Control of Silica Exposure in Sanitaryware Plants

Effective control measures can reduce dust generation or contain it before the worker is exposed. Redesigning work areas can help reduce heavy lifting injuries

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Researchers at the National Institute for Occupational Safety and Health teamed with investigators from the New Jersey Department of Health to survey a manufacturer of vitreous china lavatories and toilets. Overexposure to silica was known to exist at this facility because of reported silicosis cases. During the survey, lost-time injuries related to heavy lifting also were found to be a significant problem.

The primary raw materials used in the plant surveyed consist of clay, feldspar and flint. In the production of a unit, clay slip is cast into a mold and dried. The dried casting is shaped, dried further, smoothed and trimmed. The cast piece receives one or more glaze coats containing crystalline silica prior to firing in a tunnel kiln. The clay slip and glaze contain approximately 15% to 25% crystalline silica.

All areas of the manufacturing portion of this plant had the potential for silica exposure. Environmental evaluations were conducted in several areas of the plant including the slip house, casting, glaze preparation and glaze spray departments. Both personal and area air samples were evaluated for respirable dust and crystalline silica content.

In addition, bulk samples of raw materials and clay slip mixtures were collected and analyzed for crystalline silica. Real-time monitoring of dust exposures and simultaneous videotaping of work operations were used to evaluate sources of dust and to estimate excessive physical body stresses. From the observations of work practices and evaluation of environmental conditions, recommendations were made to change work practices and administrative procedures. The recommendations can be of use to other sanitaryware producers.

When inhaled, the crystalline forms of silica can cause silicosis, a form of lung disease caused by the deposition of fine particles of crystalline silica in the lower portions (alveoli) of the lungs. Symptoms, which usually develop insidiously, include cough, shortness of breath, chest pain, weakness, wheezing and non-specific chest illness. Silicosis usually occurs after years of exposure, but may appear in a shorter time if exposures are very high.[1]

Disabling injuries

A review of the plant's Workers' Compensation Log from May 1986 to November 1987 indicated that lost-time injuries were a significant problem. High rates of injury occurred particularly in the glaze spray, glaze preparation and casting areas. Overexertion accounted for a large number of the disabling injuries. Most of these injuries resulted from manually handling materials and included acute traumatic injury, such as lacerations, bruises or fractures.

Long-term overexertion may cause fatigue, postural stress or musculoskeletal injury. However, the principal long-term health effect is injury to the spine. Prevention of these problems is discussed in the NIOSH Technical Report "Work Practices Guide for Manual Lifting."[2]

Manual handling of products in several areas of the plant accounted for many lost-time injuries. This occurred particularly in the casting shop and glaze spray areas, where compressive forces on the back of a worker during lifting can be excessive. These injuries could be significantly reduced by examining all of the lifting operations and redesigning the work area or, where appropriate, substituting mechanical aids.[3]

Dust controls, work practices and changes in administrative procedures were identified as the most effective means to reduce dust exposure and lost-time injuries from heavy lifting. These recommendations were based on the observation of work practices and the evaluation of the air and bulk sampling data from the survey at the sanitaryware plant.

Engineering controls

High priority should be assigned to controlling the general glaze spray area because of the potential for high silica exposure levels and the large number of exposed personnel. One or more coats of glaze are applied to each casting using a compressed air spray system. This creates a significant opportunity for exposure even though ventilated spray booths are used.

Glaze spray booths should provide maximum enclosure of the operations and provision of adequate air velocity at all openings. For example, for effective control in small spray booths, the *ACGIH Industrial Ventilation Manual* recommends from 100 to 200 $ft^3/min/ft^2$ of

open area depending upon the size and use of the hood (Plates VS-603 and 604).[4] Smoke tubes can be helpful in defining air flow patterns in and around the hoods.

Reduced dust exposures also can be achieved through a reduction of air pressure in the spray guns and by the use of extensions on the guns to reduce overspray and bounce-back. The close proximity of the spray operators to the sprayed fixtures and the bounce-back of the overspray contribute to worker exposure.

In addition, it was found that the use of "man cooler" fans in the glaze spray area reduced the effectiveness of the local exhaust ventilation into the spray booth and also stirred up settled dust. The directional flow pattern, developed by the hood ventilation system, also was disturbed by the "man cooler" fans so that spray mist escaped from the hood.

Improving work practices

Poor housekeeping can be a major source of dust contamination. A major source of airborne dust in the sanitaryware plant was found to come from cross-contamination from other activities and re-entrainment of dust from scrap and waste on the floor and other surfaces. Improved methods of cleaning up scrap material, using either a centralized vacuum system or portable vacuum cleaners with high efficiency particulate air filters, would significantly reduce dust exposures; "dry sweeping" should be eliminated.

