

ORGANOPHOSPHATE FLAME RETARDANTS IN THE INDOOR ENVIRONMENT: A COMPARISON OF CENTRAL EUROPE AND NORTH AMERICA

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Short abstract

Flame retardants (FRs) have been used for several decades to prevent fire and reduce the flammability of a wide range of materials. These properties are offset by their environmental persistency, toxicity and bioaccumulative potential. Worldwide restrictions on the use of old types of brominated FRs have therefore resulted in extended use of alternate compounds, such as organophosphate flame retardants (OPFRs), produced in increasing volumes in recent years. Since in most applications OPFRs are used as additive chemicals and therefore are not covalently bound to the polymeric materials, they can be released to the environment easily. Due to their presence in common household products, humans are exposed to the released OPFRs in the indoor environment, especially as people spend most of their time indoors.

Air, dust and window film samples were collected from a total of 63 houses and apartments in the Czech Republic, Canada and USA during a sampling period of 28 days in May-August 2013. Samples from one room, usually the bedroom, were collected in each home while a second room, usually the living room, was sampled in 10 randomly chosen homes in each country. In addition to the sampling, data about the building and the household were also collected, i.e. information on electronic equipment and furniture in the sampled rooms, occupants, cleaning, ventilation habits, etc.

The objectives of the present study were to examine the concentration of 14 OPFRs found in different matrices in the same room and compare individual rooms in the same home, identify possible sources of these compounds in indoor environments and study regional differences in Central Europe and North America. Overall OPFRs concentrations follow the geographic trend USA > Canada > Czech Republic in the case of dust and air samples. Significantly lower concentrations were found in air samples from the Czech Republic in comparison with North America. The highest concentration in particular matrices

were observed for tris(2-butoxyethyl)phosphate (TBOEP), tris(1-chloro-2-propyl) phosphate (TCIPP) and tris(1,3-dichloro-2-propyl) phosphate (TDCIPP). The highest TBOEP concentrations were found in US dust (median 21,200 ng/g) and Canadian dust (median 6,390 ng/g) while Czech dust was dominated by TCIPP (median 1,860 ng/g). Although TCIPP was prevalent in Czech window film (median 566 ng/m²), US and Canadian window film samples primarily contained TDCIPP (medians 83.2 ng/m² and 82.3 ng/m²). In all three countries, air samples were dominated by TCIPP, with the highest levels found in Canadian (median 73.6 ng/m³), followed by the US (median 26.3 ng/m³) and the Czech (median 16.4 ng/m³). The results suggest there are general similarities in the use and composition of OPFRs between Europe and North America, but differences in individual OPFRs which may be indicative of differences in use between the two continents.

Key words: organophosphate flame retardants (OPFRs), indoor environment, human exposure, indoor dust