. Cleanout/inspection occurred after completion of each bolting location. At this point in time each operator was outfitted with the personal sampling vest. The actions of operators when opening the dust box for cleanout and the amount of time required to perform the task were recorded. During cleanout, bulk samples were taken of the material in the dust box. The changeout of filters was dependent upon the mine's normal changeout schedule.

This study was conducted over three days for testing of the dry collection system roof bolter machine simultaneously with the wet collection system roof bolter machine. Three bolting locations per day were obtained in order to obtain the necessary information to determine collector system performance.

Silica analysis

Filters from gravimetric samplers were analyzed to determine the amount of crystalline silica present. One filter with the most mass of respirable dust collected was selected from the gravimetric sampling packages. The selected filter samples were sent to an external laboratory to be analyzed using the standard NIOSH 7500 method [NIOSH 2003]. The results of the analysis provide information on the respirable quartz content (%) for each sample and are presented in the following Tables 2 through 6 that present the respirable dust concentrations.

RESULTS FROM SAMPLE FILTERS

The following presents the results from the gravimetric and CPDM sampling during the study. It should be noted that the results from the filters and CPDM cannot be used for compliance sampling. In order to compare the gravimetric results with the CPDM results, all samples must be converted to MRE (Mine Research Establishment)[1] equivalent results. For the gravimetric samples, the MRE equivalent is 1.38 times the sample concentration result (Tomb et al., 1973). For the CPDM samples, the MRE equivalent is 1.05 times the sample concentration result (Page et al., 2008). All results from the gravimetric filters and CPDMs are shown as MRE equivalent.

The data from pDR-1000 was available. Since the evaluation of the wet box collector and dry box collector at the operator location was conducted over the entire daily survey time frame, the pDR-1000 data was not needed. Additionally, during cleanout, the pDR-1000 data was not needed as the gravimetric samplers were turned off and on when cleanout activities occurred.

Intake, return, and roof bolter machine exhaust samples

Table 2 shows the time weighted average (TWA) concentrations and percent quartz from the roof bolter entry intake, entry return, and roof bolter exhaust samples. These samplers operated daily from the time roof bolting started until the end of the survey when roof bolting ended. These samplers were turned on and turned off while underground.

Table 2. Respirable dust concentrations for the roof bolter entry intake, entry return, and roof bolter exhaust during testing.

Date	Filter Location	Time	Concentration (mg/m^3)	% Quartz
8-Oct-19	Intake	375	0.853	0.0
8-Oct-19	Intake	376	0.858	NC
8-Oct-19	Return	379	0.870	NC
8-Oct-19	Return	380	0.882	6.6
8-Oct-19	Roof bolter exhaust	376	0.845	NC
8-Oct-19	Roof bolter exhaust	376	0.855	6.8
9-Oct-19	Intake	304	1.265	NC
9-Oct-19	Intake*	305	1.338	0.0
9-Oct-19	Return	376	1.681	NC
9-Oct-19	Return	377	1.331	5.2
9-Oct-19	Roof bolter exhaust	299	0.985	0.0
9-Oct-19	Roof bolter exhaust	299	0.927	NC
10-Oct-19	Intake	356	0.729	NC
10-Oct-19	Intake	357	0.737	0.0
10-Oct-19	Return	365	0.717	NC
10-Oct-19	Return	366	0.807	0.0
10-Oct-19	Roof bolter exhaust	371	0.631	0.0
10-Oct-19	Roof bolter exhaust	370	0.605	NC

*filter casing was cracked but no damage to filter
NC – No silica analysis completed

The entry intake and return sample TWA concentrations are nearly similar for each day of testing. The roof bolter exhaust sampler was placed at the dust collection system exhaust location. At this location, the exhausts from both the wet and dry box were located adjacent to each other. The TWA concentrations determined from this sample location include any respirable dust in the airflow from both exhausts. There is no way to differentiate the concentrations for each type of exhaust—wet or dry. The results show that the environmental concentrations were relatively stable throughout testing.

