

FLOAT COAL DUST SAMPLING AND PRELIMINARY ANALYSIS

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ABSTRACT

Maintaining sufficient rock dust coverage is vital to preventing a coal dust explosion following a methane ignition. The objective of this research is to sample float coal dust deposited in underground mine airways. Based on research done by the US Bureau of Mines we sampled settled float dust in longwall and, room and pillar mines. Coal samples were taken from the roof, ribs, and floor at multiple breaks along single air splits. The samples were analyzed using thermogravimetric analysis to quantify float coal dust deposition. Preliminary results show the coal dust weight per unit area has uniform variation without regard to ventilation air split. This paper presents the sampling and analysis techniques used with the results obtained with a theory as to the reason for the uniform variation.

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INTRODUCTION

Float dust produced during normal mining operation travels from the point of origin through ventilating air and deposits on the surfaces of mine (Kawenski, Murphy, & Stahl, 1963) (Rider & F.Colinet, 2011). Float coal deposits are hazardous during methane explosion as the dust can be re-entrained and can cause coal dust explosion which is more violent than methane explosion (Sapko, Dollar, & M.Green). Float coal dust consists of particles of coal that pass a 200mesh sieve (particles diameter less than 75 microns) (Courtney, Kost, & Colinet, 1982). The primary defense against coal dust explosion is rock dusting, which is distributed upon the roof, floor, and ribs of underground mines (Colinet, Rider, Listak, Organiscak, & Wolfe, 2010). The regulations state that rock dust shall be distributed in such a manner that incombustible content combined must not be less than 80% in return airways and 65% in other areas in a mine (Harris, ES Weiss, Harteis, & Goodman) (Shahan, Seaman, Beck, Colinet, & Mischler, 2017). Therefore, the necessity of designing and implementing proper rock dusting practices are important. There are several methods used for dispersing rock dust into the mine. However, deposition behavior of float coal dust generated is unknown. This results in casual practices of rock dusting thereby causing a safety hazard.

This paper presents the results of a field survey in longwall, and room and pillar mine. The purpose of this study was to investigate the deposition behavior of the airborne coal dust in the mine airway. The ultimate objective is to model the dispersion of dust in a mine ventilation network model and develop an easy to use tool for underground mines. With the successful integration of a dust dispersion model and a network model, mine operators could make use of the resulting application to aid in the scheduling of rock dusting in mine airways.

SAMPLING METHODOLOGY

Sampling is vital for dust analysis. The dust sampling procedure followed was based on US Bureau of Mines research (Courtney, Kost,

& Colinet, 1982). The procedure requires air velocity lower than 300 fpm in the region chosen for sampling. No sample was taken at an area with a higher velocity at the time of the sampling. Equipment and material used for sampling are listed as follows:

- a) A 3x3 inch-scoop
- b) Collection pan
- c) Brush
- d) No. 100 sieve
- e) No. 200 sieve for determining float dust

Underground sample collection was performed using the following guidelines:

- 1) A skim dust sample was collected using the brush from the surficial layer floor, not more than 1/8-inch-deep, in the scoop for standardized sampling.
- 2) Samples were collected from both the ribs with the help of brush and scoop keeping the area of sampling consistent shown in Figure 1.
- 3) The loose dust from the roof was collected using a brush and into the scoop.
- 4) The same brush pan method was used to collect 1-inch deep sample from the floor.

Large quantities of dust collected from the floor were screened through a No. 100 sieve. The sampling location and the oversize portion was discarded. In the lab, the dust was screened using a No. 200 sieve. The weights were recorded from No.200 sieve undersize and the combustible contents were determined by thermogravimetric analysis (TGA) (Meredith L. Scaggs, 2016).



Figure 1. Sampling at West Virginia mines from ribs.

SAMPLING FROM WEST VIRGINIA MINE ROOM AND PILLAR MINE

Dust samples were collected from 13 locations in a room and pillar mine in West Virginia. The mass of the samples was predominantly from the floor material. Samples from the ribs and the

roof in quantities enough (2 grams) for experiments were scooped as well. A total of 52 samples were collected at locations shown in Figure 2. TGA was carried out on all floor samples. Sampling was done at two locations, one near the last open crosscut and one away as shown in Figure 3. Results from sampling have been shown in the same figure.

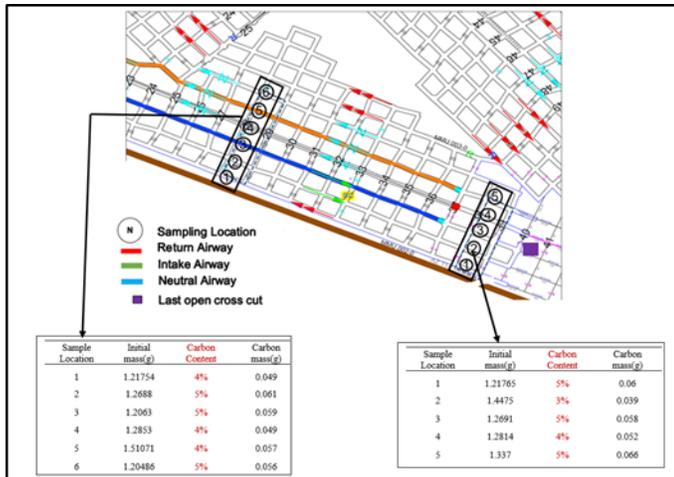


Figure 2. Mine map and sampling Results.



