Silica

Papers 324–327

324.

EVALUATION OF MISTING CONTROLS TO REDUCE EXPOSURE TO RESPIRABLE CRYSTALLINE SILICA FOR WORKERS ENGAGED IN BRICK CUTTING. B. Beamer, D. Watkins, S. Shulman, A. Maynard, NIOSH, Cincinnati, OH.

It is estimated that more than 1.7 million workers in the U.S. have been exposed to respirable crystalline silica, with a large percentage having been exposed to silica concentrations higher than limits set by current standards and regulations. The purpose of this study is to characterize the use of water-type engineering controls to reduce exposure to respirable crystalline silica for construction workers engaged in the task of brick cutting.

Since data concerning the efficacy of engineering controls collected at work sites is often confounded by variations like wind, worker skill level, etc., experimentation was conducted in a laboratory environment. A completely enclosed testing chamber housed the brick-cutting saw. Respirable dust concentrations were measured by the Model 3321 Aerodynamic Particle Sizer® Spectrometer. Specifically, the laboratory experiment was designed to compare dust suppression of water misting with conventional flooding techniques. Three flow rates of the brass atomizing nozzles were used for making this comparison: low (4.8 gallons per hour), medium (8.6 gallons per hour), and high (17.3 gallons per hour). The flow rate for flooding was 48 gallons per hour.

The experiment consisted of five replications of five samples each (low-misting, medium-misting, high-misting, flooding, and no control). The order of sampling within each replicate was completely randomized. Results showed that low-misting nozzles reduce respirable dust levels by about 62%, mid-misting nozzles by about 71%, high-misting nozzles by about 82%, and flooding by about 92%. Based on these results, it may be feasible to use misting to control respirable silica dust instead of flooding. This strategy is of practical interest to the construction industry which must frequently limit the amount of water used on construction sites for a variety of reasons.

325.

A COMPREHENSIVE APPROACH TO CRYSTALLINE SILICA EXPOSURE ASSESSMENT. M. Pannell, Los Alamos National Laboratory, Los Alamos, NM.

Potential employee exposure to crystalline silica must be considered throughout the construction, mining, and agricultural industries. Although environmentally ubiquitous and long known as a lung hazard, the ability to accurately quantify worker exposure remains problematic. This paper identifies four aspects of crystalline silica exposure assessment that present potential pitfalls, and subsequently suggests means of resolution for each. The identified pitfalls are: (1) the use of the OSHA calculated permissible exposure limit, (2) sampling, (3) analysis, and (4) control measures. The OSHA calculated permissible exposure limit, as defined in 29 CFR 1910.1000, Table Z3, allows immediate, on-site gravimetric analysis and reduces the cost and delay of comprehensive x-ray diffraction analyses. However, the ability to acquire a representative x-ray diffraction sample is difficult and there are potential variations in the reference constituents among the four prescribed sources. Facilities following ACGIH recommendations face additional concerns with the difference in respirable fraction value component of the calculated permissible exposure limit as well as the threshold limit value for quartz. Sampling presents the second presented aspect of crystalline silica exposure assessment. These include determining the type of cyclone, flow rate, the sample location, and collecting a representative sample. Sample analysis is the third aspect discussed. Specific components discussed are x-ray diffraction analysis variability, gravimetric analysis, sufficiency of sample loading, filter dessication, and sample mass losses. The final aspect discussed in this paper is the use of control measures, including dust suppression, the inherent control ability of equipment, and personal protective equipment. Recommendations are presented to minimize the variability within each of the presented problem components, designed to enhance the industrial hygienist's ability to more accurately assess worker exposures to crystalline silica. The recommendations presented are based on 1500-plus samples in numerous construction, maintenance, and mining activities.

326.

OCCUPATIONAL EXPOSURE TO CRYSTALLINE SILICA DUST IN THE UNITED STATES. A. Yassin, R. Tingle, U.S. DOL/OSHA, Washington, DC.

The purposes of this study were (a) to measure concentration of crystalline silica (respirable) dust exposure levels among U.S. workers; (b) to identify high-risk occupations and industries; and (c) to conduct time trends analyses on silica dust exposure levels for time-weighted average (TWA) measurements. Compliance inspection data that were taken from OSHA Integrated Management Information System for 1988–2003 (n = 7055) were used to measure the crystalline silica dust exposure levels among the U.S. workers. Log-linear trend regression analysis was used to assess time trends in exposure measurements of silica. The overall geometric mean of silica dust level for an 8-hour personal TWA measurement was 0.038 milligrams per cubic meter (mg/m³). This level was well below the applicable exposure guidelines, including the National Institute for Occupational Safety and Health recommended exposure limit of 0.05 mg/m³ and the American Conference of Governmental Industrial Hygienists threshold limit of 0.1 mg/m³. Mining industry had a geometric mean silica exposure level of 0.285 mg/m³ compared with 0.057 mg/m³3 for the construction industry. Service industry combined with other industries had the lowest geometric mean crystalline silica exposure level of 0.025 mg/m³ for an 8-hour TWA measurement. Although crystalline silica exposure levels declined in some industries, the results showed an upward trend in the silica respirable dust exposure levels in certain industries and occupations.

327.

HEALTH EFFECTS OF STRUCTURAL SPECIALIZATION OF SILICA SURFACE. E. Demchuk, V. Murashov, M. Harper, NIOSH, Morgantown, WV.

Inhaled crystalline silica is commonly viewed as an increased risk factor for pulmonary fibrosis, pneumoconiosis, silicosis, and lung cancer, although the mechanisms involved in silica-dependent lung injury are poorly understood. Based on the structural analysis of crystals and computational modeling, a new association between the structural specificity of silanol sites on silica surface and health effects of respirable silica is proposed. Silica surface accommodates two types of silanol sites. They are the Si-OH (single) and $Si{=}(OH)_2$ (geminal) sites. It is found that unlike natural grown quartz or kaolinite, the surface of cleaved quartz is enriched with geminal silanol sites. An estimated concentration of 0.067 $Å^{-2}$ silanol sites on the conchoidal fracture of pure α-quartz is obtained. About 25% of these sites are geminal. In contrast, surfaces of pristine quartz crystals and kaolinite are found to be virtually free of geminal sites. Because of the higher calculated surface energy of geminal sites, it is proposed that the concentration of geminal sites on respirable particulate matter may be associated with the increased fibrogenic potential of crystalline silica. It is suggested that structural specificity of silanol sites on silica surface may be a factor deserving consideration in occupational risk assessment.

Poster Session 402

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Beryllium

Papers 328–332

328.

FIELD TESTING OF A NEW FLUOROMETRIC METHOD FOR THE DETECTION OF BERYLLIUM. G. Whitney, R. Winkel, T. McCleskey, D. Ehler, E. Minogue, Los Alamos National Laboratory, Los Alamos, NM.

The DOE beryllium rule (10 CFR 850) and concerns over health hazards have lead to an increased demand for measuring beryllium sur-

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