Identifying Flame Retardant Chemicals in Consumer Products Insights into Human Exposure Pathways

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NIEHS
National Institute of Environmental Health Sciences

Srp
Superfund Research Program



Flame Retardants (FRs) Used to Meet California's TB 117

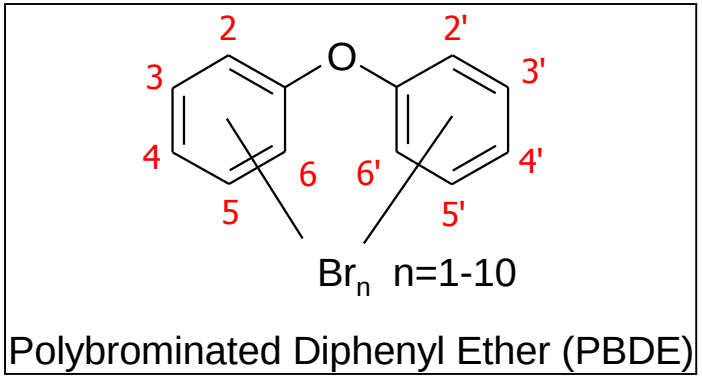
- Promulgated by California Bureau of Home Furnishing and Thermal Insulation, within the Department of Consumer Affairs

- Requires 12-second open flame testing for polyurethane inside furniture

PentaBDE Flame Retardant Mixture

- 98% of World Market Demand for PentaBDE was in North America, primarily to meet TB 117

- Concern about persistence, bioaccumulation and potential toxicity led to voluntary phase-out in US in 2005; (banned in Europe in 2002)

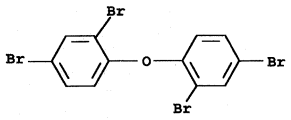


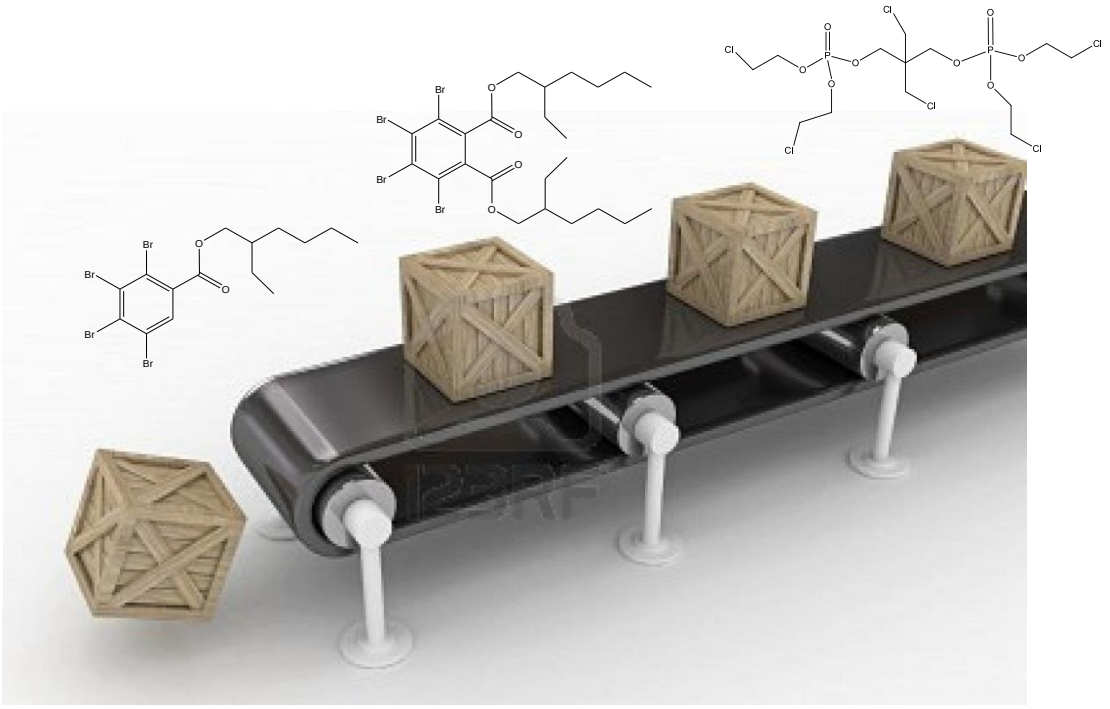
Polybrominated Diphenyl Ether (PBDE)

- However, there are very limited data available on the flame retardants used as replacements for PentaBDE

The Chemical Conveyor Belt

When one flame retardant is banned, another chemical moves in to take it's place, and less is known about the replacement chemical…







EPA's PentaBDE Alternatives Assessment

Table 4-1 Screening Level Toxicology and Exposure Summary

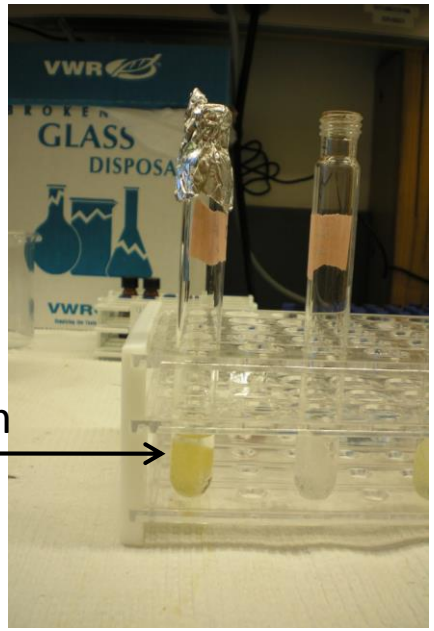
L = Low hazard concern
M[4] = Moderate hazard concern
H = High hazard concern
N = No
Y = Yes
P = Yes for pure chemical
*Ongoing studies may result in a change in this endpoint
▲Persistent degradation products expected[5]
L, *M*[1], or *H* = Endpoint assigned using estimated values and professional judgment (Structure Activity Relationships)

