Mining Dust Control Technology with Potential Application for the Oil and Gas Industry

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To eliminate mining fatalities, injuries, and illnesses through relevant research and impactful solutions.

Safe mines — Healthy workers

Outline

- Background
- Filtration and Pressurization Research
- Helmet-CAM
- Clothes Cleaning Booth Technology
- Dust Control Handbook
- Current Potentially Applicable Research
Silicosis Outbreaks

1) 1910 to 1913 - 46% (3,700 miners) of Missouri lead miners found to have silicosis

2) 1919 - 93% of Vermont granite workers (427 miners) found to have silicosis/1924 – 100% showed early signs silicosis within 4 years.

3) 1933 - 476 deaths from Hawk’s Nest Tunnel Project: workers died from silicosis drilling this tunnel in West Virginia
Impact of Silicosis

Hawk's Nest Tunnel Disaster


West Virginia Department of Culture and History
Quarter weights: 5.6 grams

Evenly distribute 5.6 grams respirable silica dust in air volume in the Rose Bowl stadium – would cause a worker breathing this air over 8 hrs. to be over-exposed

Current Silica Standard: 0.1 mg/m$^3$ or 100 µg/m$^3$

NIOSH REL / Pending OSHA Standard: 50 µg/m$^3$
**PROBLEM:** Miners are exposed to elevated dust (respirable crystalline silica) in enclosed cabs and environmental enclosures.
Research Goal: Optimizing filtration and pressurization efficiency to enclosed cabs/environmental enclosures to minimize respirable (silica) dust exposure and provide maximum air quality
Key Components for Effective Cab Filtration and Pressurization Systems
1. Effective Filtration
2. Cab Integrity
3. Monitoring and Maintenance
Effective Filtration

1. Pressurized Intake/Outside Air
2. Recirculated Cab Air
Powered Unit: Self-cleaning or centrifugal design

Self-cleaning

Centrifugal

Static
Recirculated Cab Air

- Effectiveness is by multiple passes through filter media
- Substantial reduction in cleaning time from in-cab dust sources
- MERV 14 -16 rated filter media
- 3-4 times the intake airflow quantity (200-300 cfm typical)
- Unidirectional design
Measured PF, log scale

Modeled PF, log scale

Face Drill

Roof Bolter

Unity line

No final filter used

Added recirculation filter (open points)
Cab Integrity

Installing new doors gaskets and seals/plugging and sealing cracks and holes
Cab Pressure Monitoring and Maintenance

Crusher Booth: Protection Factors

Protection Factors with MERV 16 was 4 times greater when compared with HEPA.
Our ability to provide these filtration systems across many of our product lines was heavily influenced by the work provided by NIOSH, both technical papers and the interactions we’ve had with you and members of your team. The visit you and John made to present at our cab summit (2015) was a very positive influence to our cab design and machine product partners. This provided a great deal of knowledge and understanding to our cab partners which then made it much easier to incorporate advanced filtration systems into our operator cab designs.

Daniel Spurgeon, Engineering Manager, Earth Moving Division
Note how extremely low respirable dust levels were in the enclosed cab of the new CAT988K front-end loader. Average concentration = 0.42 µg/m³

Respirable Dust Reduction: 95–99 pct.
Key Resources

Design, Testing, and Modeling of Environmental Enclosures for Controlling Worker Exposure to Airborne Contaminants

Dust Control Handbook for Industrial Minerals Mining and Processing
Second Edition
Application: Enclosed cabs of mobile equipment, control rooms/command centers at oil and gas sites
Video Exposure Assessment Monitoring: Helmet-CAM and EVADE

- Helmet-CAM technology and EVADE software to assess dust sources and magnitude of exposures
- Helmet-CAM also provides effectiveness of engineering controls and interventions to lower exposures.
EVADE Software Adapted - Dust Monitors and Cameras

Dust Monitors: Thermo pDR 1000, Thermo pDR 1500, TSI AM 520/510, Nanozen DustCount 9000 or any device where data can be stored to a Comma-Separated Values “CSV” file (Excel file): Video Cameras: Contour ROAM3, BODYCAM by PRO-VISION, GoPro Hero Series.
EVADE 2.0 – the second generation

• Still extremely easy to use but more powerful!

