Universal method for inhalational exposure assessment of foam and droplet spray applications

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Use of spray products always may result in generation of inhalable aerosols, independent of the spraying technology used and the properties of the spray product.
In safety assessment of spray products, increasing emphasis is being placed on the potential release of such inhalable aerosols. Thus, information on the potential exposure of the user to particles in the health-related size ranges under conditions of use of the product is essential.

Usually inhalation exposure characterization is based on droplet size distribution analysis of the native spray. However, the main fraction of the droplets is comprised of solvents and/or propellants. Therefore, in general, droplets generated during spraying evaporate within a short period of a few seconds, so that the spray aerosol will shrink to the non-volatile constituents, resulting in maximum inhalability. This status is assumed to represent the real exposure situation of the spray user and needs to be considered for inhalation exposure characterization for sprays containing non-volatile active components.
Regarding the risk of inhalation exposure from the use of droplet spray products as well as further consumer and application-driven advantages, there is an increasing interest in the development of foam applications in recent years. However, foam sprays are not accessible to a direct measurement of the native spray, e.g. via laser diffraction spectrometry. Similarly, exposure scenarios, such as surface treatment, cannot be reasonable considered using methods for native droplet characterization.

Therefore a new, feasible mass balance method, characterizing the so called aged or matured aerosol for reliable determination of exposure risk from sprays was established.

In this approach, the exposure risk is quantified in terms of release fractions, defined as mass of aerosol generated in the health-related size classes, normalized to total mass of liquid spray product released. Therefore, a well defined spray bolus is released into a control chamber followed by aerosol concentration measurement in the health-related size fractions (respirable, thoracic) according to international standards, European standard EN481 and ACGIH standard. This is performed using the RESPICON personal aerosol monitor (Helmut Hund GmbH, Wetzlar, Germany), enabling gravimetric and on-line light scattering analysis.

For various spray products and spraying technologies, the aerosol release fractions were determined successfully using the mass balance method. Importantly, this method also allows for characterization of the inhalational exposure hazard of foam spraying processes under application-oriented conditions. By direct comparison of aerosol release potential of foam spraying to droplet spraying of aqueous biocidal solutions using the mass balance approach, efficiency of foam spraying of potentially harmful substances as measure to mitigate the risk from inhalation exposure can be evaluated (For further information see separate contribution (poster) from Schwarz et al. “Does foam application reduce aerosol formation?”)

The mass balance method, which enables realisitic exposure characterization for sprays containing non-volatile components taking into account chemical and physical properties of the spray formulation and the aerosol ageing process under conditions of use of the product (e.g. surface treatment), represents an important step towards assessment of the risks from occupational or consumer application of spray products (for example for registration under Biocidal Products Directive and Regulation, BPD/R).