Brominated Flame Retardants – Another Class of Emerging Contaminants

Monica Danon-Schaffer and William H. DiGuiseppi, CH2M

Bromine-based flame retardant (BFR) formulations are added to approximately 2.5 million tonnes of polymers per year globally. Approximately 70 different BFR compounds account for a global consumption of more than 300,000 tonnes of BFRs per year, which include 56,000 tonnes in North America alone. PBDEs, TBBPA and HBCDs are some of the many BFRs commercially used. Regulating these compounds across various jurisdictions has increased in recent years. BFRs are typically used in thermoplastics (e.g. acrylonitrile butadiene styrene (ABS), high impact polystyrene (HIPS), polystyrene (PS) and polycarbonate (PC) and are blended with polymer constituents, together with other additives such as plasticizers. They are also found in the effluents from the industrial facilities that manufacture and use them.

BFRs are formed by substituting bromine for hydrogen in biphenyl molecules. They are divided into 3 subgroups depending on how they are incorporated into the polymer: brominated monomers, reactive (chemically bonded to the polymer) and additive (blended with the polymer). Additive flame retardants are more likely to leach out of the product.

BFRs are bioaccumulative, persistent, undergo long-range transport, are lipophilic and have the potential to act as endocrine disruptors. Their concentrations in the environment have been increasing since the 1970s. They may leach out of products, and go through wastewater treatment facilities to end up in sewage biosolids. BFRs may be present in leachate from landfills, but no previous studies have been carried out on their fate in waste disposal streams (landfills, sewage treatment plants, incinerators). There is also limited knowledge regarding their environmental fate and toxicity.

Trends in concentration depend on the location and type of BFR. For example, sediment in Norway showed a linear increase in concentrations from the 1960s to the end of the 1990s. Sediment samples in Germany were found to have lower concentrations of brominated congeners in the 1960s than in the late 1990s. North American PBDE levels are generally much higher than in Europe or Japan, as observed in ringed seals from Holman Island, in northern Canada.

Monica Danon-Schaffer, PhD

Monica is a Principal Chemical Engineer at CH2M. With 28 years of consulting engineering experience, Monica went back to school to work on her PhD in chemical engineering. She explored how brominated flame retardants from consumer products reach the environment, circulating from waste streams to water and soil, and to distant locations. Monica’s research indicated that these contaminants persist for decades with far-reaching implications on environment and future policies. She developed a comprehensive mechanistic model to assist in predicting the concentration of brominated flame retardants (PBDEs) in and near landfills. In addition, Monica works within the Emerging Contaminants practice at CH2M, including PFAS and 1,4-dioxane compounds. Dr. Danon-Schaffer is a registered P.Eng. in BC, ON, NT, NU and YK as well as Mexico, and has extensive experience dealing with environmental, social and geologic challenges of the Arctic. She has also taught Environmental Forensics at the British Columbia Institute of Technology and is a Certified Environmental Auditor.

Bill DiGuiseppi

Bill DiGuiseppi is a principal hydrogeologist and program technology manager with almost 30 years of applied experience on 100’s of soil and groundwater investigation and remediation sites. He is a licensed Professional Geologist and is the leader of CH2M’s Chemicals and Issues of Emerging Concern Community of Practice. In that role, Bill directs a team of professionals in the identification, prioritization and management of chemicals such as 1,4-dioxane, perfluorinated compounds, 1,2,3-trichloropropane, hexavalent chromium and other critical emerging pollutants. Bill has led large and complex environmental investigation and remediation projects, published technical articles, chaired sessions at international conferences and co-authored a definitive book on 1,4-dioxane with Tom Mohr.