SANDTEC®
ENGINEERED SILICA DUST CONTROL
PROPPANT COATING TECHNOLOGY
Oil and gas companies and service providers are continually challenged to design, operate and optimize hydraulic fracturing systems to be safe and environmentally-friendly while delivering better results. Social concerns and regulatory standards for hydraulic fracturing have made safety and environmental stewardship a priority in hydraulic fracturing system design and operations.

One process that poses significant environmental, health and safety (EHS) challenges is the shipping and transfer of frac sand which generates silica dust. While conventional mechanical dust abatement systems provide a certain level of dust control, the setup and breakdown of such systems and the inefficiencies of using them at all transfer points not only limits their effectiveness, but also slows fracturing operations and hence production.

With current regulatory requirements that mandate compliance with low permissible exposure limits (PELs) for silica dust, a better, more effective solution for silica dust control is needed.
INTRODUCING SANDTEC

Introducing SandTec – engineered by ArrMaz, the global leader in dust control coating technology.

The result of two years of collaboration with hydraulic fracturing experts, this patented, next-generation silica dust control coating technology is a proven solution backed by industry leading coating and fracturing expertise, which, when applied to frac sand, results in significant reductions in silica dust generation.

SILICA DUST REDUCTION BUILT INTO THE SAND
• Frac sand coated with SandTec shows a significant reduction in silica dust generation of up to 99% throughout the supply chain

SIGNIFICANTLY IMPROVED SITE CONDITIONS
• Reduced personnel- and equipment-related inefficiencies
• Reduction of dust generation during completion operations

ENHANCED PROCESS EFFICIENCY
SandTec coating technology:
• Simplifies and fast-tracks frac sand logistics
• Lowers proppant attrition rates
• Reduces silica dust generation throughout the supply chain from sand plant to wellhead
• Provides stable, long lasting dust control that lasts through multiple frac sand transfers
• Is compatible with a wide variety of frac fluids
• Does not negatively affect well performance
• Does not slow down fracturing operations
• Works on all frac sand sizes

SMALLER FOOTPRINT
• Does not occupy valuable real estate at the fracturing site

ENVIRONMENTALLY FRIENDLY
• USDA Certified 100% Biobased Product under the BioPreferred® Program
• Made from naturally occurring biodegradable / biorenewable substances used in every day food, nutritional and personal care products
• Non-toxic, non-irritating and odorless

SANDTEC HAS BEEN TESTED ON A WIDE RANGE OF FRAC FLUIDS AND HAS SHOWN TO BE COMPATIBLE.
ARRMAZ HELPS OILFIELD SERVICE COMPANY REDUCE SILICA DUST GENERATION IN HYDRAULIC FRACTURING OPERATIONS

THE CHALLENGE

Our client, a prominent oilfield service company, has been using mechanical dust control systems during completion operations.

The company was seeking alternate solutions for maintaining dust within permissible exposure levels (PELs) set by OSHA and recommended by NIOSH. They also sought to reduce personnel- and equipment-related inefficiencies.

The new solution should control silica dust at all transfer points on each well site without negatively impacting fracturing operations or well performance.

THE SOLUTION

The ArrMaz Team provided a complete, portable silica dust control solution that integrated ArrMaz’s SandTec® silica dust control proppant coating technology and our proprietary coating application system to achieve optimal results.

SandTec works by applying a microscopic coating on sand proppant which controls dust and lowers fines generation by reducing abrasion whenever proppant is transferred.

SandTec coating was completely and evenly applied to frac sand supplied by a sand company for use in each well site’s completion operations. The sand company then transported the SandTec coated frac sand to all required locations using pneumatic trucks, and personal monitors were placed on job personnel to sample and measure respirable silica dust exposure as the sand was used in completion operations.
THE RESULTS

Monitors placed on multiple operators on each job site all showed frac sand coated with SandTec produced silica dust levels below current permissible exposure levels (PELs) set by OSHA and recommended by NIOSH.

