

An Experimental Study to Determine the Effect of Amount Handled and Dustiness on Dermal Exposure during Manual Transfer of Powder

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Background. Predictive models are used to assess the potential of both inhalation and dermal workplace exposures to chemical agents. Since the exposure models do not provide adequate information on dermal exposure during manual transfer of small amounts of powders such as by scooping, an experimental study was initiated. The aim of the study was to generate data on dermal exposure for such a specific exposure scenario and to investigate the effect of amount handled and dustiness.

Methods. In the experimental study, six volunteers conducted in total 82 experiments using three powders i.e. zinc oxide granules, zinc oxide powder, zinc stearate, with dustiness ranging from 242 to 7859 mg/kg, respectively. Dermal exposure mass on the hands was assessed by a removal method, i.e. washing two hands two times in barrels with soap. Whole body dermal exposure mass was assessed by an interception method using a cotton monitoring coverall, of which sleeves, trousers and torso were analysed separately. Dustiness of the powders was determined with a rotating drum tester provided with porous metal size-selective foams.

Results. The inhalable fraction of zinc stearate has a 25 times higher dustiness than zinc oxide powder and zinc oxide powder has a 1.5 times higher dustiness than zinc oxide granules. Highest exposure levels were observed for hands, whereas exposures of legs and torso were mostly below LOD (Figure 1).

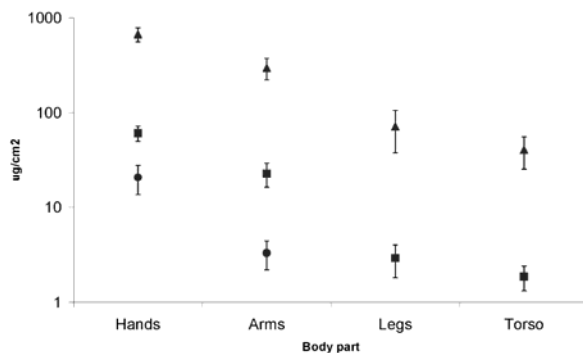


Figure 1. Mean (AM) dermal exposure loadings ($\mu\text{g}/\text{cm}^2$) and 95% confidence limits by body part and type of dust. For handling 15 kg zinc oxide granules exposure loadings for torso and legs are < LOD.

▲ 15 kg zinc stearate, ■ 15 kg zinc oxide powder ● 15 kg zinc oxide granules

Handling zinc stearate resulted in about 12 times higher levels of exposure for hands compared to zinc oxide powder, whereas zinc oxide powder results in about 3 times higher exposure than zinc oxide granules. Similar observations were made for exposure of the arms. Handling of 15 kg powder shows about 2 times higher exposure loading of the hands in comparison with handling 10 kg (Figure 2).

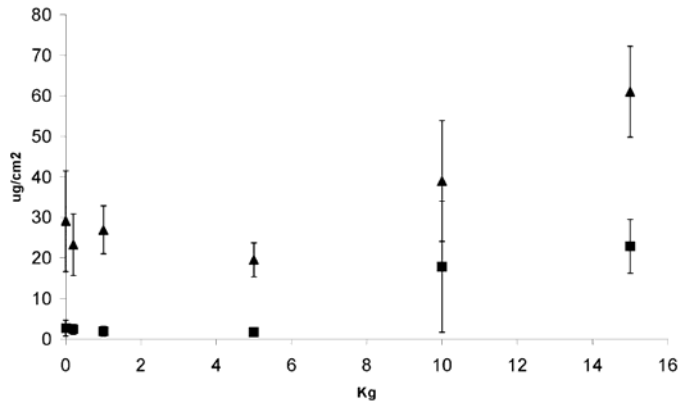


Figure 2. Mean (AM) dermal exposure loadings ($\mu\text{g}/\text{cm}^2$) and 95% confidence limits for hands and arms and amount of zinc oxide powder handled ▲ hands, ■ arms

Conclusions. Based on the results, we conclude that overall dermal exposure loading during manual powder handling is heavily dominated by contamination of the hands. Both amount handled and dustiness of powder appear to be determinants of exposure. Type of physical form is the major determinant of exposure on all body parts; the powder with the highest dustiness results in the highest dermal exposure.

The results can be used to adjust predictive models for dermal exposure assessment for small volume powder transfer scenarios.