Figure 3. Sample bags collected from mines.

THERMOGRAVIMETRIC ANALYSIS

TGA was performed on a total of 11 floor samples using the standard ASTM D5142 moisture ash method. To prepare the sample for TGA analysis, the sample was wet sieved from 200 mesh (75µm) size as shown in Figure 4. To isolate the float coal dust flocculent was added to the wet sieved sample which aided in the separation of the particles from water as shown in Figure 5. The separated particles were then oven dried at 105°F (40.5 °C) to drive off the moisture. The oven dried sample was then scrapped out of the filter paper and mixed uniformly to prepare the sample for TGA analysis as shown in Figure 6.

To determine the accuracy of TGA analysis, synthetic samples were weighed carefully and run through TGA containing raw coal, rock dust, and an equal proportion of rock and coal dust as shown in Figure 7.



Figure 4. Wet of particles sieving from 200 mesh.



Figure 5. Separation of particles from the water.

An investigation of a typical thermogram as shown in Figure 8 indicates that the presence of rock dust alters the overall carbon content of the sample reported by TGA because limestone thermally decomposes to release CO₂ beyond 480°C., to calibrate the true carbon content in the sample, weight loss of sample occurring around (360°C to 480°C) was considered the area of coal loss.

SAMPLING IN LONG-WALL MINE

Dust samples were collected from 12 locations in a longwall mine. The mine maps and sampling locations have been shown in Figure 9 and Figure 10. A total of 45 samples were collected from the floor, right rib, left rib, and roof. TGA was carried out on those samples after sieving the samples through 200 mesh (75µm) to have an insight on the amount of float dust deposited at sampled locations.

SAMPLING FROM MINE AS THE MINING PROGRESSES

This sampling was done to get a better insight of float coal dust deposition as the mining progresses forward. A total number of locations covered for samplings were 10. In some of the areas, the roof

samples were difficult to get due to the high roof height. The procedure for TGA analysis was the same as done in previous mines. Figure 11 shows the mine map and results from TGA analysis.



Figure 6. Prepared sample for TGA.



Figure 7. Mixture of 50% raw coal, 50% rock dust.

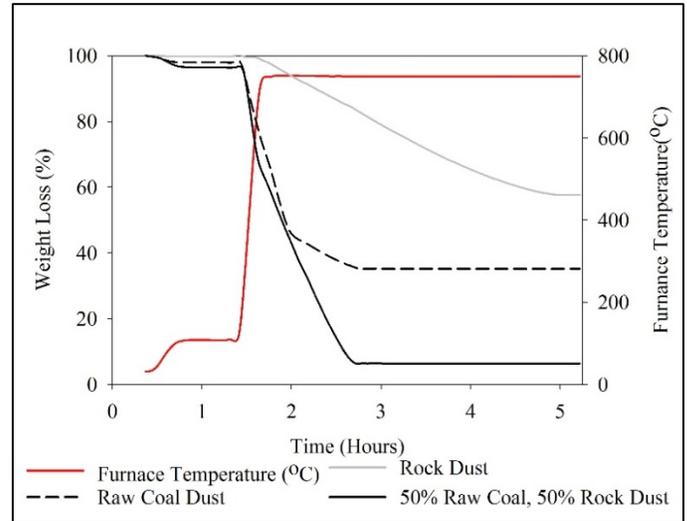


Figure 8. Representative thermo-gram of raw coal, rock dust, and an equal proportion of raw coal and rock dust.

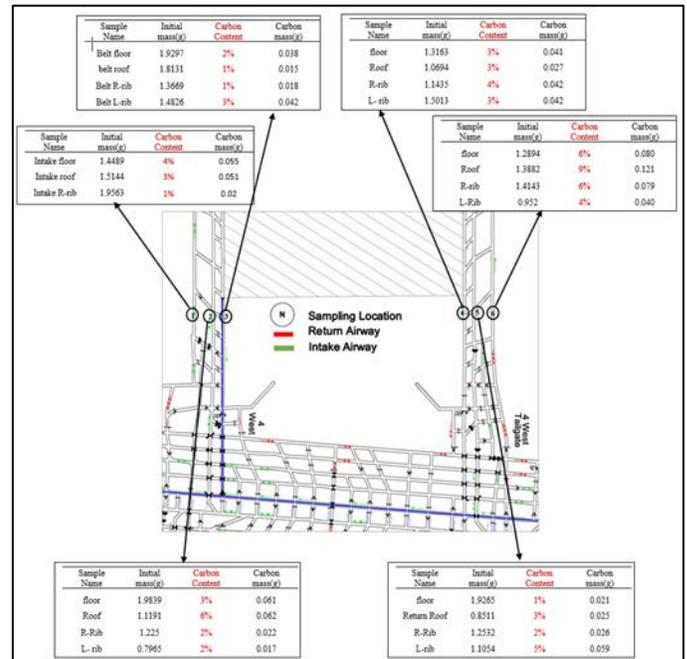


Figure 9. Mine map, sampling locations and results.