Company	Chemical	% in Formulation[6]	Human Health Effects							Ecotoxicity		Environmental		Potential Routes of Exposure							Reactive or Additive?
			Cancer Hazard	Skin Sensitizer	Reproductive	Developmental	Neurological	Systemic	Genotoxicity	Acute	Chronic	Persistence	Bioaccumulation	Worker			General Population			Aquatic	
														Inhalation	Dermal	Ingestion	Inhalation	Dermal	Ingestion		
Albemarle	SAYTEX RZ-243																				
	Proprietary E Tetrabromophthalate diol diester		*L*	*L*	*L**	*L**	*L*	*M**	*L*	*L*	*H*	*L*▲	*L*	N	Y	Y	N	N	Y	Y	Additive
	Proprietary B Aryl phosphate		*L*	*L*	M*	M*	M	M*	*L*	H	*H*	*L*	*M*	N	Y	Y	N	Y	N	N	Additive
	Triphenyl Phosphate CAS # 115-86-6		*L*	L	L	L	L	M	L	H	*H*	L	L	Y	Y	Y	Y	Y	Y	Y	Additive
Ameribrom	FR513																				
	Tribromoneopentyl Alcohol CAS # 36483-57-5		*M*	L	*M*	*M*	*M*	M	M	M	*M*	L	*L*	Y	Y	Y	N	N	Y	Y	Reactive
Great Lakes	Firemaster 550																				
	Proprietary F Halogenated aryl ester		*L*	*L*	*M*	*M*	*L*	*M*	*L*	H	*H*	L▲	L	N	Y	Y	N	Y	Y	Y	Additive
	Proprietary G Triaryl phosphate, isopropylated		*L*	*L*	M*	M*	M	M*	*L*	H	*H*	*L*	*M*	N	Y	Y	N	Y	N	N	Additive
	Triphenyl Phosphate CAS # 115-86-6		*L*	L	L	L	L	M	L	H	*H*	L	L	Y	Y	Y	Y	Y	Y	Y	Additive
	Proprietary H Halogenated aryl ester		*L*	*L*	*M*	*M*	*L*	*M*	*L*	H	*H*	L▲	L	N	Y	Y	N	Y	Y	Y	Additive
Great Lakes	Firemaster 552																				
	Proprietary F Halogenated aryl ester		*L*	*L*	*M*	*M*	*L*	*M*	*L*	H	*H*	L▲	L	N	Y	Y	N	Y	Y	Y	Additive
	Proprietary G Triaryl phosphate, isopropylated		*L*	*L*	M*	M*	M	M*	*L*	H	*H*	*L*	*M*	N	Y	Y	N	Y	N	N	Additive
	Triphenyl Phosphate CAS # 115-86-6		*L*	L	L	L	L	M	L	H	*H*	L	L	Y	Y	Y	Y	Y	Y	Y	Additive
	Proprietary H Halogenated aryl ester		*L*	*L*	*M*	*M*	*L*	*M*	*L*	H	*H*	L▲	L	N	Y	Y	N	Y	Y	Y	Additive

(Furniture Flame Retardancy Partnership V 1, EPA 2005)



Screening Consumer Products for FR Chemicals:



Foam

Gas Chromatograph Mass Spectrometer (GC/MS)



Flame Retardants (FRs) Used to Meet California's TB 117

- Previous research in our laboratory has focused on identifying FR chemical additives in polyurethane foam:
  - Baby Products (Stapleton et al. 2011)
  - Residential Sofas (Stapleton et al. 2012)

Sleep Positioners

- The most common FRs identified in furniture are:
  - PBDEs associated with PentaBDE
  - Tris (1,3-dichloro-isopropyl) phosphate (TDCPP)
  - Chemicals associated with Firemaster® 550 (FM 550)
  - Triphenyl phosphate (TPP) and isomers of tris(4-isobutyl) phenyl phosphate
  - Tris (1-chloro-isopropyl) phosphate (TCPP)

Testing for Flame Retardants in PUF

- A number of consumer products meet CA TB 117 standard
- General public has no access to information on chemical flame retardant applications in these products
- The Superfund Research Center Program is providing support for analytical testing of FRs in PUF

http://foam.pratt.duke.edu

What is the primary route of exposure to flame retardants?

Is Their High Exposure to FRs a Result of Applications to Polyurethane Foam?

Flammability Regulations
(Residential = TB 117)

↓

High FR Use in Commercial Products
(polyurethane foam)

↙ ↘

Off-Gassing to Air → ↘

Accumulation in Dust → ↘

Human Exposure

↑

Diet

****PBDEs in dust correlated With PBDEs in serum (Johnson et al. 2011; Stapleton et al. 2012)**