



From the Toxipedia website in original form. Last updated by Toxipedia in 2014.
Dr. Steve Gilbert, author.

Polybrominated Diphenyl Ethers (PBDEs)

Overview

PBDEs, a subgroup of brominated flame retardants, are persistent and bioaccumulative industrial chemicals that cause numerous problems including Cancer, thyroid problems, and neurodevelopmental effects (Schmidt, 2003) (Eriksson et al, 2006). They have been widely used since the 1970s as flame retardants in electronics, textiles, and polyurethane foam, among others (Stiffler, 2007 and Birnbaum, 2004). They are mixed into the products in order to raise the temperature at which they burn, making the products more flame resistant. PBDEs are released from products when TVs or computers heat up, while sleeping on mattresses, or when the products degrade (Stiffler, 2007).

The group - made up of penta, deca, and octa formulations - was voluntarily banned in the EU, and octa and penta mixtures have been banned nationally in the US with certain states banning the deca formulation (Birnbaum, 2004). In general, lower brominated compounds are more toxic than higher brominated compounds (Birnbaum, 2004).

Chemical Description

Structurally, PBDEs are very similar to PCBs. There are over 209 different PBDE compounds, and the three most common commercial formulations are deca, octa, and penta depending on the number of bromine atoms. PBDEs are considered more degradable than other persistent chemicals due to their weak carbon-bromine bond (Schmidt, 2003).

Because they are merely additives mixed into products, they have the ability to leave the products during degradation (ATSDSR, PBBs and PBDEs).

They accumulate in fatty tissues of organisms and are passed up the food chain to larger organisms in a process known as Biomagnification. A 25-year Swedish study indicated that PBDE levels in people double approximately every five years (Stiffler, 2007, Schmidt, 2003).

Deca

Deca accounts for 80 percent of the PBDEs currently produced and is composed of around 97 percent pure brominated diphenyl ether. It is used primarily as an additive in electronics, electronic equipment, and textiles, and it is commonly found in mattresses and TVs (Birnbaum, 2004). It is practically nontoxic in laboratory conditions, but in sunlight it breaks down into penta and tetra forms of PBDEs, which accumulate within organisms and biomagnify (Schmidt). The U.S. produces deca, the most controversial

and widely used formula, at a rate close to 50 million pounds a year, most of which is used in television casings. Deca demand is expected to grow because it is now approved for use to meet new federal fire safety standards for residential furniture and mattresses.

Octa

Manufacturers discontinued production of Octa in 2004 (#Stiffler, 2007).

Penta

Penta is a viscous liquid used primarily as an additive in textiles and polyurethane foams and is composed of 24-38 percent tetraDPE, 50-60 percent penta, and 4-6% HxBDE (#Birnbbaum, 2004). Manufacturing of this form was halted in 2004 (#Stiffler, 2007).

Exposure

PBDEs enter the air, water, and soil when they are put into products or when they exit products as a result of degradation (#ATSDR, PBBs and PBDEs). They biomagnify up the food chain and are stored in fats. They are now ubiquitous in the environment - found from the Arctic to the Antarctic - and are present in nearly all human bodies (#Stiffler, 2007).

Health Effects

Very serious health effects are associated with exposure to PBDEs, but toxicity depends on the compound and the amount that one is exposed to. PBDEs are chemically similar to PCBs and, not surprisingly, they show similar health effects as well (#Sightline). They are biomagnified toxic compounds, meaning they accumulate within food chains. Laboratory studies on mice have shown them to be neurotoxic chemicals, neurobehavioral and developmental toxicants, and Carcinogens. They have noticeable effects on the thyroid and liver (#Schmidt, 2003, #Birnbbaum, 2004, and #ATSDR, PBBs and PBDEs) and they impair learning, memory, sexual development, and behavior (#Sightline). Additionally, PBDEs and PCBs - still present in the environment - can "interact and enhance neurobehavioral defects when the exposure occurs during a critical stage of neonatal brain development" (#Eriksson et al, 2006).

