POPRC-9/4: Decabromodiphenyl ether

The Persistent Organic Pollutants Review Committee,

Having examined the proposal by Norway to list the commercial mixture decabromodiphenyl ether (c-decaBDE, CAS No. 1163-19-5) in Annexes A, B and/or C to the Stockholm Convention on Persistent Organic Pollutants and having applied the screening criteria specified in Annex D to the Convention,

1. *Decides,* in accordance with paragraph 4 (a) of Article 8 of the Convention, that it is satisfied that the screening criteria have been fulfilled for decabromodiphenyl ether as described in the evaluation contained in the annex to the present decision;

2. *Also decides,* in accordance with paragraph 6 of Article 8 of the Convention and paragraph 29 of decision SC-1/7, to establish an ad hoc working group to review the proposal further and to prepare a draft risk profile in accordance with Annex E to the Convention;

3. *Invites,* in accordance with paragraph 4 (a) of Article 8 of the Convention, parties and observers to submit to the Secretariat the information specified in Annex E before 10 January 2014.

Annex to decision POPRC-9/4

Evaluation of decabromodiphenyl ether against the criteria of Annex D

A. Background

1. The primary source of information for the preparation of the present evaluation was the proposal submitted by Norway (UNEP/POPS/POPRC.9/2).

2. Additional sources of scientific information included critical reviews prepared by recognized authorities.

B. Evaluation

3. The proposal was evaluated in the light of the requirements of Annex D regarding the identification of the chemical (paragraph 1 (a)) and the screening criteria (paragraphs 1 (b)–(e)):

(a) Chemical identity:

(i) Adequate information was provided in the proposal and supporting documents. The proposal refers to commercial decabromodiphenyl ether;

(ii) The chemical structure for the pure compound decabromodiphenyl ether was provided. Commercial decabromodiphenyl ether is a chemical product consisting predominantly of decabromodiphenyl ether (> 97 per cent) with low levels (0.3–3 per cent) of nonabromodiphenyl ether and octabromodiphenyl ether (0-0.04 per cent) as impurities;[1]

The chemical identity of commercial decabromodiphenyl ether and the pure compound decabromodiphenyl ether is adequately established;

(b) Persistence:

(i) The half-life of decabromodiphenyl ether in soil is longer than six months. The half-life of decabromodiphenyl ether in sediments ranges from hours, when the degradation process is dominated by photolysis, up to 50 years. Hydrolysis is unlikely to be a relevant

[1] The composition of older products or products from other sources may be different. For example a product that is no longer supplied in the European Union had a composition of 77.4 per cent of decabromodiphenyl ether, 21.8 per cent nonabromodiphenyl ether and 0.85 per cent octabromodiphenyl ether.

degradation process in the environment, due to the very low water solubility of decabromodiphenyl ether (< 0.1 ug/l at 25 °C) and the fact that the molecule does not contain any functional groups that are susceptible to hydrolysis (Ref. 1);

(ii) In a field study on freshwater lake sediment covering more than 65 years, decabromodiphenyl ether was found to be highly persistent (Ref. 2);

There is sufficient evidence that decabromodiphenyl ether meets the criterion on persistence;

(c) Bioaccumulation:

(i) Log bioaccumulation factor (BAF) values derived from environmental monitoring data for aquatic species range between 4.06 and 6.7, where logBAF>3.7 corresponds to a BAF of >5000. Log K_{OW} values for decabromodiphenyl ether are reported to range from 9.97 to 12.11. The calculated bioconcentration factor (BCF) values (< 3000) are considered to be unreliable and BCF is considered to be less relevant than BAF due to the extremely low water solubility of decabromodiphenyl ether and steric hindrance of diffusion across gills and cell membranes in aquatic organisms of the large molecules of decabromodiphenyl ether;

(ii) and (iii)

Experimental and field data of the biomagnification factor (BMF) (1.4–7) demonstrate that decabromodiphenyl ether biomagnifies in terrestrial species and food webs (Ref. 1). Other data demonstrate biomagnification potential in aquatic species (Refs. 1, 3) and foodwebs with BMF and trophic magnification factor (TMF) ranging between 0–34 and 0.2–10.4 (Ref. 1). There are also many experimental and field data, however, that do not provide evidence for biomagnification (Refs. 4–6);

Decabromodiphenyl ether was detected in the muscles and livers of frogs from a contaminated site in South China. The concentration ranged from 0.13 to 1.37 ng/g ww. Decabromodiphenyl ether was also detected in frog eggs (0.45 ng/g ww) indicating that there is a transfer from mother to egg. BMF from diet (insects) were 10.4 and 13.0 in male and female frogs, respectively (Refs. 1, 7). In frogs, effects on the thyroid gland were detected at concentrations of 1 ng/L when frogs were exposed to a commercial decabromodiphenyl ether mixture (Ref. 8);

The detected levels of decabromodiphenyl ether in a variety of species spanning different trophic levels of terrestrial and aquatic food chains in the Arctic provide additional evidence that decabromodiphenyl ether is bioaccumulated and biomagnified in freshwater and marine environments, since the detected levels cannot be explained by high continuous exposure from nearby sources (Refs. 1, 9);

Several assessments have concluded that there is a high probability that decabromodiphenyl ether is transformed in biota to lower brominated diphenyl ethers that are more bioaccumulative and are listed in the Stockholm Convention, i.e. tetra-, penta-, hexa- and hepta-bromodiphenyl ethers (Refs.1, 10).

