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New permeation parameters for evaluating decontamination efficacy of chemical protective clothing materials

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Decontamination efficacy of chemical protective clothing is a critical issue for decision making on whether the clothing can be reused, should be retired, or needs to be disposed of as nonhazardous waste. Currently, change in breakthrough time (BT) using a permeation test and measurement of residual chemicals using an adequate analytical method are two approaches to evaluating decontamination efficacy. However, change in BT offers no information on the amount of residual chemicals that is essential for risk analysis; while the other approach requires validating extraction efficiency which is time consuming.

We propose two new permeation parameters, baseline slope (BS) and estimate of residual chemical (ERC), for evaluating decontamination efficacy. For a permeation curve with concentration (μg/L) on the y axis and elapsed time (min) on the x axis, BS is the ratio of the concentration just before breakthrough to the elapsed time. For a closed loop system, the ERC is the concentration just prior to breakthrough multiplied by the dead volume of the system, in liters; for an open loop system, the ERC is the area under the curve, from the start of the test to the point just prior to breakthrough, multiplied by the sampling flow rate in L/min. In this study, neoprene gloves were exposed to acetone and the gloves were then decontaminated using adsorbent in conjunction with applying a vacuum or using thermal extraction. A newly developed computer program was employed for the calculations. Using a paired t-test, the BS and the ERC for the adsorbent decontamination were significantly different after the first cycle ($p < 0.05$). The BT for the adsorbent decontamination was only significantly different after the second cycle ($p < 0.05$). The BS, BT, and the ERC for the thermal decontamination were only significantly different after the third cycle ($p < 0.05$). The study demonstrates that the changes in BS and ERC appear to be more sensitive indicators for decontamination efficacy than the BT. The residual chemicals inside the clothing material due to ineffective decontamination procedures can be estimated by the new parameter of ERC. In addition, the study has shown that thermal decontamination efficacy was better than the adsorbent decontamination ($p < 0.001$).

OEESC 2005

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This conference follows the success of the first International Conference on Occupational and Environmental Exposures of Skin to Chemicals: Science and Policy, which was held near Washinton, DC, in September, 2002.

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