Exposure to PBDEs is nearly impossible to avoid due to their ubiquity in the air, water, food, human fat, and breast milk (#ATSDR, PBBs and PBDEs). The fetus is exposed to the toxins in utero as well as from breast milk, which where the toxins are transferred from the mother to the baby. A 25-year Swedish study found that the concentration of PBDEs in breast milk doubled every five years during the 25-year period (#Eriksson et al, 2006).

PBDE Benefits

PBDEs are low-cost chemicals that can halt or slow the spread and duration of fires (#Stiffler, 2007). However, manufacturers have abandoned production of penta and octa formulations, and some have found suitable alternatives to deca (#Stiffler, 2007).

Consumer Precautions

Consumers do have the ability to limit exposure to PBDEs. Below is a list of tips from the *Green Guide*:

- Eat a heart-healthy diet. Reducing your consumption of animal fats will also lower amounts of PCBs, PBDEs, dioxins and other POPs in your diet. "Eating less amounts of animal fats will

result in lower PBDE levels (in our bodies) in the long run," says Dr. Birnbaum. She recommends a heart-healthy diet, which will reduce your exposure to biomagnifying chemicals such as PBDEs, PCBs and dioxins, as well as reduce your risk of cardiovascular disease.

- Eat farmed fish less frequently (some researchers recommend no more than once per month), especially European and Atlantic salmon, which have been shown to have high PBDE, PCB and Dioxin levels. Choose wild salmon - fresh, frozen or canned - instead.
- Clean floors with a HEPA filter vacuum cleaner that traps fine particles of dust, soot, and pollen, and wet mop regularly. Keep your home well-ventilated. This will also help reduce concentrations of other forms of indoor air pollution, according to Dr. McDonald.
- Cover and seal rips in upholstery with exposed polyurethane foam, especially if the foam is loose and crumbling. Exposed foam may release PBDEs directly into house dust and air.
- Contact your mattress manufacturer to see whether your mattress is made with polyurethane foam that contains PBDEs. If it does, but you aren't ready to replace your mattress, consider purchasing a tightly woven allergen-barrier mattress casing to block dust that may be laden with PBDEs. As soon as the mattress shows wear, replace it with a PBDE-free option.

See the Green Guide and the Pollution in People website for more tips on how to avoid PBDEs.

Manufacturing Precautions

From the Toxic Free Legacy Coalition:

Manufacturers can avoid using PBDEs by designing products using inherently flame resistant materials, such as metal, glass, pre-ceramic polymers, Kevlar, leather, and natural fibers including jute, hemp, and wool. Safer flame-retardant chemicals are another option as well.

Many manufacturers of electronics, mattresses, and furniture have already stopped using PBDEs and are still meeting the highest fire safety standards.

Washington's PBDE bill will not prescribe what non-PBDE materials manufacturers should use, but instead allows flexibility on how to comply with the ban. The legislation's ban on the deca form of PBDE will be enacted in January 2010 only if the Washington Departments of Ecology and Health find a safer alternative to deca that is available at a reasonable cost AND approved by a fire safety committee made up of five fire association representatives.

Electronic manufacturers can meet the highest fire safety standards without using PBDEs. Many large computer companies have already voluntarily stopped using PBDEs and switched to inherently more fire-resistant materials, or the use of other chemical retardants. Because the bromine industry has voluntarily stopped manufacturing the highly toxic penta and octa forms of PBDEs, the focus of alternatives assessment is on safer, effective alternatives to the use of deca.

Companies that have stopped using PBDEs include Dell, Canon, Hewlett-Packard, Ericsson, Mitsubishi, and Sony. Many other companies are phasing out the use of PBDEs in their product lines.

Washington State Legislation

Washington State became the first state in the country to ban the use of all forms of PBDEs when Governor Christine Gregoire signed the legislation in April of 2006 (#La Corte, 2007). The measure prohibits the manufacture, sale, or distribution of most items containing PBDEs.

