Flame Retardants (Polybrominated Diphenyl Ethers, Pbdes) and Organophoshates, Opfrs) in Dust from Canadian Fire Stations

Brown F.R.[1], Tarrant D.H.[1], Gill R.[1], Dhaliwal J.[1], Sarala R.[1], Patton S.[2], Park J.S.[1], Petreas M.[1,*]

[1] Environmental Chemistry Laboratory, Department of Toxic Substances Control, Berkeley, CA, USA
[2] Biomonitoring Resource Center, Commonweal, Bolinas, CA USA

*corresponding author: e-mail: myrto.petreas@dtsc.ca.gov

Abstract
Dust is a good medium to assess indoor exposures to many persistent organics, including flame retardants. With concerns regarding persistence, bioaccumulation and toxicity of many flame retardants, a series of bans and regulations have created shifts in their usage. For firefighters, exposures to flame retardants on and off duty is a high concern. In 2018 we measured flame retardants in Canadian fire station dust and compared our findings with those of our 2015 US fire stations study. We used isotope dilution HRMS for PBDEs and GC-MS/MS for OPFRs. The same flame retardants were present in all stations with high within- and between-station variability. The most prominent among PBDEs was BDE-209, followed by BDE-99. TDCIPP and TPhP were the dominant OPFRs. Overall, data from 2015 (US) and 2018 (Canada) show that OPFRs have surpassed PBDEs in fire station dust, probably reflecting shifts in flame retardant use in consumer products and building materials.
Keywords: flame retardants, PBDEs, OPFRs, fire stations, dust

1. Introduction

Flame retardants (FR) have been widely used in consumer products such as furniture, plastic electronics casings, and fabrics with the intention of delaying the spread of fires. Concerns over persistence, bioaccumulation and health effects led to the phase-out of one class of FR, i.e., polybrominated diphenyl ethers (PBDEs), with other FRs, including phosphorous-containing flame retardants (OPFRs), taking their place. Because FRs are additives, they can escape from products and eventually settle in indoor dust. The latter has been used extensively to characterize occupant exposures to semi-volatile and persistent organics (Whitehead, 2013). Firefighters are exposed to a wide range of chemicals while fighting fires, including flame retardants, and in our earlier studies we reported high PBDEs in California firefighters' blood (Park, 2015). We also found high PBDEs and OPFRs (Shen 2017) and other brominated FR (Brown, 2014) in fire station dust. With the same approach and methodologies, we conducted the first ever study on dust from Canadian fire stations.

2. Materials and Methods

2.1. Recruitment and sample collection

In 2018, and in collaboration with the International Association of Fire Fighters (IAFF), we approached Canadian fire stations and requested bags from vacuum cleaners used in fire station living quarters, along with information on firefighters' practices and activities, as well as building characteristics. We received 24 dust samples: 4 from Windsor, and 5 each from Toronto, Winnipeg, Calgary and Vancouver.

2.2. Sample processing and analysis

Dust was sieved to 150 mm and a 50 mg sample was vortexed, sonicated and following Florisil cleanup, 2 fractions were collected and analyzed using isotope dilution:

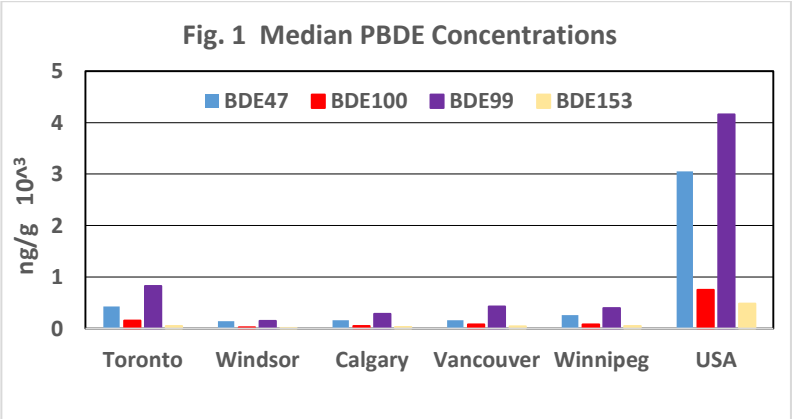
F1 (19 BDEs) analyzed by HRMS (Thermo DFS); and

