SysDEA – Systematic analysis of dermal exposure to hazardous chemical agents at the workplace

Dag Rother[1], Ulrich Poppek[1], Michael Roitzsch[1], Remy Franken[2], Suzanne Spaan[2], Konstantinos Kasiotis[3], Angelos Tsakirakis[3], Ilianna Chartzala[3], Dimitra Nikolopoulou[3], Pelagia Anastasiadou[3], Almar Snippe[2], Eric Schoen[2], Jan Baan[2], Roel Engel[2], Jaap Turkenburg[2], Kyriaki Machera[3], Rianda Gerritsen-Ebben[2]

Federal Institute for Occupational Safety and Health (BAuA)[1], Netherlands Organisation for Applied Scientific Research(TNO)[2], Benaki Phytopathological Institute (BPI)[3]

Background and objectives

Different methods are available to measure dermal exposure, such as *interception methods* (gloves, whole body methods/coveralls or patches), *removal methods* (tape stripping, wiping, washing, rinsing), and *in situ methods* (fluorescence). However, knowledge of the strengths and limits of the different methods and comparability of these methods is limited.

The goal of the SysDEA research project was to generate scientific knowledge to improve and standardize measurement methods for dermal exposures to chemicals at the workplace. Different measurement methods were compared and the experimental data generated during the project was used to provide knowledge to reduce current uncertainties in assessing occupational dermal exposure, as well as to characterize the strengths and weaknesses of various dermal measurement methods.

Study design

Five tasks were carried out with different products: a solid (dusty powder), a high viscosity (HV) liquid, and a low viscosity (LV) liquid, resulting in ten product-task combinations (exposure situations).

A. Transfer	A1 - dumping dusty solid (powder)
	A2 - pouring LV liquid
	A3 - pouring HV liquid
B. Spreading	B1 - rolling LV liquid
	B2 - rolling HV liquid
C. Spraying	C1 - spraying LV liquid
	C2 - spraying HV liquid
D. Immersion / dipping	D1 - handling objects immersed in LV liquid
	D2 - handling objects immersed HV liquid
E. Handling contaminated objects	E1 - Handling objects contaminated with dusty solid

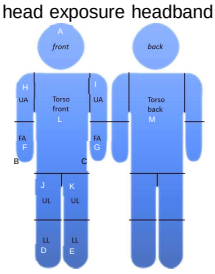
The test substance was Tinopal SWN – a fluorescent tracer with excellent detectability.

Each experiment was carried out four times by four different volunteers for each of the two different sets of measurement methods, leading to a total of 320 individual experiments.

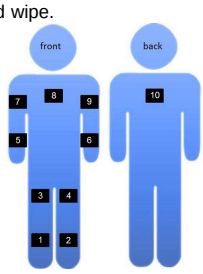
Measurement methods

Two sets of different measurement methods were applied:

- for body exposure coverall versus patches,
- for hand exposure cotton gloves versus hand wash,
- for head exposure headband versus head wipe.

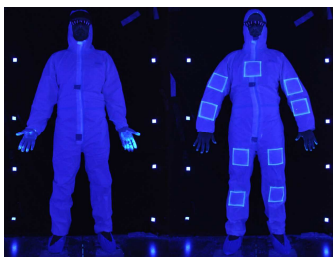


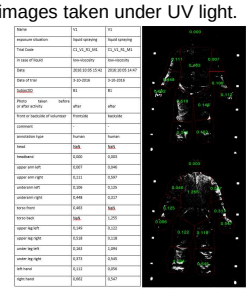
Whole body dosimeter (WBD): coveralls, gloves, headband



Patch method: patches, hand wash, head wipe

In addition, a fluorescence method was developed and used for all body parts (except hands and head) and exposure situations. The method is based on picture analysis (pixel count for assigned body areas) of images taken under UV light.





Preliminary results

Body exposure: patches resulted in significantly higher exposures compared to coveralls for all exposure situations with liquids. For powders, no significant difference was found.

Hand exposure: gloves resulted in significant higher exposures compared to the hand wash for all exposure situations except for dumping powders (no significant differences).

Head exposure: wipes resulted in higher exposure compared to using the headband, except for the spraying situation (no significant difference). However, many samples were <LOQ and thus the results should be interpreted with care.

Statistical evaluation: within-person variation was 2-3 times larger than between-person variation (hand exposure showed the largest within-person and between-person variation).

Fluorescence method: Estimated exposures using the fluorescence method showed much lower exposure and poor correlation (non-linearity) between fluorescence intensities and chemical analysis for all exposure situations.

Conclusions

For body exposure the patch method is suitable for tasks with a uniform exposure pattern (e.g. spraying, handling dusty powders), and/or if “worst-case” values are of interest. Coveralls are better suited for non-uniform distribution patterns and where body exposure is prone to “random” splashes (e.g. pouring, rolling, immersion/dipping).

For hand exposure gloves result in higher exposure compared to hand wash.

Qualitative evaluation of images of a fluorescence tracer under UV light is an easy way to determine the exposure distribution and pattern. However, the current method cannot yet be used for quantification of dermal exposure and is an ongoing field of investigation.

Research on health and safety at work www.baua.de

Bundesanstalt für Arbeitsschutz und Arbeitsmedizin
Friedrich-Henkel-Weg 1–25
44149 Dortmund
phone +49 231 9071-0

TNO innovation for life

BENAKI PHYTOPATHOLOGICAL INSTITUTE

baua: Federal Institute for Occupational Safety and Health