Flame Retardants: Alarming Increases in Humans and the Environment

Brominated flame retardants, chemicals used to make foam, textiles, electronics, and other products fire resistant, are turning up in high amounts in the breast milk of American women. Two recent studies found that not only did American women have brominated flame retardants in their breast milk, but that the levels found were the highest known in the world. This fact sheet presents an overview of the concerns about brominated flame retardants.

Flame Retardants: Rising Levels of Concern

The widespread use of plastics and other synthetic materials in electrical appliances, textiles, upholstery and construction materials has increased the flammability of these products, making it necessary to modify them to meet fire safety standards. Flame retardants have thus been added to many products to meet these standards. Recent research, however, has raised concerns about the persistence and toxicity of flame retardant chemicals themselves.

Some flame retardants are now ubiquitous in the environment, including in remote areas such as the Arctic and deep in the oceans. Rapidly increasing levels have been measured in sediments, marine animals and humans, indicating a significant potential for damage to ecological and human health. Growing evidence suggests some of these chemicals are toxic in ways that are similar to other halogenated, persistent, bioaccumulative toxicants such as PCBs (polychlorinated biphenyls), which were banned in 1977 due to toxicity and widespread diffusion in the environment. Fortunately, numerous and effective alternative flame retardants are being used worldwide.

Focus on Flame Retardants Containing Halogens (Bromine, Chlorine)

Many chemical classes are used as flame retardants. Of greatest concern are those with halogens attached to the carbon backbone, particularly the halogens chlorine and bromine. The latter, called brominated flame retardants (BFRs), are widely used in consumer products - especially plastics for electronics, foams, and textiles - because they are a cost effective means of retarding flame while also allowing continued durability and performance of the material. Three of the most commonly-used BFRs are Penta-, Octa-, and Deca-brominated diphenyl ethers (diphenyl ethers containing 5, 8 and 10 bromines, respectively). Collectively, they are referred to as polybrominated diphenyl ethers, or PBDEs.

Chlorinated flame retardants (CFRs) are used in textiles, paints and coatings, plastics, and insulation foams. Like BFRs, some chlorine-containing flame retardants persist in the environment, and may accumulate in the tissues of humans and other animals.[1] Tris(2-chloroisopropyl phosphate) (TCPP) and Tris(2-chloroethyl) phosphate (TCEP), and chloroparaffins are some examples of chlorinated flame retardants.

Flame Retardants with Bromine and Chlorine Accumulate in the Environment and Humans

The chemical structures of BFRs are very stable—they don't break down easily in the environment where they attach to particles and accumulate in media such as dust and sediments. BFRs also are light enough to be transported long distances through the atmosphere. In the past decade, BFRs have been detected in sediments,

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sewage sludge, air, soil and water samples in the U.S., Canada, the Arctic, northern Europe, Taiwan and Japan.[2] BFRs are not only persistent in the environment; they are also persistent in living tissues. Similar to PCBs, BFR concentrations have been found to increase up the food chain, indicating that these chemicals are readily absorbed by the body where they accumulate in fatty tissues.[3]

Rapidly rising PBDE levels have been documented in living tissue, from humans, mammals and other wildlife. A recent study from the California Department of Toxic Substances Control reported that total PBDE levels in harbor seal blubber from the San Francisco Bay were among the highest reported in the world.[4] The same group tested 32 breast milk and 50 serum samples from Bay Area women and found PBDE levels significantly higher than those reported anywhere in the world. Average PBDE levels in San Franciscan women were three times higher than those in Swedish women, 10 times higher than average levels reported in women from Germany and Canada, and 25 times higher than human tissue levels in Spain.[5] The same group also tested and compared serum samples of Bay Area women stored from the 1960s. No PBDEs were found in the 1960 samples. During the past 30 years, PBDE levels in human milk, blood and tissues have increased by a factor of 100, doubling about every 5 years.[6]

Chlorinated flame retardants have not been as well-studied as BFRs and there are no studies of levels in human or wildlife. However, chlorinated flame retardants have been found in household dust, water, sediments and biological materials both near and distant from industrial sources.[7]

