LRI Project B12.3-VTEC / Executive summary

A rapid micro chamber method to measure SVOC emission and transport model parameters

Assessing exposure to semivolatile organic compounds (SVOCs) that are emitted from consumer products and building materials in indoor environments is critical for reducing the associated health risks. Many modeling approaches have been developed for SVOC exposure assessment indoors, including the DustEx webtool. However, the applicability of the DustEx tool depends on the availability of model parameters such as the gas-phase concentration at equilibrium with the source material surface, y_0, and the surface-air partition coefficient, K_s, both of which are typically determined in chamber measurements. Most previous emission chambers focused on reducing the sink-to-source surface area ratio to shorten time required to reach steady state, but consequently, the dimensions of those chambers did not represent real-world conditions.

In this study, we designed two types of chambers, a macro chamber, which downscaled the dimensions of a room to a smaller size with roughly the same surface-to-volume ratio, and a micro chamber, which minimized the sink-to-source surface area ratio to shorten the time required to reach steady state. We examined optimal chamber designs to measure SVOC emission and transport parameters and assessed human exposure to SVOCs in simulated indoor environments using the measured parameters and the DustEx webtool.The results show that the two chambers with different sink-to-source surface area ratios yield comparable steady-state gas- and surface-phase concentrations of SVOCs, while the micro chamber required significantly shorter times to reach steady state. Additionally, by adding a mixing fan on the ceiling of both chambers, the mass-transfer coefficients were enhanced significantly. This enhancement of mass transfer results in y_0 being approximately equal to the steady-state gas-phase concentration in the chamber and reduces the need to obtain mass-transfer coefficients for each SVOC.

The DustEx webtool was updated by implementing y_0 estimation and extending K_s specification. Using the measured model parameters from the chamber experiments and the updated DustEx webtool, we predicted the concentration of di-2-ethylhexyl phthalate (DEHP) and diisononyl phthalate (DINP) under simplified, but reasonably realistic indoor conditions and the resulting human exposure. The predicted gas-phase concentrations in the simulated room agreed with those measured in residential homes as reported in the literature. The estimated DEHP exposure was found to be dominated by dermal absorption from air, followed by inhalation of gas-phase DEHP. For DINP, exposure was dominated for children by dust ingestion and inhalation of particle-phase DINP, and for adults by inhalation of particle-phase DINP followed by dermal absorption from the gas-phase. The exposure to DEHP and DINP was further compared with regulatory reference doses and found to be significantly lower.