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Respirable Crystalline Silica exposure during ceramic tile processing

Objective: Respirable Crystalline Silica (RCS), classified as a Group 1 carcinogen by the International Agency for Research on Cancer, poses significant health risks when inhaled, including silicosis and lung cancer. Exposure to RCS can occur especially in occupational settings, including in the glass, ceramic, brick and tile industries, where materials are mechanically processed through cutting, grinding, crushing, drilling or abrasive blasting.

Activities related to the processing of ceramic tiles may vary considerably in terms of hours worked per day and days worked per week. This variability is high for craftsmen who carry out cutting, grinding or other processing of ceramic materials directly on site, during installation of tiles and not in a completely suitable environment, in terms of health and safety of the worker. In these situations, it may be difficult to control RCS exposure by means of dust extraction or abatement systems including wet processing. Further, actual working time for these operations is unpredictable. These uncertainties make it difficult to estimate the exposure to RCS of artisans/craftsmen, a critical factor for assessing occupational risks and implementing appropriate safety measures.

This study investigates the occupational risks associated with RCS exposure during ceramic tile installation, particularly focusing on cutting and grinding tasks.

Methods: Simulated RCS exposure evaluation were conducted to replicate real-world conditions where ceramic tiles are processed for installation by cutting and grinding. The tiles used in this study varied in composition (in term of formulations) and thickness (12 mm and 20 mm).

RCS exposure was measured using personal and environmental samplers, collecting respirable dust. Sampling occurred during 2-hour task durations, assuming no further exposure for 8-hour TWA calculations. Accredited gravimetric and X-ray diffraction techniques were used to quantify RCS concentrations. These measurements were compared against OELs, and task-specific durations were calculated for safe exposure levels. The efficacy of personal protective equipment (PPE), including FFP2 and FFP3 masks, was incorporated into the analysis by applying protection factors of 10 and 20, respectively.

Results: Principal results of this study (worst-case simulation) show that, during the processing of ceramic tiles releasing RCS, the worker exposure can be very high (average: 240.9 $\mu\text{g}/\text{m}^3$; maximum: 889.3 $\mu\text{g}/\text{m}^3$), exceeding the Occupational Exposure Limit - OEL. In particular, even working for a few hours a day, the RCS 8-hour TWA (Time Weighted Average) OEL is likely to be exceeded. Furthermore, without respiratory protection, workers could perform cutting for only 54 minutes or grinding for 115 minutes daily before exceeding the OEL. Inhaled exposure concentrations can be reduced by using appropriate respiratory protection, by a factor equal to 10 or 20. However, the study emphasized that reliance on PPE alone could be insufficient due to potential misuse, failure to fit, or discomfort, underscoring the importance of engineering controls and administrative measures.

Conclusion: The findings confirm that ceramic tile processing poses a substantial risk of RCS exposure, especially in unstructured environments like construction sites where engineering controls are often lacking. Effective risk management must integrate a hierarchy of controls, prioritizing collective measures such as local exhaust ventilation and wet processing techniques, supported by appropriate use of PPE. Training workers in safe handling practices and ensuring regular maintenance of protective systems are critical to minimizing exposure. Additionally, task durations, material properties, and working conditions must be carefully assessed to develop tailored safety protocols.

The assumption of this work was that (i) the cutting/grinding times are not always necessarily equal to 2-hours, and that (ii) these processes are not characterized by pre-established and continuous processing times.

For these reasons, it is important to evaluate carefully the duration of exposure to RCS during the various tasks/activities performed, as these may vary.

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