The Draft Environmental Screening Assessment of Polybrominated Diphenyl Ethers in Canada.

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Introduction

The *Canadian Environmental Protection Act, 1999* (CEPA 1999) requires the Minister of the Environment and the Minister of Health to conduct screening assessments of substances that meet the categorization criteria set out in the Act and Regulations to determine, in an expeditious manner, whether substances present or may present a risk to the environment or to human health. Based on the results of a screening assessment, the Ministers can propose taking no further action with respect to the substance, adding the substance to the Priority Substances List (PSL) for further assessment, or recommending that the substance be added to the List of Toxic Substances in Schedule 1 and, where applicable, the implementation of virtual elimination.

Method

A screening assessment involves an analysis of a substance using conservative assumptions to determine whether the substance is "toxic" or capable of becoming "toxic" as defined in CEPA 1999. This environmental screening assessment examines various supporting information and develops conclusions based on a weight of evidence approach as required under Section 76.1 of CEPA 1999. The screening assessment does not present an exhaustive review of all available data; rather, it presents the most critical studies and lines of evidence supporting the conclusions. One line of evidence includes consideration of risk quotients to identify potential for ecological effects. However, other concerns that affect current or potential risk, such as persistence, bioaccumulation, chemical transformation and trends in ambient concentrations, are also examined in this report.

Discussion

PBDEs comprise a class of substances consisting of 209 possible congeners with 1–10 bromine atoms. The following seven PBDE isomer groups are on the Domestic Substances list (DSL) and were identified in the pilot project list of 123 substances and are considered in this assessment: tetrabromodiphenyl ether (tetraBDE, CAS No. 40088-47-9); pentabromodiphenyl ether (pentaBDE, CAS No. 32534-81-9); hexabromodiphenyl ether (hexaBDE; CAS No. 36483-60-0); heptabromodiphenyl ether (heptaBDE, CAS No. 68928-80-3); octabromodiphenyl ether (octaBDE, CAS No. 32536-52-0); nonabromodiphenyl ether (nonaBDE, CAS No. 63936-56-1); and decabromodiphenyl ether (decaBDE, CAS No. 1163-19-5).

PBDEs are generally present in the form of mixtures, referred to as commercial pentabromodiphenyl ether (PeBDE, which is predominately a mixture of penta–, tetra–, and hexaBDE), commercial octabromodiphenyl ether (OBDE, which contains mainly hepta–, octa–, and hexaBDE, but may also contain small amounts of nona– and decaBDE) and commercial decabromodiphenyl ether (DBDE, of which current formulations are almost entirely decaBDE with a small amount of nonaBDE).

PBDEs are used mainly as additive flame retardants in polymer resins and plastics and, to a lesser extent, adhesives, sealants and coatings. Additive flame retardants are physically combined with the material being treated rather than chemically bonded as in reactive flame retardants. It has been estimated that approximately 90% or more of PeBDE produced globally is used in polyurethane foams.[1,2] Most OBDE produced globally is added to polymers (mainly acrylonitrile butadiene styrene), which are then used to produce computers and business cabinets, pipes and fittings, and appliances.[1,3] DBDE is used as a flame retardant, to a large extent in high-impact polystyrene and other polymers, with broad use in computer and television cabinets and casings, general electrical/electronic components, cables and textile back.[4,5]

The identical base structure and combinations of congeners within the different commercial mixtures supported consideration of a category approach to assessment of these compounds. To the extent that the data permit comparison, consideration of these compounds as a group is further supported by trends in physical/chemical properties with increasing degree of bromination.

PBDEs may be released to the environment during manufacturing and polymer processing operations, throughout the service life of articles containing them, and at the end of article service life during disposal operations. With their low vapour pressures (e.g., 2.95×10^{-9} for decaBDE to 4.69×10^{-5} for PeBDE)[2,6], low water solubility (13.33 µg/L for PeBDE to <0.1 µg/L for DBDE)[2,5] and high log Kow (e.g., 6.57 for PeBDE to 9.97 for DBDE)[2,5] values, it is expected that PBDEs entering the environment will tend to bind to the organic fraction of particulate matter, notably in sediment and soils, with only small amounts partitioning into water and air.

Empirical and predicted data indicate that all PBDEs under consideration are highly persistent and are subject to long-range transport,[2,3,5,7,8,9] and each satisfies the requirements for persistence as defined by the CEPA 1999 Persistence and Bioaccumulation Regulations.[10] Although considered persistent, evidence suggests that PBDEs are susceptible to some degree of metabolic transformation[11] and photodegradation.[2,3,5] Studies have shown the transformation of higher brominated PBDEs (e.g., hepta– to decaBDEs) to lower brominated congeners (e.g., congeners of tetraBDE, pentaBDE and hexaBDE) which are associated with high levels of bioaccumulation.

PBDEs have been detected in a variety of species worldwide, and evidence from many studies indicates that their levels in biota in North America (including the Canadian Arctic) are increasing steadily and even substantially over time.[8,9,12,13]

Measured data indicate that tetra–, penta– and hexaBDEs are highly bioaccumulative[2,14] and satisfy the criteria for bioaccumulation as described in the CEPA 1999 Persistence and Bioaccumulation Regulations. Despite their large molecular size, a low level of uptake of heptaBDEs and decaBDE in biota is supported by the fact that concentrations have been measured in the tissues of wild fish, mammals and/or bird eggs.[15,16,17] There is a weight of evidence suggesting that highly brominated PBDEs such as octa– and decaBDE are precursors of the more toxic, bioaccumulative and persistent lower brominated PBDEs.

Risk quotient analyses, integrating known or potential exposures with known or potential adverse environmental effects, were performed for each of the three commercial PBDE products subject to this assessment. The results indicate that risk quotients were below one with respect to the water and soil compartments for all PBDEs. For benthic organisms, quotients exceeded one for PeBDE, but not for OBDE or DBDE. However, hexaBDE is a component of both PeBDE and OBDE and could be a transformation product of hepta- to decaBDE degradation. The risk quotients for secondary poisoning exceeded one for the congeners found in PeBDE and OBDE.

Pyrolysis and extreme heating can cause all PBDEs to form brominated dibenzo–*p*–dioxins and dibenzofurans.[2,3,5] These transformation products are considered to be brominated analogues of the Government of Canada Toxic Substances Management Policy (TSMP) Track 1 substances polychlorinated dibenzo–*p*–dioxins and dibenzofurans.

Available data indicate the potential for exposure of organisms to PBDEs at concentrations of concern. Although concentrations of homologues from commercial decabromodiphenyl ether may not currently exceed known effect thresholds, those homologues are persistent and may contribute to the overall loadings of lower brominated PBDEs over the long term. The long-range transport of PBDEs has resulted in their widespread occurrence, including in remote regions. The persistent and bioaccumulative character of these substances can lead to prolonged exposure and potential accumulation in organisms. Field evidence indicates increasing concentrations in organisms over time.

Conclusion

As is done with other assessments conducted under CEPA 1999, the environmental and human health components of the screening assessment of the PBDEs, including the proposed conclusion as to whether the substances satisfy the definition of "toxic" in CEPA 1999, will be published in the Canada Gazette, Part I and will be posted on the CEPA Registry Web site at www.ec.gc.ca/CEPARegistry/participation for a 60-day public comment period. After consideration of the public comments, the final report with conclusions will be published in the Canada Gazette.

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