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Short communication

Comparing REACH Chemical Safety Assessment information with practice—a case-study of polymethylmethacrylate (PMMA) in floor coating in The Netherlands

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ABSTRACT

On June 1st, 2007 the European regulation on Registration, Evaluation and Restriction of Chemical substances (REACH) came into force.

Aim of the regulation is safe use of chemicals for humans and for the environment. The core element of REACH is chemical safety assessment of chemicals and communication of health and safety hazards and risk management measures throughout the supply chain. Extended Safety Data Sheets (Ext-SDS) are the primary carriers of health and safety information. The aim of our project was to find out whether the actual exposure to methyl methacrylate (MMA) during the application of polymethylmethacrylate (PMMA) in floor coatings as assessed in the chemical safety assessment, reflect the exposure situations as observed in the Dutch building practice.

Use of PMMA flooring and typical exposure situations during application were discussed with twelve representatives of floor laying companies. Representative situations for exposure measurements were designated on the basis of this inventory. Exposure to MMA was measured in the breathing zone of the workers at four construction sites, 14 full shift samples and 14 task based samples were taken by personal air sampling. The task-based samples were compared with estimates from the Targeted Risk Assessment Tool (v3.1) of the European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC-TRA) as supplied in the safety assessment from the manufacturer.

For task-based measurements, in 12 out of 14 (86%) air samples measured exposure was higher than estimated exposure. Recalculation with a lower ventilation rate (50% instead of 80%) together with a higher temperature during mixing (40 °C instead of 20 °C) in comparison with the CSR, reduced the number of underestimated exposures to 10 (71%) samples. Estimation with the EMKG-EXPO-Tool resulted in unsafe exposure situations for all scenarios, which is in accordance with the measurement outcomes. In indoor situations, 5 out of 8 full shift exposures (62%) to MMA were higher than the Dutch occupational exposure limit of 205 mg/m^3 (8 h TWA), which equals the DNEL. For semi-enclosed situations this was 1 out of 6 (17%). Exposures varied from 31 to 367 mg/m^3.

The results emphasize that ECETOC-TRA exposure estimates in poorly controlled situations need better underpinning.

1. Introduction

On June 1st, 2007 the European Regulation on Registration, Evaluation and Restriction of Chemical substances (REACH) came into force (EC, 2006). This regulation will be fully implemented in 2018. Aim of the regulation is safe use of chemicals for humans (workers and consumers) and for the environment. The core element of REACH is communication of health and safety information throughout the supply chain, from the manufacturer or importer via formulators to downstream users of the product. Health and safety information must be documented in a Chemical Safety Report (CSR), authorized by the European Chemicals Agency (ECHA). Extended Safety Data Sheets (Ext-SDS), which are based on

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the CSR, are the primary carriers of information on intended use, described by process categories (PROC) operational conditions (OC) and risk management measures (RMM) for occupational use.

In the context of REACH, risk assessment takes place by a tiered approach. The first tier is a conservative estimation using a risk assessment model. The manufacturer in this study used the Targeted Risk Assessment Tool from the European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC-TRA) (ECETOC, 2012). This model is considered to produce conservative exposure estimates (Money et al., 2007, 2014). When the first tier assessment does not show an adequately controlled exposure, a more advanced model must be applied in tier 2, or safe use must be confirmed with measurement data.

Several authors have reported about the accuracy of the ECETOC-TRA tool. Exposure to ethylbenzene during paint manufacturing and painting (Ishii et al., 2017), TDI and MDI during polyurethane foam production (Kupczezewska-Dobecka et al., 2012) and toluene, ethyl benzene and acetone during paints and lacquers production, shoe making and refining (Kupzewska-Dobecka et al., 2011) were measured and compared to the outcomes of the model. In most cases, ECETOC-TRA appeared to be conservative indeed. However, exposure during shoe manufacturing was underestimated and also during painting several measurement outcomes were higher than predicted by the model (Ichii et al., 2017). Angelini et al. (2016) propose site specific reduction coefficients to make ECETOC-TRA adequately conservative. Lamb et al. (2015) evaluated tier 1 exposure models under REACH. They consider the conservatism of an instrument low when >25% of the measured values exceed the tool estimate, and found for ECETOC-TRA V3 that this was the case for 32% of the measurements.

No information was found in the literature about the accuracy of ECETOC-TRA exposure estimates for application of floor coating. This study aimed to find out whether the exposure to methyl methacrylate (MMA) during the application of polymethylmethacrylate (PMMA) in floor coatings as calculated in the CSR (the Ext-SDS was not available) reflect the exposures situations as observed in the Dutch construction practice.