WELL #1

- Single well ops
- 12 total stages
- 3.1M lbs of treated sand
  - 40/70 mesh size
- Crosslink frac fluid
- Personal airborne monitoring
- Vacuum system shut down

WELL #2

- Single well ops
- 23 total stages
- 8.9M lbs of treated sand
  - 950k lbs 100 mesh
  - 1M lbs 20/40 mesh
  - 6.9 million lbs 40/70
- Slickwater frac fluid
- Personal airborne monitoring
- Vacuum system shut down

TRIAL RESULTS FOR SILICA DUST GENERATION

<table>
<thead>
<tr>
<th>PERSONAL MONITOR</th>
<th>DAY 1</th>
<th>DAY 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<tr>
<td>2</td>
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<tr>
<td>6</td>
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</table>

<table>
<thead>
<tr>
<th>PERSONAL MONITOR</th>
<th>DAY 1</th>
<th>DAY 2</th>
<th>DAY 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

Below Action | Action Level | Above Limit
--------------|--------------|--------------
<0.025 mg/m³ | 0.025 < x < 0.05 mg/m³ | > Current PEL

Current PEL = 0.05 mg/m³
**SANDTEC® VS. ALTERNATIVE ENGINEERING CONTROL OPTIONS**

Deciphering OSHA’s Silica Regulations for Frac Sand

### SAND PLANT

- **RESPONSIBLE PARTY**: Sand Company
- **REGULATORY AGENCY**: MSHA
- **COMPLIANCE DATE**: Typically follows OSHA
- **REQUIREMENTS**: Meet Existing MSHA Requirements (MSHA to Follow OSHA Requirements)

### FRAC SITE

- **RESPONSIBLE PARTY**: E&P/Operator Under Multi Employer Worksite + Each Individual Contractor
- **REGULATORY AGENCY**: OSHA
- **COMPLIANCE DATE**: June 2018
- **REQUIREMENTS**: Evaluate/Test for Silica Dust Levels. If RCS > 0.025 mg/m³ then: Written Silica Dust Plan, Medical Monitoring, Site Monitoring, Record Keeping

### TRANSLOAD

- **RESPONSIBLE PARTY**: Transload Owner + Possible Multi Employer Worksite
- **REGULATORY AGENCY**: OSHA
- **COMPLIANCE DATE**: June 2018
- **REQUIREMENTS**: Evaluate/Test for Silica Dust Levels. If RCS < 0.05 mg/m³ and > 0.025 mg/m³ then: Written Silica Dust Plan, Medical Monitoring, Site Monitoring, Record Keeping

**ENGINEERING CONTROL OPTIONS**

- **RESPONSIBLE PARTY**: Transloaders, Truck Drivers, Railroad Employees
- **DEADLINE FOR IMPLEMENTATION OF ENGINEERING CONTROLS**: June 2018
- **BENEFICIARIES OF SANDTEC**: Transload personnel and truck drivers are protected. OSHA RCS compliance throughout facility

### ENGINEERING CONTROLS COLOR LEGEND:

- **Does Not Meet Action Level**
- **Partially Meets Action Level**
- **May or May Not Meet Action Level**
- **Meets Action Level**

### NOTES:

- **OSHA** = Occupational Safety and Health Administration
- **NIOSH** = National Institute of Occupational Safety & Health
- **MSHA** = Mine Safety and Health Administration
- **RCS** = Respirable Crystalline Silica
- **PEL** = Permissible Exposure Limit
- **RCS PEL** = Permissible Exposure Limit
- **AL** = Action Level

- **RCS AL** = <0.005 mg/m³
- **RCS AL** = <0.001 mg/m³

*Medical Monitoring for Frac Sites effective June 2018 if above PEL and June 2020 if above AL.*
# ESTIMATED REDUCED-DUST MAINTENANCE & REPAIR (M&R) SAVINGS ON FRAC SITE EQUIPMENT (FILTERS, RADIATORS, FLUIDS)