• Beyond dust exposure. EVADE 2.0 can interface with several real-time instruments (dust, DPM, noise, organic compounds).

• Multiple channels. Multiple video channels and multiple logged data channels can now be created in a single project.

• Share a project. A file can now be shared and transferred to another computer (corporate office?) where it can be viewed complete with all video and logged data.

• Basic data analyses. Simple analysis functions such as Max, Min, Mean, Derivative, and others are now available.

Current Locations Where EVADE Software is Being Use
EVADE Version 2.0 Screen

Two maintenance workers wearing Helmet-CAM
Exposure sources were mitigated through workers’ proactive initiatives

Infographics were created to encourage worker adoption of best practices

- **Did you know?**
  - **Reduce your dust exposure**
    - Clean dust from work clothes
    - **Did you know?**
      - Using clothes cleaning technology throughout the workday can reduce your exposure to respirable dust by up to 88%
      - Launder clothes post-shift, including sweatshirts and coats, and use leather (not cloth) gloves to avoid dust buildup

- **Did you know?**
  - **Reduce your dust exposure**
    - Cover or replace cloth seats
    - **Did you know?**
      - Cloth chairs in mobile equipment, break rooms, and offices can hold high levels of dust
      - Use vinyl or leather seat covers or plastic chairs when possible

- **Did you know?**
  - **Reduce your dust exposure**
    - Tying bulk or mini-bags
    - **Did you know?**
      - Folding bulk or mini-bag loading collars away from your breathing zone can reduce peaks in respirable dust exposure up to 92%
Example: Day shift analysis shows elevated exposures in dry lab (without fan)

Exposures in dry lab consistent at 400 µg/m³
Example: Second shift analysis *(with fan)* shows a significant reduction

Exposures in dry lab consistent at 20 µg/m³
Helmet-CAM and EVADE for use with samplers for dust, diesel, noise, chemical, lighting, and other hazard assessments
10mm Dorr-Oliver cyclone classifier for respirable dust, Thermo Model pDR-1500 dust monitor used

Microphone for dosimeter, Larson Davis Spark Model 706RC dosimeter used
Cooperative Study with Vulcan Materials Company
Havre DeGrace Facility near Baltimore, MD

Kelly Bailey, Former Corporate Director of Industrial Hygiene and Health Services, Vulcan Materials Company – National Stone, Sand and Gravel Association (NSSGA)
Application: Determining dust, noise, chemical exposures at oil & gas sites

ALTAIR 4XR Multigas Detector: Hydrocarbon (combustibles LEL), O2, CO, and H2S Hydrogen Sulfide.
A safe and effective method for removing dust from work clothes.

Cooperative research effort.
Clothes Cleaning System

Key Components
1. Cleaning Booth
2. Air Reservoir (240 gallon)
3. Air Spray Manifold
4. Exhaust Ventilation System (2,000 cfm)
Vacuum:

Cleaning Time: 7 minutes 48 seconds
Air Spray Manifold

Cleaning Time: 17 seconds
Cleaning Effectiveness: (18 seconds)

Clothes cleaning system was 40–50 pct. more effective than vacuuming/ single air hose technique.

Respirable Dust Reduction: 90–99 pct.
Commercial Clothes Cleaning Booth Systems
Application:
Cleaning dusty work clothing at oil & gas sites

- Final Meeting December 2010
- Published January 2012
- Over 2,200 copies distributed
- 7,700 views on website
- Over 3,700 copies downloaded
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6 Previous and 9 New Authors: 8 from industry and 7 federal employees: 4 industrial hygienist, 4 general engineers, 3 mining engineers, 1 mechanical engineer, behavioral scientist, health communication specialist and manager of national industrial mining associations
Dust Control Task Force Members and Contributors Affiliation

- ASCGO Manufacturing:
- Martin Engineering
- Spraying Systems Company
- Titan Products/Vortex Global
- Dust Solutions, Inc.
- IMA-NA
- 3M Corporation
- Mine Safety & Health Admin.
- Unimin Corporation/Covia
- NIOSH
CHAPTERS (1 New/3 Minor/7 Significant/Major)