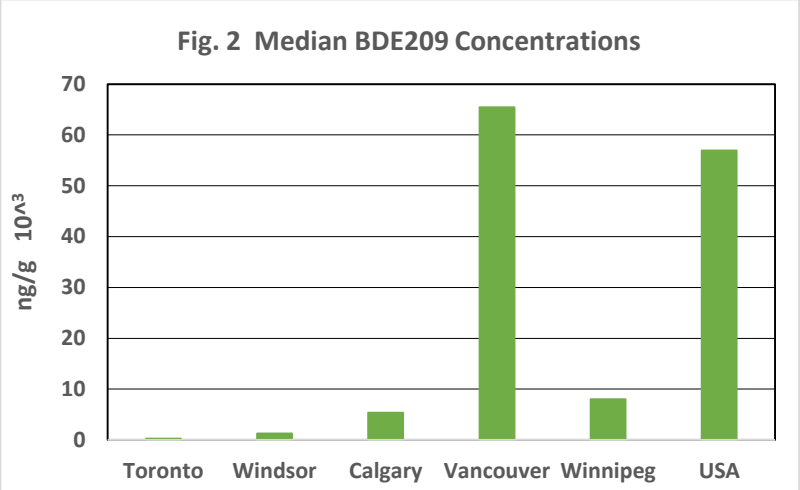
F2 (6 OPFRs) analyzed by GC-MS/MS (Agilent QQQ)

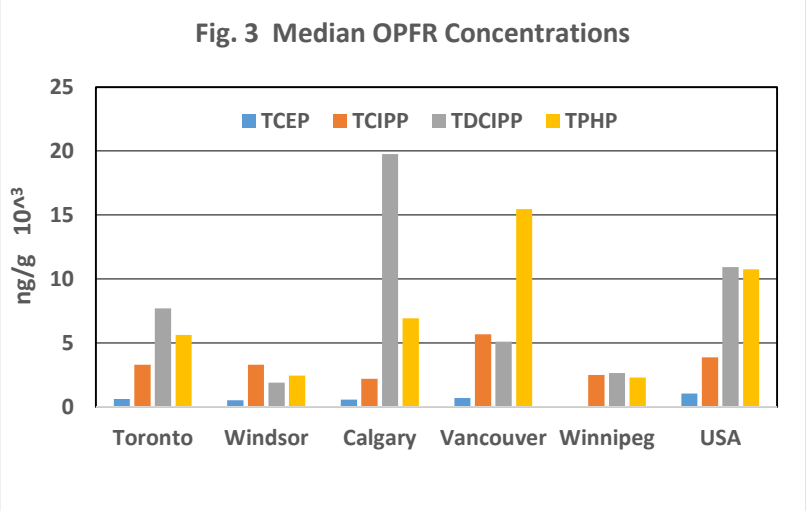
Along with the dust samples we analyzed Method Blanks, Lab Controls and Standard Reference Material (NIST SRM 2585 Organic Contaminants in House Dust).

3. Results and Discussion

All QA/QC measures met acceptability criteria. Major PBDEs were, as expected, BDE-209, -99, -47, -100, -153, while Tris(1,3-dichloro-2-propyl) phosphate (TDCIPP) and Triphenyl phosphate (TPhP) were the major OPFRs across all stations. We found high variability with statistical outliers pointing to different sources and/or practices at various stations. Overall, data from 2015 (US) and 2018 (Canada) show that OPFRs have surpassed PBDEs (except for BDE-209) in fire station dust, probably reflecting shifts in flame retardant use in consumer products and building materials. Questionnaire data could explain some of the observed variation.







References

Brown FR, Whitehead TP, Park J, Metayer C, Petreas M (2014). Levels of non-polybrominated diphenyl ether brominated flame retardants in residential house dust samples and fire station dust samples in California. *Environ Res*, 135: 9–14

Park JS, Voss R, McNeel S, Wu N, Guo T, Wang Y, Israel L, Das R, Petreas M (2015). *Environ Sci & Techn*, 49 2948 – 2958

Shen B, Whitehead P, McNeel S, Brown FR, Dhaliwal J, Das R, Israel L, Park JS, Petreas M (2015). *Environ Sci & Techn*, 49 4988–4994

Shen B, Whitehead P, Gill R, Dhaliwal J, Brown FR, Petreas M, Patton S, Hammond SK (2018). *Environ Int*, 112, 41–48

Whitehead T, Brown FR, Metayer C, Park J, Does M, Petreas M, Buffler PA, Rappaport SM (2013). Polybrominated diphenyl ethers in residential dust: Sources of variability. *Environ Int*, 57 - 58: 11 - 24.