Human Health Effects of Halogenated Flame Retardants Raise Concern

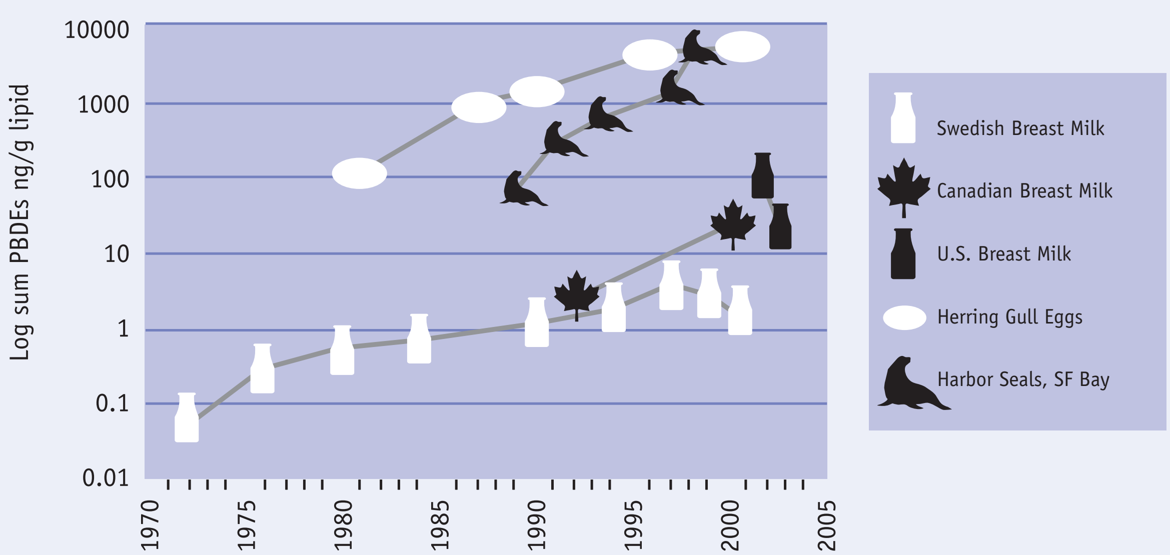
Potentially toxic chemicals typically aren't tested in humans because to do so would be unethical and prohibitively expensive. However, controlled studies in laboratory animals show that some BFRs disrupt thyroid function, causing hyperactivity and problems with learning and memory.[8] Thyroid hormone is critical for brain development early in life. Impacts of BFRs on exposed humans have not been studied; however, the results in animals are likely to predict impacts on developing humans, e.g. fetuses and children. The scientific evidence to date on PBDEs indicates that these chemicals also share many common traits with PCBs, including animal studies linking them to immune suppression[9], cancer[10], endocrine disruption[11], and neuro-behavioral and developmental effects.[12] PBDE levels now in some humans are close to the levels shown in animals to have negative effects.[13]

Chlorine-containing flame retardants have been found to accumulate in the liver and kidneys and are suspected to be carcinogens and reproductive toxicants.[14] Data on the toxicity and persistence of chlorinated flame retardants are limited.

Alternatives to Halogenated Flame Retardants

In light of the mounting evidence that some halogenated flame retardants are persistent in the environment, bioaccumulative in wildlife and

Selected Human and Wildlife levels of PBDEs



Source: from Clean Production Action, Hites 2004 (18); Lunder, 2003 (20).

humans and are potentially toxic,a review of safer alternatives is necessary. Options for meeting current fire safety standards could include the use of safer chemical substitutes for halogenated flame retardants. Initial analyses suggest safer chemical substitutes already are available. For example, a report commissioned by the German government determined that the flame retardants aluminum trihydroxide, ammonium polyphosphates and red phosphorus are less problematic in the environment.[15] Information about the safety of other alternatives is growing and in the future it will be possible to make more specific recommendations. However, it is not clear that safer alternatives are currently available for every application.

Another option is product redesign. Rethinking product design can omit the need for chemical flame retardants altogether. For instance, by using materials that are inherently more flame resistant (metal, leather, glass and wool do not require the addition of artificial flame retardants to be fire resistant), or by separating flammable materials from the heat sources in a product, a product can be designed without requiring flame retardant additives. There are three plastics—polysulfone, polyaryletherketone and polyethersulfone—that are self-extinguishing and can be used without the addition of flame retardants.[16] Also, electronics products can be redesigned to contain lower temperature generating components or redesigned to separate heat-generating components from highly flammable components.

Phase-out of Halogenated Flame Retardants

Immediate phase-out of the commercial use of some halogenated flame retardants should be considered due to the ready availability of less toxic and/or less persistent or bioaccumulative alternatives. The European Union began substituting for BFRs in the 1990s and PBDE levels in breast milk of women living in EU countries have plateaued and are beginning to decrease. Phase-outs include voluntary actions by manufacturers and retailers, as well as legislated mandates by regulatory authorities.

Some computer and electronics manufacturers such as Apple, Ericsson, IBM, Intel, Motorola, Panasonic, Phillips and Sony are using alternatives to halogenated flame retardants. For example, Motorola now uses a halogen-free laminate that is cost effective, while meeting fire safety standards. Toshiba has replaced BFR-containing plastic casings in electronic parts with inherently flame-resistant polyphenylene sulfide. IKEA furniture, Crate and Barrel and Eddie Bauer are requesting PBDE-free polyurethane foam from their manufacturer Hickory Springs. Great Lakes Chemical, the only U.S. manufacturer of penta- and octa-BDE, has announced that it will phase out these formulations by 2005. Other global manufacturers continue to produce and use these chemicals, as well as export their products to the U.S.

The European Union has enacted a ban on Penta- and Octa-BDEs and is considering a ban on Deca-BDEs as well. States are acting to phase-out the use of the PBDEs as well. California, Hawaii, New York and Maine have already passed legislation to ban certain PBDEs, with similar initiatives underway in Maryland, Massachusetts, Michigan, Minnesota, Oregon, and Washington.[17] The United States government has yet to ban brominated flame retardants.

Notes

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17. California statute will go into effect in 2008 and can be found at http://info.sen.ca.gov/pub/bill/asm/ab_0301-0350/ab_302_bill_20030724_enrolled.html; Maine statutes, L.D. 743 and 1790, May 2003 at http://www.mainelegislature.org/legis/bills/billtexts/ld074301-4.asp and http://janus.state.me.us/legis/ros/lom/lom121st/14pub601%2D650/pub601%2D650%2D33.htm; and Washington state executive order at http://www.governor.wa.gov/eo/eo_04-01.htm.

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