<table>
<thead>
<tr>
<th>Play</th>
<th>Total Maintenance Costs ($/ton Sand Pumped)</th>
<th>Low Dust Cost Reduction Factor (%)</th>
<th>Estimated M&amp;R Savings ($/ton Sand Pumped)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anardarko</td>
<td>$1.33 - $1.71</td>
<td>70%</td>
<td>$0.93 - $1.20</td>
</tr>
<tr>
<td>Appalachia</td>
<td>$1.33 - $1.71</td>
<td>75%</td>
<td>$1.00 - $1.28</td>
</tr>
<tr>
<td>Bakken</td>
<td>$1.33 - $1.71</td>
<td>75%</td>
<td>$1.00 - $1.28</td>
</tr>
<tr>
<td>Barnett</td>
<td>$1.33 - $1.71</td>
<td>65%</td>
<td>$0.87 - $1.11</td>
</tr>
<tr>
<td>DJ</td>
<td>$1.33 - $1.71</td>
<td>75%</td>
<td>$1.00 - $1.28</td>
</tr>
<tr>
<td>Eagle Ford</td>
<td>$1.33 - $1.71</td>
<td>60%</td>
<td>$0.80 - $1.03</td>
</tr>
<tr>
<td>Fayetteville</td>
<td>$1.33 - $1.71</td>
<td>75%</td>
<td>$1.00 - $1.28</td>
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<tr>
<td>Haynesville</td>
<td>$1.33 - $1.71</td>
<td>75%</td>
<td>$1.00 - $1.28</td>
</tr>
<tr>
<td>Permian</td>
<td>$1.33 - $1.71</td>
<td>60%</td>
<td>$0.80 - $1.03</td>
</tr>
<tr>
<td>Canada</td>
<td>$1.33 - $1.71</td>
<td>75%</td>
<td>$1.00 - $1.28</td>
</tr>
</tbody>
</table>

**Takeaway:** Use of SandTec Results in M&R Equipment Savings of $0.80 - $1.28/ton of sand.

Source: Maintenance cost saving estimates provided by Schlumberger.

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# ESTIMATED INDUSTRIAL HYGIENIST (IH) COSTS & REQUIREMENTS FOR RESPIRABLE CRYSTALLINE SILICA (RCS) AT VARIOUS EXPOSURE LEVELS AFTER INITIAL EXPOSURE ASSESSMENT

<table>
<thead>
<tr>
<th>IH Monitoring Costs ($/month)</th>
<th>Above the PEL</th>
<th>Above the AL</th>
<th>Below the AL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written RCS Plan</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Pulmonary Function Test</td>
<td>Yes</td>
<td>Maybe*</td>
<td>No</td>
</tr>
<tr>
<td>Chest X-ray</td>
<td>Yes</td>
<td>Maybe*</td>
<td>No</td>
</tr>
<tr>
<td>Medical Record Keeping Req’d</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Potential OSHA Fines</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>


**Takeaway:** Being Above the AL can add Significant Monitoring Costs and Regulatory Requirements.

Assumptions for IH Monitoring Costs:
- Perform (1) month of RCS sampling at hydraulic fracturing sites located in the Permian Basin of West Texas and within (3) hours’ drive from Midland, TX.
- A quantity of (6) personnel monitors and (4) area monitors will be required per site per shift.
- Operations are 24 hours per day with a (12) hour day shift and a (12) hour night shift.
- There will be (26) days of operations per calendar month.
- The final report to include all data and calculations required to determine Exposure Levels for total dust, total respirable dust, and total respirable crystalline silica dust, and to provide the determination if the results indicate exceeding the PEL of 0.05 mg/m³, within the Action Level between 0.025 mg/m³ to 0.05 mg/m³, or below 0.025 mg/m³.
- Personnel are responsible for all transportation to/from the site(s), lodging, meals, PPE, etc.

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# THE ARRMAZ ADVANTAGE

Combining the right chemistry with the right coating application method is vital for success. Since 1967, ArrMaz has been a trusted partner to the fertilizer, mining, phosphate and asphalt industries worldwide coating millions of tons of granular substances every year. With SandTec, we have applied our more than 50 years of coating technology expertise and adapted our proven coating application systems to meet the unique requirements of the oil and gas industry. Our team of engineers and technical experts will customize a system to address your specific needs while ensuring a high-quality, silica dust-reducing frac sand for hydraulic fracturing operations.
CONTACT ARRMAZ

Be a part of the solution to lowering silica dust in the oil and gas industry. Discover how SandTec can improve your hydraulic fracturing operations. Email SandTec@ArrMaz.com or call +1-863-578-1206 for further information.

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