Dust Sampling Instrumentation and Methods

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Presentation Outline

• Current respirable dust standards and sampling requirements

• Dust sampling instruments available for use in mining

• Sampling methods to quantify dust sources
Dust Standards for Metal/Nonmetal Mining
(Federal Mine Safety and Health Act of 1977)

10.0 mg/m³ total airborne dust

If silica > 1%:
respirable standard = 10 / (% silica + 2)
Gravimetric Dust Sampler

- Provides time-weighted-average respirable dust concentration
- Dorr-Oliver cyclone separates respirable and oversize dust
- Pump operated at 1.7 liters per minute in M/NM mines
Sampling with Gravimetric Samplers

• Filter is pre- and post-weighed to determine mass gain and is used to calculate an average dust concentration over sampling period.

• Filter processed using XRD analytical technique for silica content (NIOSH Method 7500).

• Sufficient mass must be collected to have confidence in measurement.

• NIOSH typically uses multiple gravimetric samplers and averages data.
personal/DataRAM (pDR)

- Model 1000 AN passive sampler
- Uses light scattering as measurement technology
- Instantaneous readings correlated with time and stored in internal memory
- pDR concentrations impacted by:
  - size distribution of dust
  - composition of dust
  - water mist in air
- OMSHR adjusts readings with ratio obtained from adjacent gravimetric samplers
pDR Field Calibration

• Divide average gravimetric concentration by average pDR concentration for same sampling period

• Multiply all individual pDR readings by ratio

• Example:
  gravimetric average = 1.4 mg/m^3
  pDR average = 1.1 mg/m^3
  grav/pDR ratio = 1.4/1.1 = 1.27
  pDR concentrations * 1.27 = adjusted pDR concentrations
pDR Provides Time Record of Dust Levels

![Graph showing dust levels over time with labeled intervals for loading, tramming to dump, dumping, and tramming to load. The y-axis represents pDR concentration in mg/m^3, and the x-axis represents time from 12:03 to 12:30.]
Personal Dust Monitor (PDM)

• Real-time measurement of respirable dust

• Combines dust sampler and cap lamp into one unit

• Sample inlet is mounted on cap lamp

• Uses mass-based measurement to quantify dust concentration (TEOM)

• Dust measurements are displayed on screen and stored internally for later analysis
Principle of Operation

- Exchangeable filter cartridge mounted on the end of the tapered element collects particles as sample stream flows through hollow tube.

- Tapered element oscillates at a known frequency, like a tuning fork.

- Frequency changes in direct relation to the mass collected on the filter.

- Measurement principle does not respond to other particle characteristics such as size distribution or composition (heated circuit removes moisture).
PDM Status

- Meets NIOSH sampling accuracy requirements (NIOSH RI 9669)
- Equivalency to CMPDSU (gravimetric sampler) published in peer-review journal
- MSHA intrinsic safety approval granted for use in underground coal mines
- New CFR 30, Part 74 rule enacted in 2009
- Thermo Scientific began delivery of commercial units in July 2009
- Two ongoing NIOSH research efforts (software and silica)
PDM Analytical Software

- Compile output from PDM samplers
- Provide user-selected summaries for multiple samplers (foreman, mine superintendent, etc.) or engineering evaluations
- Provide graphing capabilities
PDM Filter Capsule for Maintaining Sample Integrity for Quartz Analysis

- Place capsule over PDM filter when TEOM unit removed from PDM
- Use capsule as filter removal tool and to secure dust
- Send to lab, remove finger tab, ash capsule
- Plan to conduct mine surveys to complete side-by-side testing with current silica analysis method
Sampling to Isolate a Fixed Dust Source

Intake Air →

I - Intake Sampler
R - Return Sampler

Operator Booth

Dump/ Crusher

Exhaust Fan

To Return

Blowing Fan
Sampling a Mobile Position
Using Real-time Data to Quantify Multiple Dust Sources

• Evaluate dust levels during truck haulage cycle at an underground gold mine

• Use pDR samplers and time study data to quantify dust generation for different parts of cycle
  – loading
  – hauling full
  – dumping
  – hauling empty

• Two researchers conducting time studies
Time-weighted-average Dust Contributions

Dump location had highest dust contribution despite having the shortest duration… (14% time vs. 34% dust)

- **Tram Full**: 22% (6.7 mins)
- **Loading**: 15% (4.2 mins)
- **Tram Empty**: 29% (11.4 mins)
- **Dump**: 34% (3.7 mins)
Using Real-time Data to Quantify Dust Sources for Mobile Workers

• Evaluate work tasks and associated dust levels for mobile workers throughout their shift

• Merge active pDR 1500 sampling data and video (Helmet Cam) to quantify highest sources of dust generation for different tasks

• Develop controls and/or improved work practices to reduce mobile workers’ dust exposure
Sampling to Isolate an Unconfined Dust Source

A – Ambient sampling location
D – Drill sampling locations

Wind direction
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Thank you!

Questions??

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