N-methyl-2-pyrrolidinone (NMP): use in the assessment of dermal exposure

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ABSTRACT

Biocidal products are by definition biologically active and so in most - but not in all - cases can have deleterious effects on human health. To ensure safety of people, the risks associated with the use of biocidal products have to be assessed. In the assessment of such risks, an accurate evaluation of exposure of operators applying biocides is essential in order to compare the inherent toxicity of the substance with the levels of biocide impinging on the body surface and, for biocides entering the body via the skin, the systemic exposure.

The aim of this investigation was to assess the suitability of N-methyl-2-pyrrolidone (NMP) as a biomarker for systemic exposure in two commonly undertaken tasks, namely application of a liquid by wiping and mopping up of liquid spills. The investigation was divided into three parts: (a) a pilot study to determine a suitable concentration of NMP to be used in dermal exposure studies and duration of exposure; (b) an interaction study to determine whether an interaction with a widely used biocide, chloroxylenol, would occur; and (c) an exposure study in which wiping and mopping tasks were undertaken.

The results of the investigation gave the following:

Pilot study: NMP was quickly absorbed through the skin of the hands of volunteers and excreted in the urine. Post exposure, peak urinary concentrations of its metabolite 5-hydroxy-N-methyl pyrrolidone (5-HNMP) occurred between 8 and 25 hours post exposure with little or no excretion occurring after 48 hours. For the wiping/mopping study, the optimum concentration of NMP to be used was found to be 15 % v/v following 10 minutes exposure.

Interaction study: Overall results suggested there was little interaction between concentrations of 15 % v/v NMP and 0.24 % v/v chloroxylenol over 10 minutes exposure which affected dermal absorption, metabolism or urinary excretion of the substances’ metabolites.
Wiping and mopping exposure studies:

(i) high, unevenly spread concentrations of fluorescent tracer on the hands in the mopping study did not allow an accurate evaluation of the area of skin exposed

(ii) at low exposures (i.e. in the wiping study) the parameters of amount of fluorescent tracer and strontium on skin provided a consistent measure of skin exposure

(iii) under the conditions of the wiping study (low exposure scenario), the amount of fluorescent tracer on skin, and subsequent evaluation of area of fluorescence, correlated well with 5-HNMP and chloroxylenol excretion;

(iv) in the wiping study (low exposure scenario) NMP provided a good surrogate for the biocide chloroxylenol but not where high exposures occurred (i.e. in the mopping study).

General comments on the studies and recommendations: The biocide itself used in these investigations, chloroxylenol, might also be a suitable candidate for use as a biomarker in studies on systemic exposure. Only low concentrations of chloroxylenol (0.24 % v/v) were required to give measurable quantities in urine. Also in both the wiping and mopping study, the correlation between the area of skin contaminated and amount of chloroxylenol excreted was stronger and of greater significance than for 5-HNMP. However, a deeper review of chloroxylenol’s toxicology, particularly its skin irritant properties, would be required.