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Comparative characterization of particle emissions from asbestos and non-asbestos cement roof slates

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ABSTRACT

The first aim of this study was to characterise total and size-fractionated particulate matter (PM) aerosol, including fibres, released from the processing operations of cement roofing slates. The second aim was to compare particle emissions from asbestos-cement and non-asbestos cement sheets, with respect to total and size-fractionated particulate matter as well as fibres emissions. Asbestos and cellulose-based cement sheets were compared during slate treatment processes, namely crushing, rubbing, rasping and scrubbing. Generated PM and fibres were classified by a variety of methods ($PM_{2.5}$ and PM_{10} cyclones, aerodynamic particle spectrometer and optical particle counter). A substantial variation in the mass of generated particles has been noticed, both within each PM fraction and between different treatment processes. The PM_{10}/PM_{total} concentration ratio ranged from 70 to 98% and $PM_{2.5}/PM_{total}$ ratio equalled to ~20%. The new generation non-asbestos sheets produced three times higher PM emissions than asbestos-cement sheets during crushing operation. Particle size distribution of number concentrations was mostly bimodal (two modes at 0.5 and 2.5 μm). With respect to fibres, the release of cellulose fibres from non-asbestos slates was from 1.8 to 13 times lower in comparison with asbestos fibres. At the same time, cellulose fibre length was 1.4–1.6 times lower. Hence, new generation non-asbestos roofing slates were proved to be less hazardous from the point of view of fibre release, but more hazardous with respect to total particle release.

1. Introduction

Rapid reconstruction of buildings generates considerable quantities of asbestos-cement slate waste which is potentially hazardous to workers and inhabitants' health due to fibre aerosolization [1–3]. There is abundant epidemiologic evidence that asbestos fibres can cause various diseases in humans. Three primary diseases are associated with asbestos exposure: asbestosis (caused by the inhalation and retention of asbestos fibres), lung cancer, and mesothelioma (an otherwise rare form of cancer associated with the lining around the lungs) [4,5]. During last decades of previous century, as well as in the first decade of this century, many studies have been performed on worker's exposure and asbestos fibre emissions from various sources, including asbestos-cement sheets, in living areas, commercial and industrial sites [6–12]. Asbestos fibre concentrations during demolition by removal of whole sheets averaged from 0.3 to 0.6 f ml^{-1} for roofs and less than 0.1 f ml^{-1} for walls [13]. Average values for the concentration of asbestos in the workplace atmosphere were 0.1 f ml^{-1} [14]. Surface corrosion was found to be an important factor in fibre emission [15]. The release of the fibres during various mechanical operations has been also studied [7,16,17]. A study carried out by Bridle et al. [18] examined the effect of crushing of asbestos-cement sheets. Sheets were crushed using a digger driven over piles of chrysotile asbestos-cement roofing sheets. The authors did not find detectable levels of airborne chrysotile fibres, and claims have been made that the chrysotile asbestos in asbestos-cement products is altered, by an unexplained process, into a non-asbestos fibrous material. It was hypothesized that cement replaces chrysotile to less hazardous materials, because small individual particles of cement got attached to the surface of the fibres. Similar allegations have been raised by Deruyterre et al. [19]. This finding was later rejected by Burdett [7], who has closely examined fibres forming during roofing slate treatment processes and found out that the presence of free fibres in the forming aerosol was significant.

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