The percent quartz in each sample are generally 0.0%, except for the bolter return and bolter exhaust on October 8th and the bolter return on October 9th. The bolter return samplers were located directly in front of the exhaust tubing inlet. Therefore, this dust was being removed from the entry. The bolter exhaust samplers, being located at the roof bolting machine dust collector exhaust ports, could represent material from those ports or ambient air. The TWA concentrations of the bolter exhaust samples are relatively consistent for each day and are not higher than the TWA concentrations from the intake and return samplers. Any dust from the bolter exhaust most likely flows to the exhaust tubing intake and does not reach the bolter operators. Table 3, which shows the respirable dust concentrations and percent quartz at the bolter operator locations, does not show any high percent quartz.

[1] MRE is the United Kingdom Mining Research Establishment which used a sampler designed specifically to match the United Kingdom British Medical Research Council (BMRC) criterion (Page et al., 2008).

Roof bolter operator samples

Table 3 shows the TWA and CPDM concentrations along with the percent quartz of respirable dust encountered for each day of the study. Again, the gravimetric samplers were turned on and turned off while underground, operating from the time roof bolting started until the end of the daily survey when roof bolting ended. The continuous personal dust monitor (CPDM) records the cumulative mass of respirable dust collected in 1-minute intervals [Volkwein et al., 2006]. NIOSH was able to download the data and evaluate the mass collected throughout the shift. To calculate the dust concentrations of a specific time interval, the cumulative mass collected by the CPDM at the beginning of the time interval and at the end of the time interval is used. The intervals are the start and stop times of the gravimetric samplers used in conjunction with the CPDM. The following equation is used to calculate the respirable dust concentration:

$$Conc. = \frac{(Mass_2 - Mass_1) \times 1000}{(2.2 \times Time_{Int})} \quad (1)$$

where

$Conc.$ = the concentration (mg/m^3);
$Mass_2$ = the cumulative mass recorded at end time of time interval (mg);
$Mass_1$ = the cumulative mass recorded at begin time of time interval (mg);
2.2 = flowrate of the CPDM (lpm);
$Time_{Int}$ = the total time of the time interval from beginning to ending (minutes);

Table 3. Respirable dust concentrations encountered by roof bolter operators, both gravimetric and CPDM concentrations.

Date	Bolter	Type of collector	Number of bolts drilled	Time (minutes)	TWA* concen-tration (mg/m^3)	TWA percent difference (%)	CPDM concen-tration (mg/m^3)	CPDM percent difference (%)	% Quartz
8-Oct	Left/ return	Wet	50	388	0.845	8.3	0.840	-26.4	0.0
8-Oct	Right/ Intake	Dry	56	307	0.780		1.141		0.0
9-Oct	Left/ return	Wet	41	NA**	NA	NA	0.768	-31.3	NA
9-Oct	Right/ Intake	Dry	43	300	1.068		1.118		1.6
10-Oct	Left/ return	Wet	52	370	0.812	3.0	0.731	-19.1	0.0
10-Oct	Right/ Intake	Dry	65	370	0.788		0.904		0.0

*TWA – Time-weighted-average
**NA – Not available, filters damaged during transport

The left bolter operator's dust collection system was the wet box, while the right bolter's system was the dry box. The left bolter operator was on the return side of the entry, while the right bolter operator was on the intake side of the entry. The gravimetric samplers were set up on the boom of the ATRS, (automated temporary roof support) of the roof bolter (Figure 3). These samplers were located very close to each other, and as such the TWA concentration results are very similar as seen by the percent difference in Table 3. The percent difference was calculated using:

$$\%\,Differ = \frac{(Conc_L - Conc_R)}{(Conc_R)} \times 100 \quad (2)$$

where

$\%\,Differ$ = the percent difference (%);
$Conc_L$ = the TWA concentration of the left bolter (mg/m^3);
$Conc_R$ = the TWA concentration of the right bolter (mg/m^3);

Figure 3. Location of the gravimetric samplers for the left/return side bolter (left) and the right/intake side bolter (right).

Table 3 shows a percent difference of 8.3% for the left/return bolter over the right/intake bolter on October 8th and 3.0% for the left/return bolter over the right/intake bolter on October 10th. The percent quartz was 0.0% with the exception of the right/intake bolter operator location on October 9th, which had 1.6% quartz.

The CPDM showed different results—a -19% to -31% percent difference. The negative percent difference shows the left/return bolter's CPDM concentration being lower than the right/intake bolter's CPDM concentration. The difference between the gravimetric results and the CPDM results may be the fact that the operators wore the CPDM with the inlet located on their lapel and worked in their separate locations. Whereas, the bolter gravimetric samplers were located centrally adjacent to each other.

