USING PROXIMATE ANALYSIS *to Characterize Airborne Dust Generation from Bituminous Coals*

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Prolonged exposure to airborne respirable coal dust is responsible for Coal Workers Pneumoconiosis (CWP), commonly called Black Lung. Health research studies have identified that the prevalence and severity of CWP are directly related to both the amount of dust exposure and the coal rank.

The amount of airborne respirable dust (ARD) smaller than 10 micrometers (μm) generated from breakage of different coals varies widely. To investigate the cause, researchers for the National Institute for Occupational Safety and Health (NIOSH) have conducted experiments to identify the causes of airborne respirable dust liberation. Laboratory crushing experiments were conducted on a range of low to high volatile bituminous coals from eight mines (five eastern and western U.S. and three Polish).

The results indicate that the proximate analysis of a coal sample can provide a very good indicator of the potential for a dust problem. For application to the coal mining, processing, and utilization industries, data from 977 national coal seams compiled by the Department of Energy (DoE) has been used to calculate this dust generation potential from an equation based on the NIOSH measured data. A simple procedure for this calculation is provided.

DUST-THE SOURCE

Previous work indicates that the amount of ARD can generally be described by two factors. The first factor is how many respirable-sized particles are produced and available in the coal product (the source). The second factor is what amount of within-product dust actually becomes airborne.

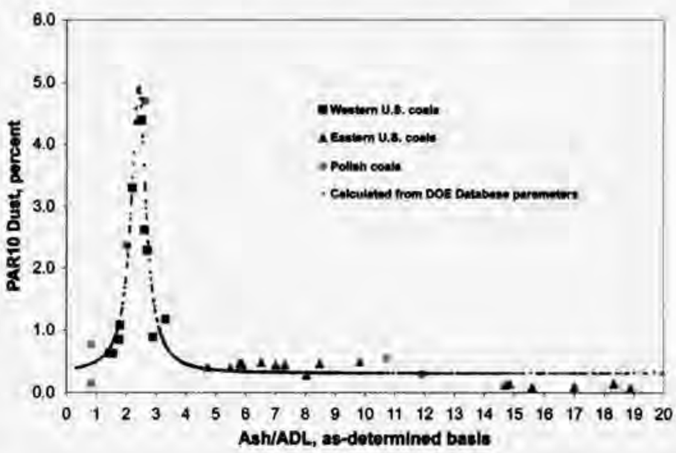
Coal rank has a significant effect on the product size characteristics and, therefore, the amount of respirable-sized particles present. Higher rank coals that are from low volatile, high ash coal seams tend to produce more within-product dust but these very coals actually tend to produce less ARD. There is published evidence suggesting that most of the respirable dust is generated by breakage along the cleat and fracture structure in coals.

A good case can be made that coal dust generation from cutting, breaking or crushing usually occurs along cleats, joints or weaknesses formed by mineral matter. This mineral matter is typically represented by the ash content. It is important to remember that the ash content is not a constituent of the coal as it is being broken and cannot be directly responsible for dust generation. This ash content is merely derived from the mineral matter distributed throughout the coal and in the fractures and cleats.

Since coals of high rank are generally more extensively cleated, there is evidence that the degree of cleating is directly responsible for the quantity of respirable-sized particles produced in the crushed product material. Previous work has shown that the amount of ARD is not related to the ash content when breaking material whose size is below the cleat size. This result also suggests that the mineral matter (ash) responsible for the dust generation is associated somehow with the cleat, fracture, or bedding plane structure of the coals. As a result, the ash content can be considered a measure of within-product dust.

DUST-GETTING AIRBORNE

The second factor in ARD generation is the effect of moisture content of the coal. Dust particles can have a significant amount of electrostatic charge and this charge can place dusts in varying degrees of agglomeration. The amount of charge on the dust is very important in determining the degree of agglomeration of the dust and the bulk material broken. The moisture in the coal directly affects the amount of electrostatic charge on the dust caused by breakage. The most important measure of moisture content is the air dry loss (ADL) moisture. The ADL moisture has a pronounced effect on the electrostatic charge carried by the crushed product, which in turn plays a large role in the agglomerating or binding forces which keep the respirable-sized within-product dust from becoming airborne. In general, the more ADL moisture, the less charge on the dust and the more dust that will become airborne. The more highly-cleated, higher ranked coals usually contain less moisture and, therefore, more electrostatic charge is associated with them upon breakage.



EXPERIMENTAL DESIGN

A double-roll crusher was selected to study the primary breakage properties of medium sized coal lumps. Low to high volatile bituminous coal samples from eight mines (U.S. and Polish) were studied using the coal crushing procedure developed. The eight bituminous coals were roll-crushed under uniform procedures to investigate the effects of coal type on ARD generation.

A total of 32 samples were prepared from these eight seams. The coal was channeled from the mine wall, near the working area.

Bulk coal samples were collected at three continuous miner sections located in the Eagle and Upper Freeport seams in West Virginia and the Blind Canyon seam in Utah. Three days of coal collection were conducted at each mining section in sufficient quantity to yield six test samples from each seam of approximately 12 kg each. Also, a high-volatile, high-ash bulk coal from the Wadge seam in Colorado was processed to obtain four additional test samples for the crushing experiments.

In addition, coal samples were obtained from three Polish coal seams in such quantities to provide two additional test samples for each seam. The size ranges for each sample tested was a mixture consisting of equal weights of 50 by 25 mm, 25 by 19 mm, and 19 by 12.5 mm.

EXPERIMENTAL RESULTS

PAR10 is definded as the percentage of respirable-sized particles in the crushed product which become airborne, adjusted per kilogram of product crushed. A key point regarding the use of the PAR10 variable is that it is considered as a ratio representation of the two significant factors which affect ARD generation. The first significant factor is the ash content of the coal. The second significant factor is the ADL moisture. The net effect of these factors is that different percentages (PAR10) of coal particles of respirable size become airborne for each coal.

From the definition of PAR10, the ratio of ADL÷ash is the equivalent to the amount of ARD÷total respirable dust in the product. Figure 1 indicates that a clear delineation of coals which generate the most ARD appears possible, based on the ash and ADL contents determined by proximate analysis. Figure 1 uses the inverse ratio of ash÷ADL for an equivalent but more graphically representative picture. This appears to be very useful for dust control to protect the health of coal miners as well as fugitive dust emissions from coal preparation plants for environmental air quality improvement.

APPLICATION

The first step in determining the ARD generation potential for a coal of interest is to collect a representative sample of the general seam currently being mined or being processed. Recommended procedures for this are found in the ASTM standards and typically are performed on a routine basis by mining companies.

After obtaining the sample, have a laboratory perform a routine proximate analysis on a coal sample. Request that the results be reported on an "as-determined" basis with the air dry loss moisture (ADL) also being reported.

Next, calculate the ash/ADL ratio by division and locate this value on the "ash/ADL" axis of Figure 1. From this point, read up to the DoE database curve indicated by the blue dots. The position on this curve will provide a relative comparison to other coals for ARD generation potential.

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