Technology News

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Coal Dust Explosibility Meter

Objective

To enable mine operators and mine inspectors to make quick and accurate measurements of the explosible nature of coal and rock dust mixtures.

The Problem

Past research has shown that the accumulation of coal dust in underground coal mines can be rendered nonexplosible by adding sufficient quantities of inert rock dust, such as limestone dust. Federal regulations for underground coal mines require mine operators to dust mine corridors with an inert rock dust and maintain a total incombustible content of at least 65% in the entries and at least 80% in the returns, where the coal dust is expected to be finer in size. Currently, samples of the deposited coal and rock dust are collected for aboveground analysis of the inert percentage, which consists of rock dust, ash, and moisture. The processing time for this analysis can be as long as 2 weeks. In addition, research has shown that measuring the incombustible percentage is not always sufficient to determine the explosibility of a sample, especially for finer coal dust. The National Institute for Occupational Safety and Health (NIOSH), Pittsburgh Research Center (PRC), has devised a prototype handheld instrument that can provide a direct assessment of the potential explosibility of a coal and rock dust mixture.

How It Works

The coal dust explosibility meter (CDEM) is a portable optical device that determines whether or not a coal and rock dust mixture is explosible (figure 1). It consists of an optical probe connected to a small electronics box with a digital display. The principle of operation of the CDEM is based on the measurement of infrared radiation reflected from the surface of a homogeneous mixture of two substances with different optical reflectances, such as light colored rock dust and dark coal dust (figure 2). Near-infrared radiation is emitted by a light-emitting diode in the optical module located behind the window of the optical probe. When the meter is inserted in the dust mixture, the infrared radiation reflects off the dust's surface and back to the silicon photodiode sensor, also located in the optical module. For a given coal volatility, the normalized optical reflectance of such mixtures is relatively constant at the limit of explosibility (the amount of rock dust required to inert) and independent of the coal dust particle size. Samples whose normalized reflectance measures below the threshold would be identified as explosible; samples with reflectances greater than the threshold would be nonexplosible.

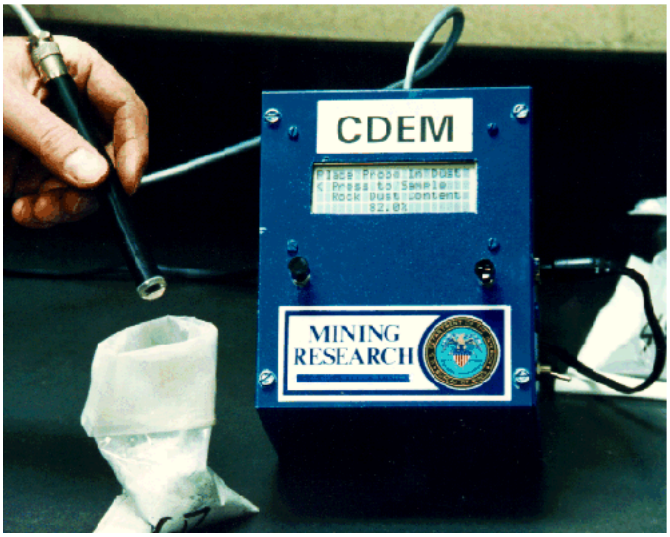

Figure 1.—The CDEM is used to analyze the composition of a coal and rock dust mixture.

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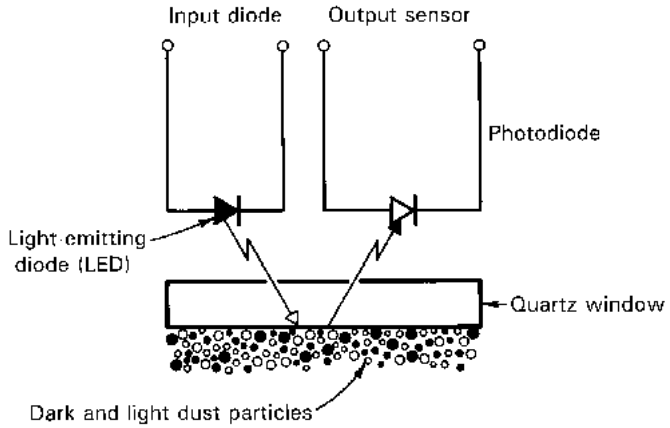

Figure 2.—Drawing depicting principle for measuring the optical reflectivity of a coal and rock dust sample.

Test Results

The limit of explosibility for many coals was determined in PRC's 20-liter explosibility chamber using several types of rock dust. As expected, the percentage of rock dust required to inert the coal dust increases for finer coal dust size. Coals with mass median particle sizes in the range of 10 to 70 μm required 90% to 60% rock dust, respectively, to be inerted. At the finest particle sizes, mixtures are still explosible even above the federally mandated 80% rock dust requirement for return airways, confirming the fact that measuring the rock dust concentration is not sufficient to determine the explosibility of a sample.

For each mixture, the CDEM optical reflectance was measured at the limit of flammability and was found to be constant over the range of particle sizes for a given coal volatility. In practice, the normalized reflectance to which the meter alarm would be set would depend on the volatility of the coal seam in which the instrument was being used. The CDEM thus provides a measurement of the explosibility of a dust sample over the entire range of coal dust sizes, rather than being restricted to the two coal sizes (intake and return) in current regulations.

Continued Efforts

Currently, the CDEM could provide an efficient method to determine the explosibility of air-dried, homogeneous samples at aboveground laboratories at the mine site. Research is in progress to measure and correct for the presence of moisture in the samples by measuring the electrical resistivity in addition to the reflectivity. This correction would allow the CDEM to be used on samples directly from the mine and possibly to provide an in situ explosibility measurement to eliminate the danger of operating under hazardous conditions while samples are processed. The CDEM could provide mine operators and safety inspectors with a valuable means for determining the explosible nature of coal and rock dust deposits.

Efforts are currently underway to commercialize the CDEM, along with a related instrument, the reflectance rock dust meter, which provides a direct measurement of the rock dust percentage in mine dust samples.

For More Information

To obtain a free copy of a technical paper on the CDEM or answers to technical questions about the device, contact Carrie E. Lucci or Kenneth L. Cashdollar, National Institute for Occupational Safety and Health (NIOSH), Pittsburgh Research Center, Cochrans Mill Rd., P. O. Box 18070, Pittsburgh, PA 15236-0070, phone (412) 892-4308 or (412) 892-6753, fax (412) 892-6595, e-mail: **chl4@cdc.gov** or **kgc0@cdc.gov**

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

To receive additional information about mining issues or other occupational safety and health problems, call **1-800-35-NIOSH (1-800-356-4674)**, or visit the NIOSH Home Page on the World Wide Web at http://www.cdc.gov/niosh/homepage.html

As of October 1996, the safety and health research functions of the former U.S. Bureau of Mines are located in the National Institute for Occupational Safety and Health (NIOSH).