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MIGRATION OF ORGANOPHOSPHORUS FLAME RETARDANTS FROM CLOASED CELL FOAM TO SETTLED DUST

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Many industrial and consumer products, such as electrical and electronic products, furniture, plastics, textile, and building materials are manufactured with organophosphorus flame retardants (OPFRs). OPFRs can leach or diffuse out of the products and are released to the surrounding air and accumulate in indoor dust, leading to human exposure. OPFRs, including tris(2-chloroethyl) phosphate (TCEP), tris(1-chlor-2-propyl) phosphate (TCPP), and tris(1,3-dichloro-2-propyl) phosphate (TDCPP) are semi-volatile organic compounds (SVOCs) and are U. S. Environmental Protection Agency (EPA) action plan chemicals for chemical assessments under the Toxic Substances Control Act (TSCA). Due to their physiochemical properties, these OPFRs attach to dust particles on indoor surfaces and airborne suspended dust and partition between gaseous and particulate phases. Limited information is available on the mechanisms through which OPFRs migrate from products into dust on the surface of products. This research studied the transfer of TCEP, TCPP, and TDCPP from polyisocyanurate rigid polyurethane foam (PIR-PUF) to settled house dust on the foam surface through direct contact. The house dust was obtained from household vacuum cleaner bags that were collected in 2000-2001 during U. S. EPA's Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants (CTEPP) study. The house dust was irradiated to eliminate microbiological activity, sieved with 150 µm sieve, and then conditioned at 160°C to remove quantifiable TCEP, TCPP, and TDCPP before use. The organic carbon (OC) was 20.11 ± 0.56% (w/w) and total carbon was 20.83 ± 0.48% (w/w) by thermal-optical analysis (TOA). The mean particle size was 67.88 ± 0.21 µm with the range from 0.92 to 259.75 µm and the surface area was 3.60±0.02 m^2/g. The PIR-PUF was made by ICL Industrial Products with 0.5 % of total flame retardants (TCEP/TCPP/TDCPP) in the foam. Seven OPFR-containing PIR-PUF pieces (15 cm x 3 cm x 1.1 mm) and seven OPFR-free aluminium foil pieces (15cm x 3 cm x 0.04 mm) were placed in a 53L stainless steel small chamber at 1 air exchange rate (ACH) and 50% relative humidity (RH). Each piece of PIR-PUF and aluminium foil was loaded with about 0.1 g of house dust as evenly as possible. During the test, pieces were removed from the chamber at different times and the dust was collected and extracted to determine its OPFR content. The test lasted for 480 hours. The results show that the OPFR concentrations on the dust from OPFR-free aluminium foil were all below the instrument detection limit and those on the dust from OPFR-containing PIR-PUF were increased steadily over exposure time. The migration due to dust/source partitioning was not significantly affected by the volatilities of the OPFRs. The OPFR dust/PIR-PUF partition coefficients were estimated by the ratio of the migration concentration of OPFRs in the house dust at the end of the test to its concentration in the source, which are found to be 1.76×10^{-3}, 3.40×10^{-3}, 3.74×10^{-3} for TCEP, TCPP and TDCPP, respectively. This study should shed light on the correlation of OPFR concentrations in settled dust and the surface material. Other work is undergoing to better characterize the factors that affect the degree of migration of OPFRs on dust. The results could help to fill the data gaps required for interpreting the exposure data and for risk assessment.