MSHA requested sampling of roof bolter operators

During the study, MSHA requested roof bolter sampling with sampling occurring only when the roof bolter operators were installing bolts. These samplers were located underneath the canopy on the post supporting the canopy (Figure 4), operating only when roof bolting occurred. NIOSH instructed the roof bolter operators to turn the samplers on when beginning roof bolting operations. When they left the area for other work, they were instructed to place the samplers on hold. Therefore, only respirable dust concentrations during roof bolting activities were obtained with these samplers.

Figure 4. Locations of MSHA-requested respirable dust sampling. The left/return operator sampler corresponds with the wet box collector (left). The right/intake operator sampler corresponds with the dry box collector (right).

Only one day of results is available and is shown in Table 4. Sampling was not conducted on the first day, October 8th, because the final request from MSHA was not received in time. The sampling that was conducted on Oct 10th encountered problems with the pump times not being equivalent after sampling that day. It is assumed that one of the operators forgot to restart the sampling pump when returning to bolting operations. Additionally, the filter numbers were not recorded for that day. Therefore, the Oct 10th sampling is unusable. The sampling collected on Oct 9th (Table 4) showed the return bolter's respirable dust TWA concentration is higher than the intake bolter's TWA concentration. This is possibly due to the sampling location on the canopy post being closer to the rib than the roof bolter gravimetric and CPDM samplers. These samplers would be more within the ventilation airflow with the intake air following the rib on the right side and the return air following the rib on the left side. However, the percent difference is only 18%. The percent quartz in these filters was 0.0% for each location.

Table 4. Respirable dust TWA concentrations measured from MSHA-requested sampling

Date	Bolter	Type of collector	Number of bolts drilled	Bolting Time (min)	TWA concentration (mg/m^3)	% Difference	% Quartz
9-Oct	Left/return	Wet	41	192	0.864	18.2	0.0
9-Oct	Right/Intake	Dry	43	192	0.731		0.0

Dust collector box cleaning

An important aspect of this study was to measure the respirable dust exposure to the roof bolter operators during cleaning of the roof bolter dust collector boxes. The roof bolter operators performed their normal procedures for cleanout/inspection of the collector boxes. To sample respirable dust at this time, operators wore a sampling vest which contained four gravimetric samplers. Two vests were used—one for cleaning of the wet box and the other for cleaning of the dry box. Of concern was obtaining sufficient mass on the filters for silica analysis. Therefore, two samplers on each vest used filters that were not changed out during the study; the same filter was used on Oct 8th, Oct 9th, and Oct 10th. The other two samplers on the vest had their filters changed out daily. These vests only sampled during the cleanout of the boxes. The wet box was cleaned out first with the dry box being cleaned out second. Table 5 shows the TWA concentrations and the percent quartz encountered during the daily cleanouts. Table 6 shows the TWA concentrations and percent quartz from the filters used on all three days of the study.

Table 5. Respirable dust TWA concentrations from cleaning out dust collector boxes.

Date	Bolter	Type of collector	Cleaning time	TWA concentration (mg/m^3)	% Reduction	% Quartz
8-Oct	Left/return	Wet	8	1.257	87.9	0.0
8-Oct	Right/Intake	Dry	19	10.399		4.6
9-Oct	Left/return	Wet	20	0.656	82.3	0.0
9-Oct	Right/Intake	Dry	24	3.696		10.3
10-Oct	Left/return	Wet	17	1.458	71.0	0.0
10-Oct	Right/Intake	Dry	17	5.024		7.4

Table 6. Respirable dust concentration from the single filter used all three days of the study.

Date	Bolter	Type of collector	Cleaning time	TWA concentration (mg/m^3)	% Reduction	% Quartz
8-Oct Thru 10-Oct	Left/return	Wet	45	1.010	82.1	0.0
8-Oct Thru 10-Oct	Right/Intake	Dry	60	5.638		12.0

Results show that the wet box has substantial reductions in respirable dust TWA concentrations when cleaning the boxes, 71% to 88% reductions compared with the cleaning of the dry box. Silica analysis of the gravimetric filters shows that while cleaning the dry box the operator encountered respirable quartz dust with quartz contents ranging from 4.6% to 10.3% quartz. When cleaning the wet box, the operator did not encounter any respirable quartz dust as the quartz contents were 0.0%. This is due to the material being fully saturated and not able to entrain any dust during material movement.

