Endocrine Disrupting Effects of Brominated Flame Retardants

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Brominated Flame Retardants

• What are BFRs?
  • Broad class of chemicals, including PBDEs, TPPBA, HBCD

• Why do we use them?
  • Increased fire hazard with increased volume of flammable consumer products

• What’s the concern?
  • Detected in human breast milk, ubiquitous in the environment
  • Found in blood of electronics recyclers
  • Routes of exposure remain largely unknown

• What’s happening?
  • Voluntary Industry Phase-outs (electronics, Great Lakes Chemical)
  • Legislated Phase-outs (CA, WA, others)
  • Furniture Flammability regulations (CA TB117, CPSC national standard)
What Are the BFRs?

• Includes
  • Polybrominated diphenyl ethers, PBDEs
  • Bisphenols, Cyclododecane

• Commonly used as flame retardants
  – 95% of consumer electronics use deca-BDE
    • Computer casings, printed circuit boards, cabling, etc.
  – Upholstered furniture, drapes, carpeting
    • Penta-BDE in polyurethane foam

• 450 million pounds of BFRs manufactured annually worldwide
  • North America: highest usage; increasing in Asia, especially TBBPA
Chemical Structure of the BFRs

Polybrominated diphenylethers (PBDE)

Tetrabromobisphenol A (TBBPA)

Hexabromocyclododecane (HBCD)
What’s the Concern?

• PBDE concentrations are increasing in human tissue and biota
• PBDEs are of toxicological concern
  • Bioaccumulative
  • Endocrine disrupters
  • Affect fetal brain development
• Routes of exposure are largely unknown
  • Use or end-of-life exposure for consumer products?
  • Occupational exposure: recyclers, firefighters, others?
  • Air, soil, food?
Total PBDEs, Swedish Milk Study
(Noren & Meironyte, 1998)
PBDE-47 in Human Tissues

- SF (adipose)
- Sweden (serum)
- Germany (whole blood)
- Canada (milk)
- Finland (milk)
- Japan (milk)
- Sweden (milk)

PBDE-47, ng/g lipids

Structural Similarity of PBDEs, Their Metabolites and Environmental Derivatives to T4 and PCBs

- 2,2',4,4',5,5'-hexachlorobiphenyl (PCB-153)
- 2,2',4,4',6-pentabromodiphenylether (PBDE-100)
- 2-(2',4'-dibromophenoxy)-4,6-dibromoanisol (methoxy-PBDE)
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- 2,3,4,7,8-pentabromodibenzofuran (PBDF)

Thyroxine (T4)

4-(2',4',6'-tribromophenoxy)-2,6-dibromophenol (hydroxy-PBDE)
What We Know

• Ubiquitous in environment, biota
• Mammalian Toxicity
  – Endocrine disruption (PBDEs, TBBPA)
  – Dioxin formation (PBDEs, TBBPA)
  – Altered behavior and learning (PDBEs)
  – Inadequate testing for cancer, brain development, sensitization effects
• Ecological Toxicity
  – Photolytic and/or anaerobic debromination
  – Formation of dioxins, furans upon incineration
PBDEs Are Everywhere

• Indoor/ outdoor air, office dust
  • European Parliament buildings: Greenpeace
• Rivers, lakes, sediments
• Bio-solids, used for agricultural fertilizer
• Arctic, marine and terrestrial mammals
  • Long-range transport
  • Bio-concentration
• Food
Serum PBDE Levels in Three Occupational Groups

Emerging Issues

• Potential exposures
  • Export of harm when recycling done off-shore
  • Use of prisoners for US electronics recycling
  • Fire fighters’ occupational exposure
  • As yet unknown impact in foam, recycled foam industries (carpets, auto, etc.)

• Impact on Recycling
  • What do we do with BFR plastic from electronic waste?
Larger Impacts

• Case study for inadequacies of current chemicals management approach
  • Grossly inadequate data before chemicals put on market
    » 85,000 chemicals in use, with 1,000 added every year
  • No data on interactions with other chemicals
  • No systematic assessment of potential persistence, bio-accumulative properties, long-range transport, breakdown, etc.

• Need:
  • Better ongoing monitoring of humans, environment
  • Better data PRIOR to putting chemicals on the market
  • Alternatives, alternatives, alternatives
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