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Polystyrene, polyisocyanurate, and polyurethane are highly energy efficient insulation materials whose use in green buildings is increasing. However, due to their flammability, fire retardant chemicals (FRs) must be added to meet building codes. Many of the FRs currently in use are halogenated organic chemicals, meaning that they contain chlorine or bromine bonded to carbon. Most of these FRs have not been adequately evaluated for their impact on human health and the environment. When tested, many are found to be persistent, bioaccumulative, and/or toxic. Being persistent means that they do not break down into safer chemicals in the environment over months or years. Being bioaccumulative means that they accumulate in plants and animals, becoming more concentrated as they move up the food chain. Additionally, some of these FRs are carcinogens, mutagens, and/or reproductive, neurological, thyroid, and/or developmental toxicants.

The impacts of exposure to fire retardant chemicals upon workers, human and animal health, building occupants, wildlife and the global environment should be considered when selecting insulation materials.

- All **polystyrene foam insulation** used in building insulation (both XPS, such as Styrofoam, and EPS) is treated with hexabromocyclododecane, (**HBCD**), a persistent, bioaccumulating, and toxic fire retardant. This chemical was recently nominated for the first EU list of sixteen "Substances of Very High Concern" and will likely be banned in Europe. It has been widely detected in household dust, sewage sludge, breast milk and body fluids as well as wildlife and the global environment. HBCD is also used with fabrics and plastic; however 85% is used with polystyrene insulation, which is likely the primary source of the global contamination.

- **Polyisocyanurate (polyurethane)** board often contains **TCPP** (tris (1-chloro-2-propyl) phosphate). While its toxicity in mammals appears to be limited, the effects of long-term exposure are unknown, and it is toxic in aquatic environments. Triethyl phosphate (TEP), a non-halogenated FR used in the EU, is a safer alternative

- Polyurethane boards can contain up to five percent "**blowing agents**", which are usually volatile hydrocarbons or halogenated hydrocarbons. Polyurethane spray foam formulations can contain both blowing agents and proprietary FRs with unknown composition and health effects.

- For example, Dow THERMAX(TM) Insulation board contains a maximum of ten percent of TCP and five percent 1-Bromopropane. The MSDS states that this blowing agent can cause central nervous system effects in humans and harm to male and female reproductive organs and the liver as well as interference with reproduction and fertility and toxicity to the fetus in animal studies. The sheet also states that "normal handling and cutting are unlikely to result in exposure levels of 1-bromopropane sufficient to cause the listed effects."

The impact of long term and cumulative exposures to mixtures of such chemicals upon the health of workers, inhabitants of homes, and the environment is not known.

Halogenated fire retardants are becoming widespread in the environment

Halogenated fire retardants (FRs) can migrate out of furniture foam, electronics, fabric and other consumer products as well as foam insulation so humans are exposed to a "cocktail" of such toxins. Levels of FRs are increasing rapidly in household dust, human breast milk, and wild animals. The chemicals are widely distributed in the outdoor environment with the highest concentrations in the Arctic and marine mammals. Certain classes of brominated fire retardants, the polybrominated diphenyl ethers, have been banned for most applications, but other brominated and chlorinated compounds have taken their place in consumer products without adequate studies to determine their health and environmental safety.

How to reduce the health and environmental hazard from FRs in insulation

- Develop design guidelines, green building credit systems, and codes to encourage designers to:
 - Consider the toxicity of insulation options when selecting insulation types.
 - Consider alternate pathways to attaining needed levels of fire safety, such as designing with fire barriers or other materials to reduce flammability.

- Encourage research and use of alternative, non-halogenated fire retardant additives such as sodium borate and triethyl phosphate (TEP).
- Support governmental programs to require full health testing of all chemicals and use of safer alternatives where available.

Energy Efficiency of Insulation

Insulation Type	R-value per Inch of Thickness	Fire Retardant
Fiberglass blanket or batt	3.2	non-flammable
High performance fiberglass batt	3.8	non-flammable
Loose-fill fiberglass	2.5	non-flammable
Loose-fill rock wool	2.8	non-flammable
Loose-fill cellulose	3.5	sodium borate 20%
Dense-pack cellulose	4.0	sodium borate 20%
Expanded polystyrene board (EPS)	3.8	HBCD 0.7%
Extruded polystyrene board (XPS)	4.8	HBCD 2.5%
Polyisocyanurate board, unfaced	5.8	TCPP 5% - 10%
Polyisocyanurate board, foil-faced	7.0	TCPP 5% - 10%
Spray polyurethane foam	5.9	?? 15% - 40%

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Reference: Article by Paul Fisette - © 2008 < http://www.umass.edu/bmatwt/publications/articles/cellulose_insulation.html >

More information:

Green Science Policy Institute: See presentations from past conferences at http://greensciencepolicy.org/?page_id=10

Health Care without Harm fact sheets:

Flame Retardants: Alarming Increases in Humans and the Environment (www.noharm.org/details.cfm?ID=1098)

and Brominated Flame Retardants: Rising Levels of Concern (

www.noharm.org/details.cfm?id=1095

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Healthy Building Network factsheet: Toxic Chemicals in Building Materials: www.healthybuilding.net/healthcare/ToxicChemicalsInBuildingMaterials.pdf