

FACT SHEET:

DECABDE IN THE ENVIRONMENT DOES NOT CONTRIBUTE TO ENVIRONMENTAL PENTABDE LEVELS

- DecaBDE in the environment does not contribute to environmental PentaBDE levels.
- Anaerobic degradation studies indicate no significant degradation of DecaBDE to lower BDEs in sediments, which is where DecaBDE is found in the rare instances it does appear at minuscule levels.
- Studies show that, in sunlight, there is an insignificant contribution to environmental PentaBDE levels.
- Environmental monitoring confirms:
 - No correlation between environmental Deca level and environmental Penta levels in sediments in Europe and North America
 - PBDEs found in the environment are similar to those in commercial PBDE products. No significant findings reported of other PBDEs that would be expected to be produced by exposure to sunlight (tri-BDE, di-BDE, etc.)

Anaerobic Degradation

DecaBDE is found in the environment in sediment, and it is important to know its fate.

- a) The environmental fate of DecaBDE was studied in anaerobic sediment/waterⁱ. Intact core microcosm systems were used to simulate fate processes in the anaerobic freshwater ecosystem. ¹⁴C labelled material was used to ensure high sensitivity. Monitoring for ¹⁴CO₂ and ¹⁴CH₄ indicated no statistically significant mineralisation. A chemical analysis did not find any indications for potential degradation products.
- b) The above results are confirmed by additional data on anaerobic degradation reported in a study by the Swedish EPA, authored by Prof. Cynthia de Wit of the Institute of Applied Environmental Research (ITM), Stockholm.ⁱⁱ

Deca in sunlight¹:

DecaBDE in sunlight has been extensively studied by the Fraunhofer Institute, Hannover, Germanyⁱⁱⁱ and Bayreuth University, Germany^{iv, v}. These studies found that

¹ Disclaimer

These results refer to photolysis of Deca dissolved in organic solvents. The degradation pathways of Deca absorbed to particles may differ and are currently under investigation. From previous experiments we know that the degradation rates in that case are slower than those in solution. However, there are no indications of a selective debromination to PentaBDE related congeners.

a) Deca, in organic solutions when exposed to sunlight, is a stepwise process resulting in sequential debromination from Deca to Nona to Octa, etc., down to fully debrominated diphenyl ether.

b) This sunlight exposure will produce a PBDE pattern that is different from commercially produced BDEs. There are 209 different PBDE congeners. Sunlight was found to produce a mixture of many different PBDEs, largely different from the profile of commercial PBDE products. This pattern is largely different from that found for PBDEs found in the environment. (Ref. Eriksson, Zetzsch, Soederstroem).

c) This process will produce Tetra and PentaBDE as intermediates. However, these are

- Largely different from commercial Penta, and
- Will further degrade themselves

d) The rates of breakdown by sunlight decrease with a decreasing degree of bromination. (Ref. Eriksson, Zetzsch, Soederstroem).

Generally speaking, the spectral overlap of sunlight and the absorption spectrum of the respective PBDE congeners decreases with decreasing degree of bromination. A decreasing overlap leads to decreasing breakdown rates. Zetzsch showed that this process will not stop at some intermediate degree of bromination but will continue until all bromine atoms are removed.

e) Were this process to be significant, one would expect to find in the environment Tri- and Di-BDE at similar amounts as Tetra and PentaBDE. They are not – confirming that this process is not significant.

Environmental Monitoring Studies

Monitoring studies indicate that there is no correlation between DecaBDE and PentaBDE levels in the European environment. European sediments have been monitored over a 20-year period by Jacob de Boer, Boon and Zegers^{vi}. The study indicates that while the levels of Deca in sediments were found to be rising over time, the levels of Penta at the same locations were decreasing^{vii}. Although the sediment concentration of DecaBDE increased in recent years, no parallel increase in the concentrations of lower brominated diphenyl ethers (e.g. Tetra- to Penta-) occurred. There was also no indication of increasing levels of Nona- and Octabromodiphenyl ethers. This indicates that the Deca levels were not significantly contributing to the Penta levels; otherwise, the Penta levels would not have decreased.

The above findings are further confirmed by analyses of various dated sediment cores from Europe. Also here, no correlation between PentaBDE and DecaBDE levels was found.^{viii}

The same (non-) correlation has been found in North America. Rayne and Ikonomou investigated PBDEs in sediments in the Fraiser River in British Columbia, Canada. Their analysis of the congener pattern indicates that the congeners present originated from the commercial Penta and Octa products, and that Deca was not the source^{ix}.