There are also several studies in sediments as well as in soils and plants that indicate debromination of decabromodiphenyl ether similarly to the lower brominated diphenyl ether congeners (Ref. 10);

There is uncertainty regarding the bioaccumulation and biomagnification potential of decabromodiphenyl ether. Considering all the evidence in a balanced manner, however, the Committee concludes that decabromodiphenyl ether is likely to meet the criterion on bioaccumulation;

(d) Potential for long-range environmental transport:

(i) Decabromodiphenyl ether is detected in air, sediment, snow and ice in the Arctic and in a wide range of organisms including birds, fish, crustaceans, mammals and plants. There is evidence of increasing levels in the Arctic atmosphere and Arctic bird eggs. The levels of decabromodiphenyl ether in the Arctic atmosphere are increasing with a doubling time in the range of 3.5–6.2 years (Ref. 1);

(ii) Concentrations detected in the Arctic from air monitoring, snow-pit and ice-core studies indicate the potential of transfer of decabromodiphenyl ether via air to the Arctic environment. An ice core study reported a flux rate of decabromodiphenyl ether to be 320 $pg/cm^2/yr$ in 1995–2005 (Ref. 1);

(iii) Decabromodiphenyl ether has a low vapour pressure (4.63×10^{-6} Pa at 21°C) and modelling data show an estimated atmospheric half-life of more than 94 days (Ref. 1);

There is sufficient evidence that decabromodiphenyl ether meets the criterion on potential for long-range environmental transport;

(e) Adverse effects:

(i) Recent experimental studies show adverse effects on important biological endpoints in aquatic organisms, such as effects on the thyroid hormone system, reproductive toxicity, reduced survival, growth and fitness (Ref. 1). Specifically controlled feeding studies with fish have shown effects on the thyroid hormone system and reproduction and mortality at low doses (3 ng/g) (Ref. 11). Another study has shown that chronic low dose decabromodiphenyl ether exposure (0.96 µg/l) in zebra fish not only affects the parent generation, but also elicits neurobehavioural alterations in the offspring (Ref. 1);

(ii) There is toxicity and ecotoxicity evidence that decabromodiphenyl ether can lead to endocrine-disrupting, reproductive, neurotoxic and immunotoxic effects, indicating the potential of decabromodiphenyl ether to damage human health and the environment. In both wild organisms and humans, early developmental stages appear to be more vulnerable to decabromodiphenyl ether exposure than adults. In vertebrates, the liver, the thyroid hormone axis and the nervous system appear to be the main targets for decabromodiphenyl ether toxicity;

Increased mortality in birds was observed following *in ovo* exposure with an LD_{50} of 44 µg/egg (740 ng/g ww) (Ref. 12). Concentrations of decabromodiphenyl ether typically found in bird eggs in the wild are only around 2–10 times lower. Reported concentrations in bird eggs are typically in the range of 1–100 ng/g ww, with concentrations up to 420 ng/g ww being reported. Hence, the margin between exposure levels in wild birds and observed adverse effects in laboratory studies is not high. This raises concerns that adverse effects may occur in wild birds (Ref. 1);

Several assessments have concluded that there is a high probability that decabromodiphenyl ether is transformed in biota to lower brominated diphenyl ethers that are listed in the Stockholm Convention, i.e., tetra-, penta-, hexa- and hepta-bromodiphenyl ethers. In addition, reported *in vitro* data suggest that the various polybrominated diphenyl ethers could act in concert to induce additive or synergistic effects;

There is sufficient evidence that decabromodiphenyl ether meets the criterion on adverse effects.

C. Conclusion

4. Although there is not clear certainty with regard to bioaccumulation potential, taking into account the potential for debromination to bromodiphenyl ethers already listed under the Stockholm Convention, and considering the provisions of Article 8, paragraph 3, the Committee concluded that decabromodiphenyl ether met the screening criteria specified in Annex D.

References

1. Proposal to list decabromodiphenyl ether (commercial mixture, c-decaBDE) in Annexes A, B and/or C to the Stockholm Convention on Persistent Organic Pollutants (UNEP/POPS/POPRC.9/2).

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3. Y. Wan and others, "Distribution is a Major Factor Affecting Bioaccumulation of Decabrominated Diphenyl Ether: Chinese Sturgeon (*Acipenser sinensis*) as an Example", *Environmental Science & Technology*, vol. 47, No. 5 (6 February 2013), pp. 2279–2286.

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10. Debromination of decabromodiphenyl ether (BDE-209) in the environment (UNEP/POPS/POPRC.9/INF/19).

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