1. Overview of Dust Exposure Assessment and Control (New)
2. Fundamentals of Dust Collection Systems (Minor)
3. Wet Spray Systems (Significant)
4. Drilling and Blasting (Minor)
5. Crushing, Milling, and Screening (Minor)
6. Conveying and Transport (Major)
7. Bagging (Significant)
8. Bulk Loading (Major)
9. Controls for Secondary Sources (Major)
10. Filtration and Pressurization Systems for Environmental Enclosures (Major)
11. Haul Roads, Stockpiles, and Exposed Areas (Major)


236 Color illustrations throughout the handbook.
Chapter 3: Wet Spray Systems

- Principles of Wet Spray Systems
- Nozzle Types and Spray Patterns
- Spray Controls and Optimization
- Maintenance Issues with Wet Spray Systems

Figure 3.14. Typical wind fence installations. Left: porous windbreak material around stockpile drop. Right: material being used in loadout hopper.

Figure 3.3. Illustration of the effect of droplet size on dust particle impingement.
Principles of Wet Spray Systems

• Keys to effective wet spray dust control: application of moisture; nozzle location; droplet size; spray pattern and nozzle type; proper maintenance of equipment.

• Airborne dust prevention
  • Achieved by direct spraying of the ore
  • Increase moisture content of the ore: Quantity > Pressure
  • Larger water droplets

• Airborne dust suppression
  • Removing dust from airstream
  • Smaller, like-sized droplets (collide and agglomerate)
  • Higher pressures more effective
Dust Exposure Identified from Climbing Ladder

**Video:** Worker getting ready to climb down ladder

Three types of ladder designs (vertical ladder, alternating tread stairs, traditional stair) and their footprint. Alternating tread & traditional stairs provide both ergonomic advantages and lower respirable dust exposures.

Peak exposure of 243 μg/m³ when worker climbs down the ladder

Respirable dust exposure to a worker from climbing down a ladder and exposure from dust released from ladder rungs.
Chapter 11 – Haul Roads, Stockpiles and Exposed Areas

- Haul road dust control measures
  - speed control
  - traffic control
  - proper road construction
  - water application
  - surface treatments

- Stockpiles and exposed areas
  - wetting
  - enclosures and wind fences
  - physical stabilization (1st edition)
FOR COPIES OF THE DUST CONTROL HANDBOOK

Download a pdf version @

https://www.cdc.gov/niosh/mining/works/coversheet2094.html

Hard copies
Current Potentially Applicable Research

Can Low-Cost Dust Sensors be useful in Mining Applications?

$20 Sensor; $250 package
LCDM Testing @ Lab
Travel Restrictions and New Opportunities

M/NM – 3M
Coal - Peabody
Foundry
NMA Safety Video Featuring LCDM work with Peabody

...We know it's accurate enough to tell us where the problems are, and that’s really what we’re trying to do. – Matt Pedersen-Howard VP Peabody

https://vimeo.com/509220469
What Level of Operator Protection is Possible with a “SmartCab”?  

<table>
<thead>
<tr>
<th>Measure</th>
<th>Improve</th>
<th>Inform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust levels</td>
<td>Adjust intake airflow</td>
<td>Display cab pressure</td>
</tr>
<tr>
<td>CO2</td>
<td>Change recirculation airflow</td>
<td>Suggest filter change</td>
</tr>
<tr>
<td>Cab Pressure</td>
<td></td>
<td>Log air quality</td>
</tr>
</tbody>
</table>

Integrate to Create SmartCab System

[Link to Smart Cab Notice of Intent @ Sam.gov]
Jeff Moredock (Sy-Klone) Led Development of ISO 23875
1. Evaluation from non-biased perspective, effectiveness of treated coatings of silica proppant for dust suppression at oil & gas sites.
2. Portable ventilation systems to minimize welding fume exposures in field (non-shop) applications.
How Effective are Portable Welding Fume Capture Units?
Conclusion

90-99 pct.

95-99 pct.

Respirable Dust Assessment

All Control Technology
Application of respirable crystalline silica control technology with potential application to the oil and gas industry
Questions

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Safe Mines, Healthy Miners!

To eliminate mining fatalities, injuries, and illnesses through relevant research and impactful solutions

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