EU Risk Assessment evaluation

The above issues have been extensively reviewed and discussed at the European Risk Assessment of Deca under the EU Existing Substances Regulation 793/93/EEC. The risk assessment report^x concludes:

On breakdown in sunlight:

- *Thus from the results of these experiments, although it appears possible for reductive debromination to occur, the amounts of the lower brominated (e.g. tetra, penta-, or hexabromo-) diphenyl ethers formed will be very small. Furthermore, it would also be expected that the products formed would themselves undergo similar reductive debromination reactions*
- *Overall, although it can be concluded that formation of lower brominated diphenyl ethers and brominated dibenzofurans can occur from the [breakdown in sunlight] of decabromodiphenyl ether in the environment, the actual significance of the process is likely to be limited owing to the lack of exposure to light of the bulk of decabromodiphenyl ether in the environment. **It is considered unlikely that such...reactions of decabromodiphenyl ether could explain the current widespread occurrence of tetra-, penta- and hexabromodiphenyl ether congeners in the environment. Instead, it is much more likely that this is mainly the result of the emissions of the commercial penta- and octabromodiphenyl ether flame retardants.** However any [breakdown] of decabromodiphenyl ether that does occur in the environment could make a (probably small) contribution to the levels of the lower brominated diphenyl ether congeners and also possibly brominated dibenzofurans present in the environment.*

On environmental monitoring

- *Further evidence for this conclusion can be taken from the sediment core data of Zegers et al. (2000 and 2003) reported in Section 3.1.1.2.2. In this study the levels of decabromodiphenyl ether and lower brominated congeners were determined in dated sediment cores from Drammenfjord (Norway), the western Wadden Sea and the freshwater lake Woserin (Germany). In these samples, the main components of the commercial pentabromodiphenyl ether were found to be present in layers corresponding to the early 1970s onwards and decabromodiphenyl ether was found to be present in layers corresponding to the late 1970s onwards. The commercial octabromodiphenyl ether (as determined by a “marker” component 2,2',3,4,4',5',6-heptabromodiphenyl ether) was absent from the cores. The levels of the commercial pentabromodiphenyl ether components were found to be levelling off in the most recent sediment layers (ca. 1995-1997) in samples from the western Wadden Sea and Lake Woserin, whereas the levels of commercial pentabromodiphenyl ether components in the samples from Drammenfjord were still found to be increasing in layers corresponding to 1999. In contrast to this, the levels of decabromodiphenyl ether had decreased in the most recent layers of all three sediment cores. The fact that the levels of decabromodiphenyl ether in more recent sediment layers were lower than in earlier sediment layers tends to suggest that decabromodiphenyl ether is*

reasonably stable in sediment and the levels found are related to the emissions at the time.

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- ⁱ “Fate of Decabromodiphenyl ether in anaerobic freshwater sediment”
E. D. Schaefer, J. M. Ariano and K.P. Rothenbacher, *Organohalogen Compounds* **52** (2001) 459-461
- ⁱⁱ Swedish Environmental Protection Agency, “Brominated Flame Retardants”, Cynthia de Wit, Report 5065, 2000
- ⁱⁱⁱ da Rosa et al. (2003). Photolytic debromination and degradation of decabromodiphenyl ether. An exploratory kinetic study in toluene. *Fresenius Environmental Bulletin*, **12**, 940-945.
- ^{iv} Zetzsch C. (2003). Environmental photochemistry of decabromodiphenyl ether: UV spectra, photolysis and photochemistry of polybrominated diphenyl ethers in organic solvents and adsorbed on particles in air and in aqueous suspension (including a feasibility study on OH reactivities in an aerosol smog chamber facility). Report for the Bromine Science and Environmental Forum.
- ^v Zetzsch C. (2004). Photochemical studies of brominated diphenyl ethers (BDEs) with special regard to decaBDE – an overview. Paper presented at SETAC Europe 14th Annual Meeting, Prague, 18-22 April, 2004.
- ^{vi} de Boer J., van der Horst A. and Wester P. G. (2000). PBDEs and PBBs in suspended particulate matter, sediments, sewage treatment plant in- and effluents and biota from the Netherlands. *Organohalogen Compounds*, **47**, 85-88.
- ^{vii} de Boer J. and Allchin C. (2001). An indication of temporal trends in environmental PBDE levels in Europe. *Organohalogen Compounds*, **52**, 13-17.
- ^{viii} Zegers B. N., Lewis W. E., Booij K., Smittenberg R. H., Boer W., de Boer J. and Boon J. P. (2003). Levels of polybrominated diphenyl ether flame retardants in sediment cores from Western Europe. *Environ. Sci. Technol.*, **37**, 3803-3807.
- ^{ix} Ikonomou M. G., Rayne S. and Addison R. F. (2002). Exponential increases of brominated flame retardants, polybrominated diphenyl ethers, in the Canadian Arctic from 1981 to 2000. *Environ. Sci. Technol.*, **36**, 1886-1892.
- ^x European Union Risk Assessment Report: Bis(pentabromophenyl ether). 1st Priority List, Volume 17. European Commission Joint Research Centre, EUR 20402 EN, 2002.
http://ecb.jrc.it/Documents/Existing-Chemicals/RISK_ASSESSMENT/REPORT/decabromophenyletherreport013.pdf