Silica Exposure Measurement in Real-Time for Construction

Application Note EXPMN-023 (A4)

Frequently Asked Questions

What is crystalline silica and why is it important to measure exposure?

Silica is found in both natural and man-made substances. Respirable silica dust is considered a carcinogen by the Center for Disease Control (CDC) and Occupational Safety and Health Administration (OHSA) advises it to be treated as hazardous in an airborne state. Because of the small size of the respirable particles, once silica gets into the deep part of the lungs, it cannot be removed or expelled. Exposure over time can cause lung disease.

Respirable crystalline silica is created by any high-energy operation such as cutting, sawing, grinding, polishing, drilling and crushing stone, rock, concrete, brick, block and mortar or when abrasive blasting with sand is performed. Other activities such as sweeping dirty areas, using compressed air to clean, driving or operating heavy equipment on dirt roads, demolition of structures or transferring of dry materials that have silica contents also create respirable silica dust.

What are the sources of silica?

There are three types of silica: quartz, cristobalite and tridymite. Materials like sand, concrete, brick, concrete block, stone, sheet rock, aggregate, tile, grout and mortar all contain crystalline silica as an element.

Dust cannot be seen in the air, what needs to be measured and why?

Respirable particles are too small to be seen and will penetrate deep into the lungs. Once respirable dust particles get into the lungs, they cannot be expelled. OSHA recommends that workers do not rely only on visible dust to assess the potential presence of silica. Airborne respirable dust particles are likely present but are not visible to the human eye.

What is the difference between dust, aerosols and particulates?

An aerosol is defined as suspension of fine particles dispersed in air or gas. Very small particles, or particulates, can become airborne or aerosolized such as mist, fumes or smoke. Real-time instruments measure the dust particles within an aerosol.

How much respirable crystalline silica is in a material?

Silica is expressed as a mass concentration of the contents of a total dust sample. To determine the silica content of an aerosol, a sample is weighed and analyzed by a lab to determine what amount of silica is present. If the sample only contains respirable dust, than the silica contained within is respirable silica.

How is gravimetric sampling done for respirable crystalline silica?

Air samples are collected with a sample pump that pulls air though a size selective cyclone (different cyclones allow for different sized particles to pass through). This process captures the larger particles, permitting the smaller particles to be collected on a filter. The particles collected on the filter are sent to a lab for analysis.

If I have to take a gravimetric sample to get a calibration factor at the beginning of an assessment and another at the end to prove OHSA compliance, why not just do gravimetric sampling all the time?

The collection, processing and lab analysis of a gravimetric sample can take weeks. When using any of the alternative compliance methods contained in the OSHA standard, silica dust sampling is required at various time intervals and frequencies. If engineering controls are changed, the sampling process begins again until workplace exposure is within compliance to the standard. This volume of testing and retesting makes doing gravimetric sampling not only time consuming but also costly, especially for large organizations.

Finally, with gravimetric sampling, there is no immediate exposure data—employees are not alerted if there is exposure above the permissible exposure limit (PEL) during the sampling time period. With this, corrective action(s) have to be taken at a later date, well after the exposure has taken place. Real-time monitoring provides a faster and less costly path for making adjustments to controls and verifying the effectiveness those adjustments prior to doing final gravimetric sampling—offering no unwanted surprises.

Once gravimetric sampling is done, how are calibration factors input into the DustTrak™ Aerosol Monitor or SidePak™ AM520 Personal Aerosol Monitor so that it closely correlates dust levels with respirable silica levels?

Assuming real-time monitoring was done simultaneously with the gravimetric sampling during the initial assessment, calibration factors are calculated based on the results of both studies. With the mass concentration of respirable silica provided by the analysis of the gravimetric sample and the real-time photometric measurement of the real-time instrument, the photometric calibration factor for silica content of the aerosol can be calculated. The calibration factors are entered into the DustTrak™ Monitor and the SidePak™ AM520 Monitor instrument software.

Each instrument can contain several calibration factors. This enables a user to select the desired calibration factor depending on what material is creating the aerosol (dust) that is being measured. If several different materials are used, a calibration factor would have to be developed for each material. The instrument uses the calibration factor to display the calculated amount of respirable silica in the dust sample.

How do real-time monitoring instruments save money?

Money is saved in several ways. Gravimetric sampling takes time to set up and execute which requires people, often times professional consultants, to manage the process. Time is money, especially when professional industrial hygiene (IH) consultants are engaged. Some labs require a minimum sample time be completed (usually several hours) to ensure there is enough particles on the filter to be weighed.

Real-time measurements can be done in a fraction of the time, requiring little set-up effort. A recent TSI® internal study showed that a representative measurement of silica was obtained in real-time in about 20 minutes whereas the same readings would have taken almost two hours using gravimetric sampling. This is 83% less time than a gravimetric pump and in very useful when measuring short duration tasks.

Second, the gravimetric samples of any duration have to be sent to a lab for analysis. In addition to the shipping costs, each sample can typically cost up to $100 or more for a lab to process. Real-time measurements are immediate, use re-usable components and do not require the same level of management to execute and compile reports.

How does real-time dust monitoring save time when taking a total-weighted average (TWA) reading over an 8-hour time period?

To be clear, real-time instruments will not replace the need for a gravimetric sample showing exposure below the PEL with a TWA over 8 hours.