Regulation

Manufacturers of penta and octa formulations discontinued production of them in 2004 (#Stiffler, 2007). There have been many legislative battles concerning deca between environmental activists and the chemical industry and lobbyists who represent them. Only a few states (including Washington and Maine) have bans on deca, and there has not been a national ban. The European Union bans all formulations of PBDEs.

History

Widespread use of PBDEs as a flame retardant began in the 1970s. The most common uses were for TVs and mattresses.

External Links

- The Washington Toxics "Pollution in People Report - PBDEs"
- WA State Department of Health - PBDEs
- Washington State Polybrominated Diphenyl Ether (PBDE) Chemical Action Plan: Interim Plan
- Summary of plan. - executive summary of WA State Plan
- SB 5515 (Senate Bill) companion to HB 1488
- ATSDR's ToxFAQs
- CHEC on PBDEs
- Critical Contaminants in the Great Lakes - Human Health and the Great Lakes.
- EPA on PBDEs
- EWG on PBDEs
- Health Canada - Polychlorinated Biphenyls (PCBs).
- Health Care Without Harm.
- *Seattle Post Intelligencer* on PBDEs
- Our Stolen Future - PBDEs
- United Nations Environment Programme (UNEP) - Persistent Organic Pollutants (POP).
- U.S. Environmental Protection Agency - Persistent Bioaccumulative and Toxic (PBT) Chemical Program.
- U.S. Geological Survey. (accessed: 9 April 2003).
- Washington State Department of Ecology : PBDEs.
- Washington State Department of Ecology - Persistent, Bioaccumulative Toxins.
- Washington Toxics Coalition (WTC). (accessed: 9 April 2003).

References

- Atkin, J. and Klaus M. Leisinger (Editors). Safe and Effective Use of Crop Protection Products in Developing Countries CABI Publishing, CAB International. (2000). 163 pages.
- ATSDR. Polybrominated Biphenyls and Polybrominated Diphenyl Ethers (PBBs AND PBDEs) Fact sheet on PBDEs. (accessed: 22 August 2004).
- Birnbaum, L. S., & Staskal, D. F. "Brominated Flame Retardants: Cause For Concern?". *Environmental Health Perspectives* 112(1), 9-17, 2004.
- Carson, Rachel. Silent Spring. Houghton Mifflin, Boston, (1994). 368 pages.

- Eriksson, P., Jakobsson, E., & Fredriksson, A. "Brominated Flame Retardants: A Novel Class of Developmental Neurotoxicants in our Environment?. *Environmental Health Perspectives* 109(9), 903-908, 2004.
- Hooper, K., & McDonald, T. A. [The PBDEs: An Emerging Environmental Challenge and Another Reason for Breast-Milk Monitoring Programs. *Environmental Health Perspectives* 108(5), 387-392.
- Hooper, K., & She, J. "Lessons From the Polybrominated Diphenyl Ethers (PBDEs): Precautionary Principle, Primary Prevention, and the Value of Community-Based Body-Burden Monitoring Using Breast Milk". *Environmental Health Perspectives* 111(1), 109-114.
- La Corte, Richard. "Fireproofing chemical may face backlash after phase-out". *The Seattle Times*, April 22, 2007.
- Schmidt, Charles. "PBDEs in breast milk: levels higher in United States than in Europe - Science Selections". *Environmental Health Perspectives*. Nov 2003.
- Sightline on PBDEs
- Stiffler, Lisa. "PBDEs: They are everywhere, they accumulate and they spread". *The Seattle Post Intelligentser*, March 28, 2007.
- Viberg, H., Fredriksson, A., Jakobsson, E., Orn, U., & Eriksson, P. (2003). ["Neurobehavioral Derangements in Adult Mice Receiving Decabrominated Diphenyl Ether (PBDE 209) During a Defined Period of Neonatal Brain Development. *Toxicol Sci* 76(1), 112-120.
- Wargo, John. *Our Children's Toxic Legacy: How Science and Law Fail to Protect Us from Pesticides*. Yale University Press. 2nd edition (1998) 402 pages.