Industry Guide

Mining

Mining currently employs about 30 million people worldwide, 10 million of whom are involved in coal mining. Although this represents only 1% of the world's workforce, mining is responsible for 8% of fatal accidents at work along with a disproportionately high injury and illness rate.[1] Occupational health hazards of mining include:

Chemical agents
- such as crystalline silica, coal mine dust, diesel engine exhaust, methane, hydrogen sulfide, and oxygen deficiency

Physical agents
- such as noise, ionizing radiation, vibration, and heat stress

The nature and magnitude of these hazards will vary depending on the type of ore being mined, the mine depth, the method of mining as well as the miner's particular job, and hazard control methods being used.

This publication is designed to assist health and safety professionals in choosing the appropriate equipment and methodology to assess the major chemical agents found in mining operations. Sources of additional information are described below.

The Mine Safety and Health Administration (MSHA) *at www.msha.gov offers numerous publications on health hazards and air sampling in mines.*

The National Institute for Occupational Safety and Health (NIOSH) Information Center *at 800-356-4674 or www.cdc.gov/niosh/95-106.html offers publications on respirable coal dust (Publication 95-106) as well as a variety of publications on silica.*

SKC Inc. *at 724-941-9701 or www.skcinc.com offers equipment to evaluate noise and heat stress levels. Be sure to confirm the approvals required before ordering testing equipment.*

Crystalline Silica

Since free crystalline silica is the most abundant element in the earth's crust, exposures to silica dust are quite prevalent in mining operations.[1] Respirable silica dust is typically produced when drilling, blasting, or cutting silica-containing rock. The most significant exposures occur in hard rock metal miners.[2]

When crystalline silica enters the lung, fibrotic nodules and scarring can occur around the trapped silica particles. This fibrotic condition of the lung is called silicosis. If the nodules grow too large, breathing becomes difficult and death may result. Silicosis victims are also at high risk of developing active tuberculosis.

NIOSH recommends that crystalline silica levels not exceed 0.05 mg/m^3 as an eight-hour Time-Weighted Average (TWA). The U.S. Occupational Safety and Health Administration (OSHA) standard is determined by performing a calculation that takes into consideration the percentage of silicon dioxide (SiO_2) in the sample.

For respirable dust containing quartz, this calculation is as follows:

$$\frac{10 \text{ mg/m}^3}{\% \text{ SiO}_2 + 2}$$

For details on sampling crystalline silica, reference the following SKC publications:

Chemical Fact Files®

Silica, Crystalline Quartz, Respirable Dust
By OSHA Method ID 142
SKC Publication 1003

Silica, Crystalline by XRD
By NIOSH 7500
SKC Publication 1370

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Coal Mine Dust

Coal mine dust is actually a mixture of coal, silica, clay, limestone, and other mineral dusts. Exposures to respirable coal dust occur in underground and surface mines when workers blast, drill, cut, or transport coal. Dust exposures are particularly high in mechanized mining where coal removal machines with rotating drums studded with picks are used.(1) Inhalation of coal dust can lead to pneumoconiosis, commonly called black lung, as well as other chronic airway diseases such as emphysema.

OSHA has two different Permissible Exposure Limits (PELs) for coal dust depending on the percentage of silica content:

For respirable coal dust with less than 5% SiO_2:

$$2.4\ mg/m^3$$

For respirable coal dust with greater than 5% SiO_2:

$$\frac{10\ mg/m^3}{\%\ SiO2 + 2}$$

For sampling respirable coal dust, OSHA recommends the sampling method for respirable crystalline quartz. Reference the following SKC publication:

Chemical Fact File

Silica, Crystalline Quartz, Respirable Dust

By OSHA ID 142

SKC Publication 1003

Diesel Engine Exhaust

The use of diesel engines underground can produce a mixture of gases, vapors, and particulates. Hazardous gases in diesel exhaust include carbon monoxide, nitrogen dioxide, and sulphur dioxide, while the vapors include volatile organic compounds, aldehydes, and Polycyclic Aromatic Hydrocarbons (PAHs). Diesel Particulate Matter (DPM) is considered a probable human carcinogen by the International Agency for Research on Cancer (IARC).(1)

MSHA has proposed new standards for DPM in both metal/nonmetal and underground coal mines. To sample for DPM, a special filter cassette loaded with a heat-treated quartz filter and cellulose pad is available to meet the requirements of NIOSH Method 5040. NIOSH 5040 analyzes for organic and elemental carbon as a surrogate for DPM using the highly sensitive evolved gas analysis technique and thermal-optical analysis. A cyclone is recommended to scrub out the larger particles.

For personal sampling in atmospheres where it is necessary to differentiate DPM from other respirable dust (such as coal dust), a special DPM filter cassette is available. In addition to the quartz filter, it contains a precision-jeweled orifice plate, impaction substrate, and filter assembly designed for one-time use.

Contact SKC for a copy of NIOSH 5040 and for information on DPM cassettes with or without the orifice plate.

Methane, Hydrogen Sulfide, and Oxygen Deficiency

When working undergound, miners face the hazards of naturally occurring gases such as methane and hydrogen sulfide as well as oxygen deficiency. Any one of these hazards can be deadly to workers. Methane is combustible and can lead to coal mine explosions; hydrogen sulfide can lead to acute respiratory depression; and oxygen deficiency can lead to asphyxia.

Direct-reading instruments are recommended for this application. These instruments can monitor explosivity, oxygen, hydrogen sulfide, and other compounds. Determine the approvals required on single or multi-gas instruments before using direct-reading instruments underground.

References

(1) Jeanne Mager Stellman, *Encyclopedia of Occupational Health and Safety,* Fourth Edition, International Labor Organization, Geneva, 1998, pp 74.2-74.55

(2) William A. Burgess, *Recognition of Health Hazards in Industry: A Review of Materials and Processes*, Second Edition, John Wiley & Sons, New York, 1995, pp 423-435

(3) *Carcinogenic Effects of Exposure to Diesel Exhaust*, Current Intelligence Bulletin No. 50, NIOSH (1988), Cincinnati, OH: Department of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH Publication No. 88-116

(4) *Recommendations for Occupational Safety and Health, Compendium of Policy Documents and Statements,* NIOSH (1992) Cincinnati, OH, Department of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH Publication No. 92-100

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