2. Materials and methods

First, the use of PMMA flooring and typical exposure situations during application were discussed in two meetings with representatives of floor laying companies in The Netherlands. The Dutch Association of Finishing Enterprises (the employers association in the Netherlands), Section Flooring has 30 members who work with MMA (Dutch Association of Finishing Enterprises, personal communication). All members were invited for a discussion on work practices during floor coating, twelve of which participated. The PROCs, OCs and RMMs, as described in Chapter 9 of the CSR of MMA were presented and the company representatives were asked whether or not these occurred in their practice, and if there were any scenarios not corresponding to the PROCs and OCs as listed. The resulting list of exposure scenarios was used to select representative situations for exposure measurements.

Measurements were performed on four days in June and July 2013 at four different construction sites. Full-shift (6.5–8 h) and tasked-based measurements in the breathing zone of the workers were executed simultaneously by personal air sampling. MMA was sampled on 3M-3500 Organic Vapour Passive Air Monitoring badges and every task was sampled on a separate badge. The collected amount of MMA was analysed according to MDHS no 96 (HSE, 2000) by the Laboratory for Occupational and Environmental Hygiene, University of Leuven (Belgium). Outdoor temperatures varied from 18 to 25 °C.

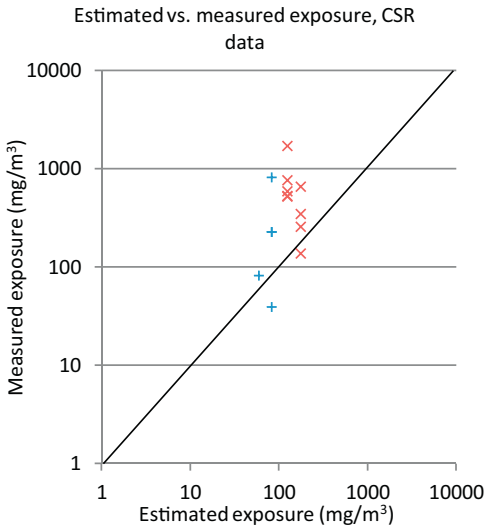

Fig. 1. Scatter plot of measured versus estimated exposures to methyl methacrylate, data as described in the CSR. + = mixing and transfer (Proc 19, n = 5), x = pouring and rolling (Proc 10, n = 9).

Task-based measured exposures were compared with the ECETOC-TRA (v.3) estimations as presented in the CSR. To check the sensitivity of these estimations, the effects of a lower ventilation efficiency (50% instead of 80%) and a higher process temperature for mixing and rolling (>40 °C instead of 20 °C) were also calculated. For comparison, exposures were also assessed with the EMKG-EXPO assessment tool (BAuA, 2008).

Full-shift exposures were evaluated against the Dutch occupational exposure limit (OEL) of 205 mg/m^3 eight hours TWA, which is based on irritation of the respiratory epithelial nose tissue as the critical health effect (Health Council of the Netherlands, 2011). This is the legally binding OEL in the Netherlands, and is equal to the long term inhalation DNEL for workers. In other European countries OELs vary from 10 to 208 mg/m^3 (GESTIS, 2016).

3. Results

Based on the list of exposure scenarios, all relevant exposure situations were divided into three situations: indoors in rooms smaller than 30 m^2 (small rooms), indoors in rooms well over 30 m^2 (large rooms) and semi-enclosed spaces (five out of six sides enclosed).

The results of the task-based exposure measurements are summarized in Table 1. In 12 out of 14 cases (86%) the measured exposure was higher than the exposure estimate in the CSR.

The results of the sensitivity analysis are presented in Figs. 1–4. For 12 out of 14 measurements (86%) the actual exposure appeared to be higher than the ECETOC TRA exposure estimate (Fig. 1). Recalculated estimations for a more realistic ventilation efficiency (50% instead of 80%, Fig. 2) did not change the results. Considering an elevated process temperature (>40 °C during mixing and transfer and during pouring and rolling), underestimation of the exposure decreased from 12 to 10 out of 14 samples (71%) for an elevated temperature during mixing and transfer alone (Fig. 3) and 1 out of 14 (7%) for an elevated temperature during mixing/transfer and rolling/pouring (Fig. 4). Calculations with EMKG-EXPO indicated an exposure range of 200–2000 mg/m^3 for preparation and mixing and >2000 mg/m^3 for pouring and rolling.

The results of the full-shift measurements are presented in Table 2. 5 out of 8 full shift exposures (62%) exceed the limit value in indoor situations. For semi-enclosed situations this is 1 out of 6 (17%).