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Synergist® Solutions: Sampling Silica

Silica: Choosing the Optimal Sampler

By Lucinette Alvarado

When sampling airborne crystalline silica, choosing the right sampler is crucial. Exposure to respirable crystalline silica (RCS) has long been recognized as a health hazard, linked to severe lung diseases like silicosis, lung cancer, chronic obstructive pulmonary disease (COPD), and kidney disease. Over the decades, OSHA, alongside other national and international organizations, has dedicated significant resources to reducing exposure and protecting workers. This article focuses on the tools you need for accurate sampling of airborne RCS and the primary considerations when choosing the optimal sampler.

Factors to Consider

The OSHA final silica rule, particularly for the construction industry, provides two distinct methods to ensure that workers are not exposed to dangerous levels of respirable crystalline silica. One is the use of specified engineering controls, work practices, and respiratory protection outlined in the rule's Table 1. The other is by conducting air sampling to determine the actual exposure levels and then implementing appropriate measures to mitigate risks. When selecting a sampler for RCS, there are several factors to consider:

Particle size fraction. For crystalline silica, it's the respirable particles that are of utmost concern because these are the ones that can deeply penetrate the lungs, leading to severe damage and potential health conditions. Respirable dust particles are smaller than 10 micrometers (µm). Samplers suitable to collect respirable dust have a 50 percent cut-point at 4 µm and should follow penetration characteristics as defined by the respirable convention agreed upon by ACGIH, the European Committee for Standardization (CEN), and the International Organization for Standardization (ISO).

Sampling rate. The airflow rate through the sampler should match its intended design. For many silica samplers, this is often in the range of 1.7 to 8 liters per minute (L/min). It is important to follow the manufacturer's recommendations, as that flow rate specification ensures accurate and reliable air sampling by selecting the correct particle sizes and maintaining consistent measurements. Deviations can compromise equipment functionality and result in noncompliant data. Adhering to these specifications is crucial for both the accuracy of exposure assessments and the longevity of the sampling equipment.

Compatibility with analytical methods. The chosen sampler should be compatible with the analytical method you intend to use. This includes how to handle the sampler, flow rate, sampling time, and volume. Not following those requirements can lead to biased results due to altered particle size selection, potentially resulting in noncompliant and inaccurate exposure data.

Environmental conditions. The sampler should be appropriate for the environment where it will be used:

- Humidity: High humidity can cause airborne particles, including silica, to agglomerate or clump together. This can change the size distribution of the particles, which can impact the effectiveness of sampling methods specifically designed for respirable-sized particles.
- Temperature: Extreme temperatures can affect the equipment used for sampling, potentially impacting the accuracy of the measurement. Some sampling equipment might require specific temperature ranges for optimal operation.

Damage or disturbance: This happens when the cyclone sampler is tipped. If this occurs, the centrifugal forces within it, which act to separate particles by size, may not work as effectively. This can lead to the collection of an incorrect size distribution of particles, potentially compromising the accuracy of the sample.

Options for Sampling

Given our understanding of the factors influencing the selection of a silica sampler, what options are on the market and how do they vary from each other? Here's a brief summary of available instruments.

Aluminum respirable dust cyclone.

Cyclone samplers. These commonly used samplers for silica use centrifugal force to separate and collect respirable particles. The airflow spirals inside the cyclone, forcing larger particles out of the airstream to collect in the sampler's grit pot, while smaller, respirable particles are drawn through and collected on a filter. Examples include the SKC Aluminum Cyclone, as mentioned previously, and the GS-3 Cyclone. The filter cassettes utilized for these types of samplers are open-faced, preloaded, pre-weighed 37-mm 5.0-µm PVC filters.

Parallel Particle Impactor (PPI) samplers.

Parallel Particulate Impactor (PPI). This is a newer respirable dust sampler that uses a series of impactors operating in parallel (hence the name). PPI samplers contain four small impactors in the inlet section of the device. Each impactor features a unique 50 percent cut-point to target a specific one-quarter segment of the ISO 7708/CEN curve, resulting in a precise fit along the entire curve. A sample pump operating at 2, 4, or 8 L/min pulls air through the inlet nozzle of each impactor in the inlet plate. Particles larger than each impactor's 50 percent cut-point are scrubbed and retained by impaction onto the porous oiled impaction substrate contained in each impactor. Smaller particles continue to the standard 37-mm collection filter for analysis.

There are many advantages to using the PPIs:

- Based on their performance, the samplers were approved by OSHA during the silica rulemaking, resulting in PPI samplers being listed in the OSHA final silica rule on page 16,439 as conforming closely to the ISO/CEN respirable convention specified by OSHA.
- The PPIs, available for use at 2, 4, or 8 L/min, can collect a quantity of respirable crystalline silica exceeding the quantitative detection limit for lab analysis. The 4 and 8 L/min PPI samplers provide the option of shorter sampling durations while maintaining adequate detection by the lab.
- This type of sampler is accurate and easy to use. You can calibrate it with an adapter instead of the calibration jar required by other samplers. PPI samplers can be inverted without invalidating the sample, unlike cyclone samplers. The samplers are available with a pre-weighed filter for respirable particulate and silica; no assembly is required.

Real-time monitors. Although not written into the OSHA silica rule for compliance, these instruments can provide real-time estimates of respirable dust concentrations and are used more as supplementary monitors. They do not typically measure silica specifically but can provide immediate feedback about potential overexposures.

However, devices such as the Environmental Devices Corp. SM 7204 are the exception. Its two co-located devices in one instrument—a real-time direct-reading monitor and a built-in compensating pump and pre-weighed filter cassette—provide simultaneous real-time particulate readout and gravimetric sampling.

SM-7204 Real-time Personal Silica Monitor.

Real-time monitors are an ideal complementary instrument to use, especially for determining if implemented controls are successful in reducing exposure.

Actionable Insights

When sampling airborne respirable crystalline silica, the optimal choice of sampler hinges on precision engineering and manufacture (that is, quality materials, precise nozzles, and testing to determine optimal flow rate for sharp cut-points); reliability (features that allow for easy, accurate calibration of the pump flow rate and prevent sample invalidation due to tipping); and the ability to selectively target the respirable fraction of airborne particulates accurately. There are several different silica samplers available that perform with acceptable bias according to the OSHA final silica rule. However, the PPI samplers emerge as a superior option due to their precise match to the entire ISO 7708/CEN curve and ease of use. The PPI's compatibility with standard analytical methods ensures that subsequent laboratory analysis is seamless and yields actionable insights. Considering its inherent features and advantages, the PPI can be confidently recommended as the optimal choice for occupational sampling of respirable crystalline silica.

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Resource

International Organization for Standardization: ISO 7708:1995, *Air Quality — Particle Size Fraction Definitions for Health-Related Sampling* (1995).