Figure 5 shows the inside views of the wet box and dry box after completion of bolting one entry. It should be noted that although the material is fully saturated, the wet box contains more material than is usually encountered. This is due to the training period required to operate the wet box. Once the vacuum of the dust collector is turned off after bolting, the operator must open the hydraulically actuated valve located at the bottom of the wet box to allow the material to discharge. There were times when the operators had not fully opened the discharge valve. J.H. Fletcher representatives stated that once the wet box is fully utilized, the operators will get a better "feel" for opening and closing the hydraulically actuated valve, which will result in less material in the wet box.

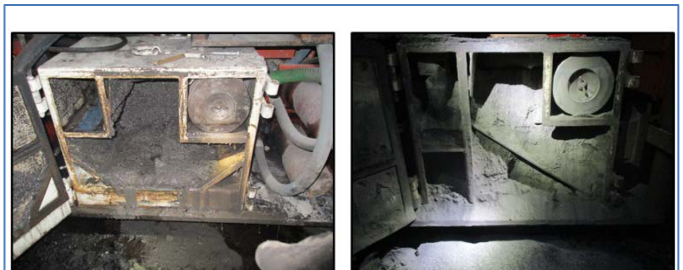

Figure 5. Inside view of the wet box (left) and the dry box (right) after bolting an entry.

Additionally, once the wet box is fully installed, a hose can be installed in the water circuit that can be used to hose out the wet box to clean it. This action will allow the operator to maintain even more distance from the collector box, thereby further reducing their exposure to respirable dust.

CONCLUSIONS

The results of the field study show that the wet box dust collector can provide better protection from respirable dust exposure. The roof bolter CPDMs showed that the wet box percent difference ranged from -19% to -31%, with a negative percent difference denoting that the operator on the wet box side of the roof bolter had lower CPDM concentrations than the operator on the dry box side. The MSHA-requested sampling percent difference was approximately 18%, denoting that the operator on the wet box side of the roof bolter had higher TWA concentrations than the operator on the dry box side. The reasoning for the wet box side being higher was previously explained due to the wet box side being on the return side of the entry and the placement of the MSHA-requested samplers. The sampler location was thought to be more impacted by the ventilation airflow through the entry since the samplers were possibly more closely aligned with the main ventilation airflow stream. The quartz contents of gravimetric sampling at the roof bolter operators' location and the MSHA-requested gravimetric sampling were 0.0% with the exception of the right/intake roof bolter location, which was on the dry collector side on October 9th where the quartz content was 1.6%.

During dust collector box cleaning, the wet box provided more protection from respirable dust exposures. The TWA concentrations encountered during wet box cleaning were 71%–88% lower than the TWA concentrations encountered for the dry box cleaning. In addition, the quartz content in the filter samples collected during wet box collector cleanout were 0.0%, while the quartz content in the filter samples collected during the dry box collector cleanout ranged from 4.6% to 10.3%. The wet box material was fully saturated, so no dust was re-entrained during cleanout, while re-entrainment of dust occurred during dry box collector cleanout.

The reductions of 71%–88% could be improved, once the wet box is fully established on the roof bolter machine, by incorporating a washout hose in the water supply to the roof bolter machine. This water hose would allow the roof bolter operators to use the hose to wash out the box allowing them to stand further away from the box during cleanout. This is an attribute not available for dry box collector cleaning.

Additionally, during this testing both boxes were cleaned out concomitantly. The dry box required cleaning after completing each bolting entry, while the wet box did not. Not having to clean out the dust collector boxes after each entry would also reduce potential respirable quartz dust exposure due to clean out even more.

Another factor to consider is that during the removal of the material during dry box cleaning, some of the material can collect on the miner's clothing, This silica bearing material embedded in the clothing can become a source of silica overexposure throughout the rest of the work shift, once the clothing is contaminated [Cecala and Thimons 1986, Joy et al 2010). The wetbox collector, due to the method of cleaning with a water hose, would prevent the potential of the dry silica material contaminating the miner's clothing; eliminating contaminated clothing as a potential source of silica exposure.

Overall, this field testing indicates that the wet box dust collector can reduce respirable quartz dust exposures to roof bolter operators.

DISCLAIMER

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

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