The influence of temperature on the emission of di-(2-ethylhexyl) phthalate (DEHP) from PVC flooring in the emission cell FLEC

Per Axel Clausen[1,*], Zhe Liu[2], Vivi Kofoed-Sørensen[1], John Little[2], and Peder Wolkoff[1]

[1]National Institute of Occupational Health, Lersø Parkalle 105, DK-2100 Copenhagen Ø, Denmark
[2]Virginia Tech, 418 Durham Hall, Blacksburg, VA 24061-0246, USA

[*]*Corresponding email: pac@nrcwe.dk*

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1 Introduction

Since the 1930s, phthalates have been used as plasticizers to enhance the flexibility of rigid polyvinylchloride (PVC) products, with worldwide phthalate production of about 6 million tons/year (Rudel and Perovich, 2009). Di(2-ethylhexyl) phthalate (DEHP) has been used in building materials, cars, clothing, food packaging, children's products, and medical devices and may be present at concentrations as high as 10-60 % (w/w) (Rudel and Perovich, 2009). Because phthalates are not chemically bound to the polymer matrix, slow emission from the products to air or other media usually occurs during the entire product use phase. As a result, phthalates are ubiquitous and among the most abundant semi-volatile organic compounds in indoor air (e.g. (Clausen et al., 2003; Rudel et al., 2003)). Several studies have indicated that exposure to phthalates increases prevalence of asthma, rhinitis or wheezing (Jaakkola and Knight, 2008), cause reproductive disorders in humans and affect endogenous hormones (Rudel and Perovich, 2009). Although needed for risk assessment and to develop control strategies, the mechanisms governing emissions and distribution of phthalates in the indoor environment are still not fully understood. The objective was to study the effect of temperature on the emission of DEHP from one type of vinyl floor covering in the FLEC (Field and Laboratory Emission Cell).

2 Materials/Methods

Emissions from PVC flooring containing approximately 13% (w/w) di-(2-ethylhexyl) phthalate (DEHP) as plasticizer were measured. The concentrations of DEHP versus time were measured in five FLECs at a flow of 450 ml/min and five different temperatures: 22°C, 35°C, 48°C, 55°C, and 62°C. When steady-state concentrations had been maintained for one week to three months the experiments were terminated and the interior surfaces of all FLECs were rinsed with methanol to estimate the surface concentrations of DEHP. Furthermore, the background level of DEHP in one blank (empty) FLEC was monitored over time as a control simultaneously with the emission experiments. The 22°C experiment was in duplicate. The DEHP was sampled on Tenax TA as previously described (Clausen et al., 2007) and analyzed by thermal desorption, gas chromatography, and mass spectrometry with tetra deuterium ring labelled DEHP (D_4-DEHP) as internal standard.

3 Results

The concentration versus time data for emission of DEHP from vinyl flooring in the FLECs at five different temperatures is shown in Figure 1. The observed steady state concentrations ± 95% confidence limit were: 0.9 ± 0.1 µg/m^3, 9 ± 3 µg/m^3, 39 ± 3 µg/m^3, 97 ± 10 µg/m^3, and 224 ± 10 µg/m^3 for the five different temperatures, respectively (Figure 2). This means that a 40°C increase (22°C to 62°C) of the temperature results in a 238 times increase of the steady-state concentration. The test is ongoing and we are currently validating emissions/surface adsorption models in the FLEC using CFD analysis.

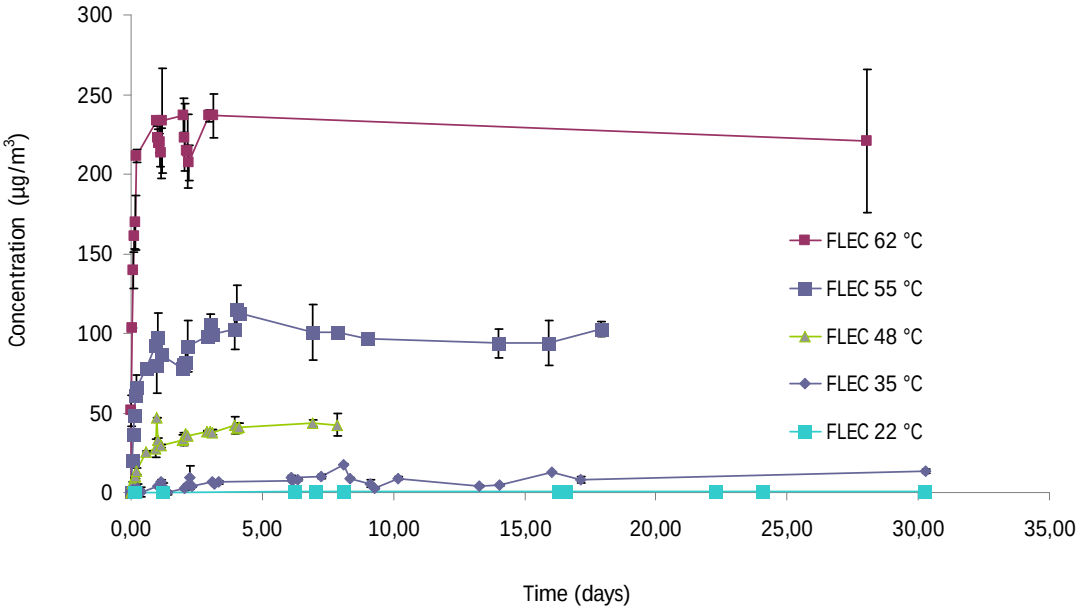

Figure 1. Concentration versus time data for emission of DEHP from vinyl flooring in FLECs at five different temperatures. The error bars indicate the standard deviation for duplicate sampling.

4 Conclusions

The steady state concentrations for emission of DEHP from vinyl flooring show a strong increase with increasing temperature. This increase is more than exponential. This is of significance for exposure concentrations in environments where vinyl products containing phthalates are heated up e.g. by incident sun light through windows such as in cars. Modelling of the data is ongoing and is required to draw more general conclusions.

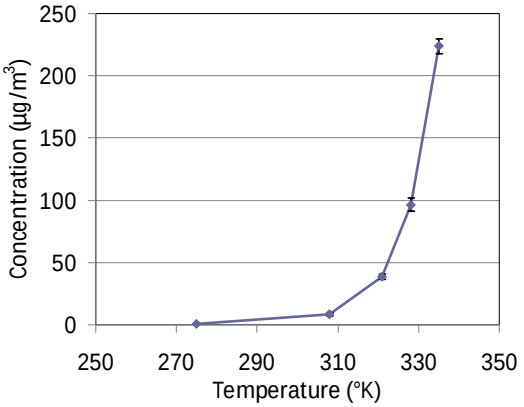

Figure 2. Steady state concentrations of DEHP emitted from vinyl flooring in FLEC as a function of temperature. Error bars is 95% confidence intervals.

5 References

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