Emission and uptake of gas phase di(2-ethylhexyl)phthalate by floor dust

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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 aim was to study the sorption of gas phase DEHP by floor dust in the FLEC (Field and Laboratory Emission Cell).

2 Materials/Methods

The experiment was carried out in a FLEC placed on a stainless steel (SS) plate which was soiled as evenly as possible with one gram of the homogenized particle fraction of floor dust (÷ fibres). The flow through the FLEC was 450 ml/min and the temperature was 22 °C. An empty clean FLEC served as blank. During the entire experiment DEHP in the effluent air of the FLEC was sampled 27 times in duplicate on Tenax TA at regular intervals. The DEHP was sampled and analysed by thermal desorption and gas chromatography (TD-GC-FID) as previously described (Clausen et al., 2004). Before the experiment the initial DEHP concentration in the dust was measured. At regular intervals during the experiment the FLEC was carefully lifted off the SS plate four times in order to collect dust samples of 60-70 mg by picking up dust at randomly selected spots with a clean SS spatula. The dust samples were extracted using pressurized solvent extraction and the extracts were analysed by TD-GC-FID as previously described (Kofoed-Sørensen and Clausen, 2004). After 667 days the outlet tube of a second FLEC unit with PVC flooring was connected to the inlet tube of the 'dust-FLEC'. The outlet air of the second FLEC contained 0.78 µg/m3 of DEHP and in this way the 'dust-FLEC' was supplied with DEHP contaminated air. The outlet DEHP concentration of the second FLEC was measured at regular intervals. After 1205 days the 'dust-FLEC' was disconnected and four dust samples were collected in order to precisely estimate the terminal DEHP concentration. All glassware used was cleaned with methanol.

3 Results

During the first period of 667 days the content of DEHP in the dust decreased from 1810±450 µg/g to 1634±97 µg/g (Figure 1). After DEHP was added to the supply air of the 'dust-FLEC' the decrease continued to 1206±110 µg/g at day 1049. After 1205 days the content of DEHP had increased significantly to 1536±71 µg/g. The average air concentration of DEHP in the FLEC was constant 0.11 µg/m3 in spite of added DEHP and significantly higher than the average concentration of 0.029 µg/m3 in the blank FLEC.

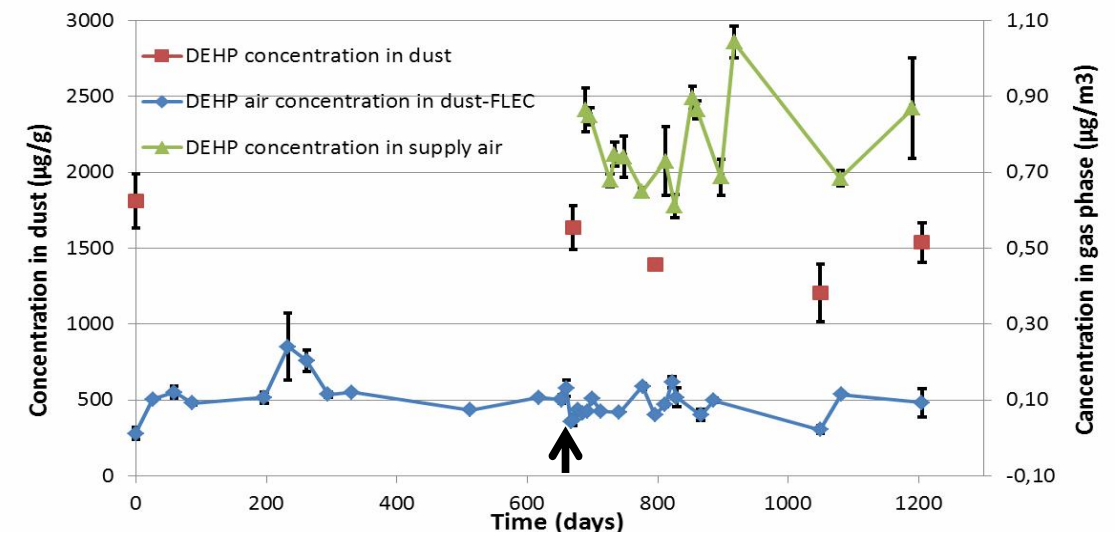

Figure 1. Dust (left axis) and gas phase (right axis) concentrations of DEHP over time in the 'dust-FLEC'. The black arrow indicates the time (667 days) at which gas phase DEHP was added to the supply air. Error bars indicate one standard deviation.

4 Conclusions

The results show that floor dust may act both as a source and a sink of gas phase DEHP. The fact that the DEHP air concentration in the 'dust-FLEC' was not influenced by the addition of 8 times higher concentration of gas phase DEHP to the supply air indicate that floor dust is a strong adsorbent of organic gas phase compounds. Previous experiments (Clausen et al., 2004) showed that the floor dust may easily absorb DEHP to a ten-fold increase of the original content. An interesting observation is that the equilibrium concentration appears constantly to be a factor 8 lower than for the vinyl flooring used to generate DEHP in the supply air. The results indicate that floor dust may be a good adsorbent (sink) for organic compounds and that it may turn to a source of the adsorbed compounds when their concentration in the ambient air decrease. This underlines that dust removal (cleaning) is a good way to remove contaminants in indoor air.

5 References

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