CONCLUSIONS AND DISCUSSIONS

The mine airways of room and pillar as well as a longwall panel were sampled systematically. The samples were analyzed using TGA to investigate any patterns of deposition with respect to the constituents of the sample. The deposition profile of dust particles as seen in Figure 3 has uniform variation and there is no apparent dependence of deposition rate with location and origin of dust source within the mine network. However, results from longwall mine survey shown in Figure 9 and Figure 10 shows the deposition rate higher in return airways but difference in percent carbon content is not significant enough to draw the conclusion that this longwall section produces more float coal dust than a continuous mining section.

FURTHER WORK

Experiments are planned to approximate the dust deposition rate using scale model of mine airway network and particle image velocimetry. The experimental results will be used to develop program in MATLAB which would be useful in scheduling of rock dusting in mines.

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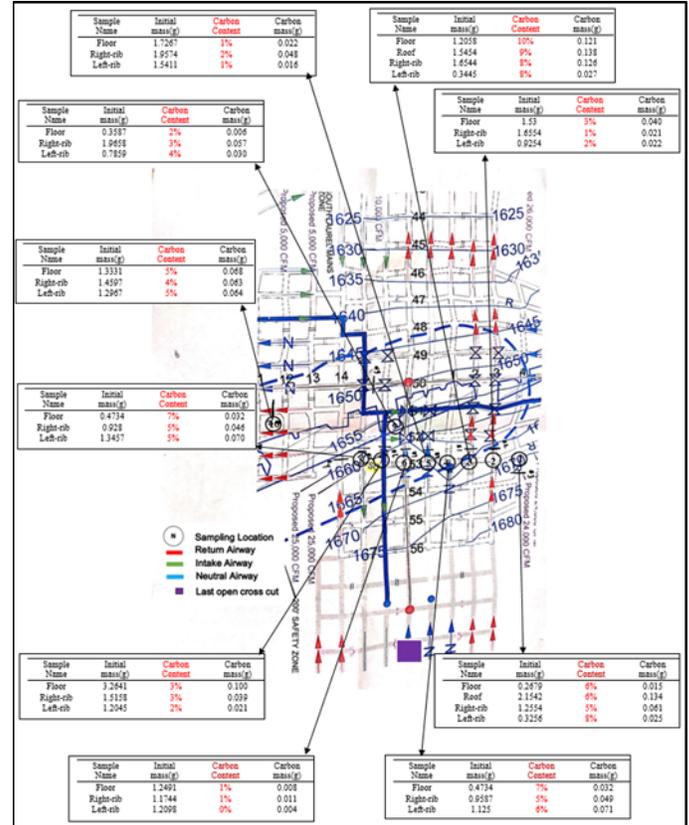


Figure 11. Mine map, sampling locations and results.

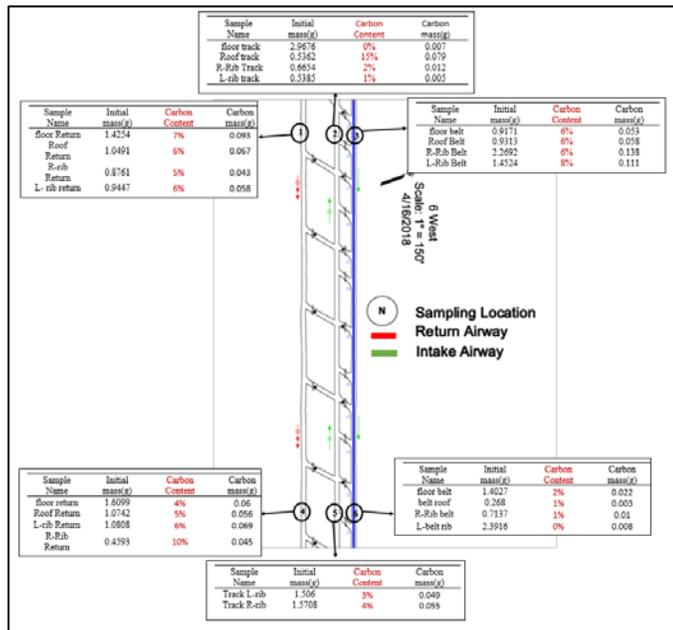


Figure 10. Mine map, sampling locations and results [6 W section].