However, real-time instruments are tools for performing quick comparisons that can save employers substantial time (and money) in three ways—when performing exposure assessments, when validating changes to engineering controls and when sending samples out for lab analysis.

Once calibrated, real-time instruments display a representation of the exposure level and calculate TWAs as collected, while logging data. This provides the user with a representation of the silica exposure levels and drives immediate corrective action if necessary. Once engineering controls are in place or adjusted, validating the effectiveness of the controls or corrective actions can be made quickly—likely the same day.

In turn, gravimetric samples typically require an 8-hour sampling of air volume. Following the sampling of a full shift, it typically takes 7 to 10 days to get the results of the lab analysis, one day to make changes to engineering controls, one day for full-shift validation sampling and 7 to 10 days to get lab results from the lab to verify that the engineering controls are working as expected. Thus, it is easy to see that the time saved with real-time monitoring is significant and compounds as more workers and tasks are assessed for silica exposure.

Does real-time monitoring equipment require servicing or maintenance?

As with any precision measurement instrument, regular service and maintenance is required. TSI® recommends that factory calibration, cleaning and maintenance be done annually along with periodic cleaning as described in the product user manuals. Any damage to an instrument should be repaired immediately.

Where is it best to place the instruments onsite?

Many variables dictate this, including process, materials, job site and more. In some cases, a professional IH consultant may be required to help you establish a written exposure control plan which will identify the tasks and locations that need to be monitored.

If projects only take a day or two, can the instrument be calibrated to the known silica content of cement or block in use?

Assuming an initial assessment has been completed and a calibration factor has been calculated and entered into the instrument, that calibration factor can be selected for use at any time. As long as the silica content of the material source of the particles has not changed, the calibration to the dust or aerosol is applicable. It is important to note that baseline gravimetric samples will be needed for each type of cement or concrete block used and a custom calibration factor will be needed for each material as the silica content is likely different for each.

Do TSI® instruments measure total respirable silica?

Not directly. TSI® instruments use light scattering photometric technology to measure the amount of total respirable dust in the air. When properly calibrated, the instrument can determine the amount of crystalline silica contained within that aerosol sample. The instrument uses a photometric calibration factor to adjust the photometric reading of the instrument to the known silica content in the dust. This allows the instrument to display a representative level of respirable silica exposure to a worker that is very close to what one would expect from a gravimetric sample.

How best to begin a sampling program?

In order to formulate a plan, it is necessary to have baseline references and know industry standards and regulations. The silica standard per OSHA supplies the targets and requirements as well as guidance for an effective written exposure control plan. A comprehensive written exposure control plan describes potential workplace exposure risks and ways to reduce exposure using engineering controls, housekeeping methods, work practices and/or restricting access to high exposure areas. OSHA also requires that the written plan include all tasks that employees perform that could cause exposure to respirable crystalline silica dust and the factors that affect exposure, including materials and environment where the task is being performed.

In many instances, a company will choose to hire an IH consultant to develop a written exposure control plan. It is likely that assistance will also be provided to get the program started (to determine the specific levels of silica exposure) and to identify areas of concern.

Why perform real-time monitoring if gravimetric sampling is required as reference data by OSHA?

Real-time, direct reading instruments provide a shorter path to compliance by allowing users to perform assessments and make adjustments to engineering controls before final gravimetric samples are collected. Real-time instruments provide immediate information regarding exposure levels, instant alerts to unsafe conditions, and detailed data for reporting and instant validation of changes to engineering controls. With real-time instruments, employers move through the assessment process faster and at a lower cost while protecting workers and reducing risk. Gravimetric sampling is required by OSHA to prove compliance to the Silica standard and using real-time monitoring provides companies with the confidence that the final lab analysis of a gravimetric sample will show that silica exposure levels have been managed and are with compliance.

How does OSHA define a competent person to handle silica exposure program?

OSHA defines a competent person as someone who can identify existing and foreseeable respirable crystalline silica hazards. This person is authorized to promptly eliminate or minimize silica hazards with the knowledge and ability to implement the written exposure control plan. They are expected to frequently and regularly inspect job sites, materials and equipment as well as implement the written exposure control plan as outlined by the employer.

Can an employer have more than one competent person on staff?

Yes. Employers can designate any employee to be a competent person if the employee is qualified, although the standard does not outline specific training criteria. The employee qualifications may be dependent upon the tasks being performed and with what type of equipment. It is best practice for a company to have a competent person assigned to every shift at every job site. How many will depend on the size of the company.

The OSHA PEL is referred to in micrograms with real-time instruments displaying readings in milligrams. How easy is the conversion process?

One milligram (mg) is equal to one thousand micrograms (µm). Simply multiply the SidePak™ AM520 Monitor or DustTrak™ Monitor readings by 1000 to convert from milligrams to micrograms. For example: SidePak™ AM520 Monitor reading of .05 mg/m^3 is equal to the PEL of 50 µg/m^3 (.05 mg x 1000 = 50 µg).

Who can provide reference to qualified consultants and accredited analytical laboratories that can assist with silica exposure monitoring?

The American Industrial Hygiene Association (AIHA) provides links to industry consultants on their website (www.aiha.org) while their sister site (www.aihaaccreditedlabs.org) provides a listing of accredited laboratories.

Knowledge Beyond Measure.

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