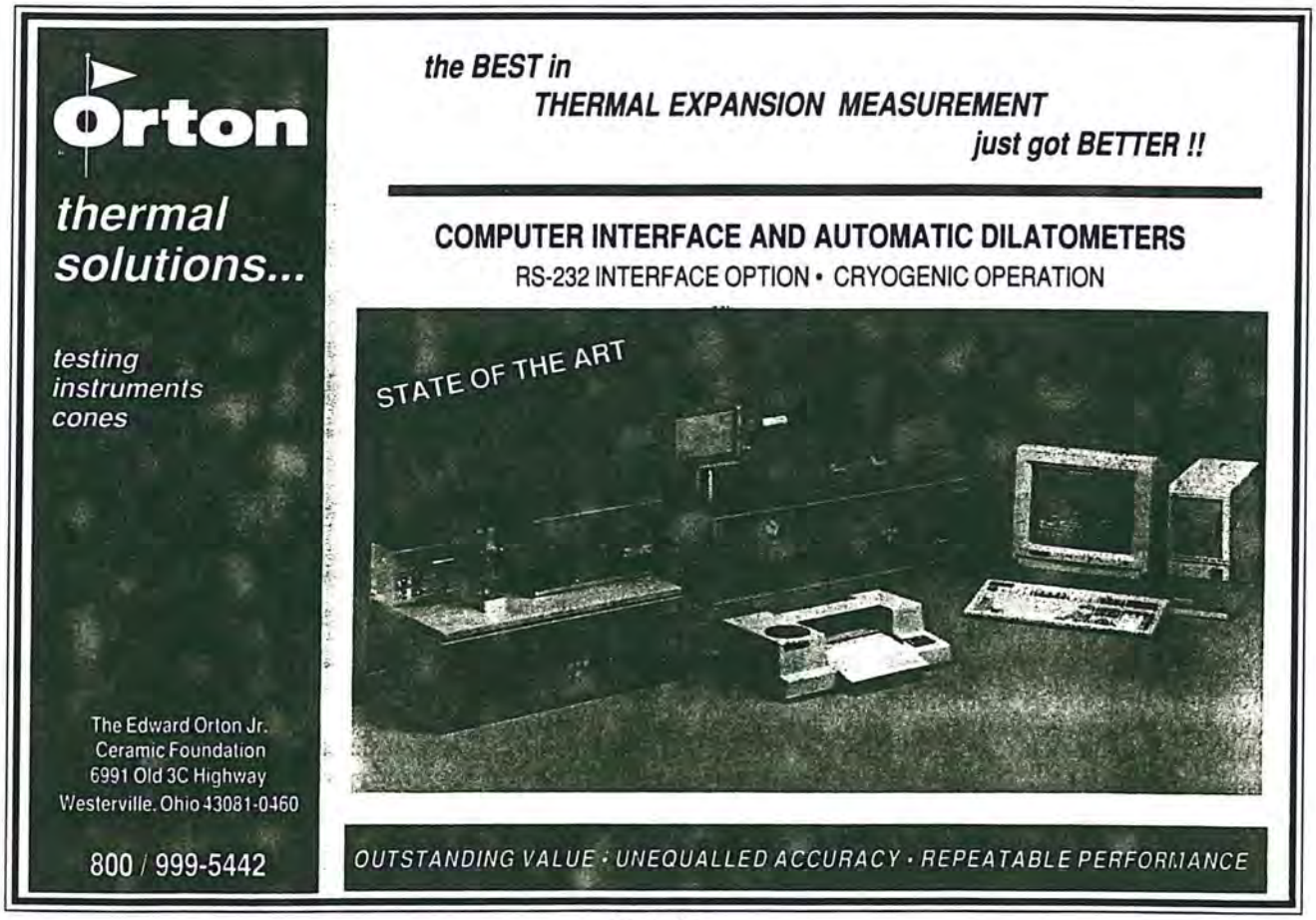
Cleaning green castings rather than white castings reduces dust emissions; i.e., it is preferable to clean castings made the previous day rather than those that have dried for two or more days. When white castings are to be cleaned, they first should be wiped with a damp sponge or misted with a sprayer. After the rough edges and mold parting lines have been scraped, the use of a portable vacuum cleaner with attached HEPA filters or a centralized vacuum cleaning system would be a more effective and less dust-producing procedure for cleaning castings than brushing.

The use of glaze overspray as a mold parting compound was a visible source of dust exposure. This material not only causes instantaneous dust exposure for the workers, but can settle and eventually be re-entrained into the workplace air. An alternative would be to substitute a nonsilica mold release for the glaze overspray material.

Repair and regularly scheduled maintenance of dust control systems, including exhaust ventilation systems, improve the overall effectiveness. The routine use of a small air velocity meter can be effective in determining the status of ventilation systems. Static pressure gauges fitted to each hood are an effective alternative method to monitor the performance of ventilation hoods. The use of direct-reading dust monitors also can help locate major dust sources in need of control.

Administrative practices

Based on the observations at this plant, respirator use was sporadic. When appropriate, respirators can be used to provide worker protection. Requirements for an effective respirator



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program are discussed in the "NIOSH Guide to Respiratory Protection"[5] and in OSHA's standard for respiratory protection.[6]

An ongoing program of medical surveillance should be instituted to validate the effectiveness of dust control programs. The following medical surveillance program developed by NIOSH for exposures to crystalline silica flour[7] also is relevant to other crystalline silica dust exposures. This program includes:

- "[P]replacement and annual medical examinations (for) all workers who manufacture, use or handle silica (flour) or materials containing silica (flour)."
- "Workers with radiographic evidence of silicosis should be given the opportunity to transfer to jobs without silica exposure (defined as exposure at concentrations less than half of the NIOSH recommended standard)."

An environmental monitoring program, including periodic air monitoring and dust control systems monitoring, would validate the effectiveness of the dust control program.

Conclusions

Any one or a combination of unexpected events can negate the most effective control systems. In designing an effective dust control system, all potential sources must be controlled. Each casting operation is different. Therefore, a combination of dust control measures and work practices, using approaches similar to those discussed in this article, must be identified and implemented. □

References

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7. NIOSH. op.cit., 1981.

Note: Additional details about this study by NIOSH and the New Jersey Health Department can be obtained from NIOSH by requesting ECTB Report 171-11b.

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