The Silica Story – Exposure Assessment and Exposure Management

A Presentation to:
The Potomac Section of the American Industrial Hygiene Association (AIHA)

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Agenda

• What is Silica? Why does it pose a health hazard?
• History of silica
• Why is it a hot topic today?
• Silica exposure sources and sampling techniques
• Case studies
What is silica?

- Oxide of the metal silicon (SiO$_2$)
- Crystalline and amorphous forms
- Silica is everywhere; quartz is the most common crystalline form found in sand, granite, etc.

Size and Structure Matter!

- Crystalline structure – scars the lungs, irreversible
- Smaller the size – deeper into the lungs
- Respirable fraction - broadly defined as particles having a diameter of 10 μm or less; other criteria
- Main concern - **RCS**
History of Silica

- Silica and silicosis - late B.C./early A.D., 17th to 19th century
- Field research - mining, granite, cement industries - 1914 through the 1920s
- Hawks Nest Tunnel Tragedy - early 1930s
  - 764 died from acute silicosis
  - Additional 1500 died later from silicosis
- Late 1940s - ACGIH - TLV based on silica content (0.5 to 5 mg/m³)

RCS Regulation

- First federal regulation established in 1971 after OSHA was formed
- Established for construction, shipyard and general industry
- General industry: PEL = 10/(silica%+2)
  ~ 0.1 mg/m³
- Construction and shipyards (based on now-obsolete particle counting method)
  ~ 0.25 mg/m³
RCS Regulation, contd.

- New OSHA silica rule - *general industry/maritime/construction*
  - PEL 0.05 mg/m$^3$
  - AL 0.025 mg/m$^3$
  - Specific requirements under standard
    - Exposure Monitoring
    - Employee Notification
    - Medical Monitoring
    - Control Measures
- Differences in control measures

OSHA Hazard Communication

- Previously
  - Listed crystalline silica as an ingredient if $\geq 0.1\%$
  - If there was no potential for exposure to RCS in the way product was used; not listed in MSDS/Product Label
- Current - SDS and Product Label
  - **DANGER**
  - May cause cancer by inhalation.
  - Causes damage to lungs, kidneys and autoimmune system through prolonged or repeated exposure by inhalation.
Potential Sources of RCS Exposure

- Construction
- Steel industry - foundries
- Mining - granite, limestone, sand & gravel, etc.
- Hydraulic fracturing (fracking)
- Utility - coal, flyash
- Abrasive blasting
- Other unique exposures

Direct Read Instruments

- Instantaneous Size-Selective Particulates Monitors (PDR, Dusttrak, Sidepak)
  - Measures aerosol concentration - dust, smoke, mists, fumes
  - Need silica concentration in the dust being measured
  - Multiple assumptions
  - Screening
Traditional Air Sampling Equipment

Silica Concentration Measurement

- Poly vinyl chloride (PVC) filters analyzed in laboratories
  - Gravimetric Analysis – Respirable Dust (mg)
  - X-ray Diffraction – Respirable Silica (mg)
- Total Air Volume (Flow rate x Sampling Time)
- Concentrations calculated in mg/m³
Construction Study

Residential Construction
- California, Florida, DC Area
- Job classes - Category I
  - Higher potential for exposures to RCS
  - Products - Brick, block, mortar, stone, concrete, granite counter, ceramic tiles, fiber cement board, masonry structures
  - Activities - Cutting, mixing, sawing, chiseling, grinding, hauling, dumping, demolition, jack hammering, dry sweeping

Construction Study, contd.

- Job classes - Category II
  - Lower potential for exposures to RCS
  - Installation Tasks (No/Limited Disturbance of Materials)
    - Grout and Stucco
    - Brick, Block and Stone
    - Ceramic tiles
  - Drywall Work
  - General Site Clean-Up
Sample Results by Product/Silica Content

<table>
<thead>
<tr>
<th>% Weight Crys. Silica</th>
<th>Samples (N)</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low: &lt; 10 %</td>
<td>16</td>
<td>0.025</td>
<td>0.008 – 0.093</td>
</tr>
<tr>
<td>Medium: 10 – 30%</td>
<td>17</td>
<td>0.633</td>
<td>0.010 – 2.631</td>
</tr>
<tr>
<td>High: &gt; 30%</td>
<td>37</td>
<td>0.204</td>
<td>0.010 – 1.689</td>
</tr>
</tbody>
</table>

Sampling Results by Category

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of Samples (N)</th>
<th>Mean (mg/m³)</th>
<th>Range (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category One</td>
<td>48</td>
<td>0.349</td>
<td>0.008 – 2.631</td>
</tr>
<tr>
<td>Category Two</td>
<td>26</td>
<td>0.081</td>
<td>0.003 – 0.675</td>
</tr>
</tbody>
</table>
Dust Suppression Methods

- Wet Cutting/Grinding
- Vacuum Dust Collection Systems
- Ventilation Booths
- Remote Cutting Devices
- Fans (supplementary use)

OSHA’s Publication 3362-04 *Controlling Silica Exposures in Construction; Table 1 in new OSHA Silica Standard*


Wet Spray Application

Wet Saw

Dry Vacuum

Challenges

- Decentralized; multiple supervisors; many sub-contractors
- NO unified exposure control approach
- Frequently changing workforce
- Respirator Protection Program management and medical monitoring - very challenging
- Multiple tasks were above the OSHA PEL

Mining Overview
IH Monitoring Program for Aggregate Industry

• Geology - limestone, granite, sandstone
• Job classes
  – Control operators
  – Heavy equipment operators
  – Maintenance crew
  – Clean up activities
• Control measures in-place

Control Measures

- Water suppression
  - Water sprays in the crusher area, conveyor system
  - Water trucks
  - Water hoses prior to maintenance work
- Regular maintenance
- Enclosed work areas - control rooms, heavy equipment cabs
- Scheduling of cleanup work before or after plant operation
- Regular and consistent follow-up
The Main Take Aways

- Silica is almost everywhere - significant health risk in its crystalline form
- Smaller the size - more toxic
- Challenges of control of RCS exposure
  - Silica content in source material
  - Industry and management
  - Tasks being performed

The Main Take Aways, contd.

- Compliance with the new OSHA silica standard is achievable, given the right resources
- Characterization of silica exposure is critical
  - Regular monitoring
  - Recordkeeping of sampling results
  - Consistent follow-up of exposure management
Brace Yourself............

........Questions Are Coming!!!

Thank you for your interest
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