newsletter

Flame retardants (FR)

Due to their harmful effect on human health and on the environment, polybrominated flame retardants have long been the subject of controversial debate on the part of regulators. Indeed, polybrominated biphenyl compounds (PBBs) and polybrominated diphenyl ethers (PBDEs) are likely to be prohibited in the EU from 2006 on.

Introduction

In Germany alone, around 700 people die and thousands are injured each year from the effects of fires. The economic loss, which runs to several billion euros each year, must not be ignored either. For these reasons, fire protection, fire-proof products and, thus, also flame retardants (FRs) play an important role in industry. Cheap, mass-produced plastics such as polyethylene (PE) and polypropylene (PP) may be used in products posing a significant fire threat (PC circuit boards, housings, etc.) only once a flame retardant has been added to the material in question.

Function, significance, and use of flame retardants

Flame retardants are chemicals which, when added to materials either during or after manufacture, inhibit or even suppress the combustion process, thus delaying the propagation of fire. Flame retardants cannot stop a fire from spreading altogether or extinguish a fire once it has taken hold.
The mechanism of a flame retardant depends on the type of its compound. Both chemical and physical processes play a role here:

- the FR forms a protective surface layer on the burning product
- the FR decomposes under energy usage to release water
- the FR interferes with the chain reaction of radicals in the gas flame phase of the combustion process
- intumescent FR systems: in a fire, the intumescent coating expands to form a thick, non-flammable layer of bubbles offering good insulation protection to the coated material

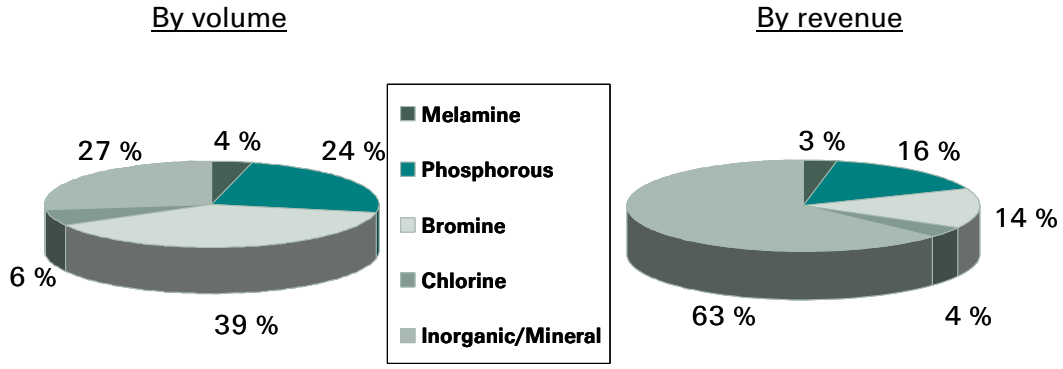
Flame retardants are used mainly in the following areas:

- Building & construction: insulation materials, water pipes, wall cladding, plastic sheeting, resins
- Electrical and electronic equipment (EE devices): monitor housings, cables, plugs & sockets, fuse boxes, printed circuit boards, computers, household goods
- Transportation: upholstery, ceiling linings, sun blinds, textiles, carpets, inner panelling, power units
- Furniture and textiles: upholstered furniture, furniture coverings, mattresses, curtains, carpets, flexible foam, protective clothing

The amount of organic flame retardants in plastics can be as much as 30 %, while inorganic FRs can make up as much as 80 %.

More than 200 different substances are used in industrial flame retardants. By far the biggest customer is the plastics industry. The choice of a given flame retardant depends on economic considerations, as well as on aspects such as processing temperature, degree of flame retardancy required, and the properties of the product in question.

Global market for flame retardants



Source: Townsend-Tarnell

Brominated FRs

Estimates put the annual worldwide consumption of polybrominated flame retardants at more than 300,000 tonnes, 30,000 tonnes of which are used in Europe. Tetrabromo bisphenol A (TBBPA) and its derivatives is currently the most widely used polybrominated flame retardant with an annual figure of 150,000 tonnes.
Due to the manufacturing processes involved, the PBDEs and PBBs used in industry are actually mixtures of different compounds.

Environmental relevance, toxicity

Brominated flame retardants are synthetic substances which rarely occur naturally. Their properties can harm the environment in a number of ways:

- Ecotoxicity and human toxicity: although the acute toxicity of PBDEs and TBBPA is very low, an EU report states that derivatives of PBDEs and TBBPA can interfere with thyroxin (thyroid hormone) serum concentrations and the sex hormones.
- Persistence and bioaccumulation: due to the high lipophility and persistence of PBDEs, these substances can bioaccumulate in the environment (eg in river sediment) and enter the food chain (eg via mother's milk, fatty tissue).
- Formation of dioxins and furans: when brominated flame retardants are heated, eg during incineration, they result in brominated dioxins and furans (PBDDs/PBDFs) the properties of which are largely similar to those of their chlorinated counterparts (see also *newsletter* 6/03; POPs).
- Dangerous additives: eg antimony trioxide (Sb_2O_3). A synergist to enhance the effectiveness of brominated flame retardants, this substance acts as a catalyst in the formation of dioxins and furans. What is more, it has a "clearly carcinogenic substance" rating by the EU.

Assessment of FRs from the toxicological and ecotoxicological viewpoints

Summarised assessment of a selection of flame retardants*	
Phase-out recommended	Decabromo diphenyl ether [1]
	Tetrabromo bisphenol A, additive [2]
Reduction expedient, replacement desirable	Tetrabromo bisphenol A [2], reactive
	Tris(chlorpropyl)phosphate
Properties pose a problem; reduction expedient	Hexabromocyclodo decane
	Sodium borate decahydrate
	Antimony trioxide
No recommendation possible due to inadequacy of available information	Bis(pentabromphenyl) ethane
	Resorcinol-bis-diphenyl-phosphate
	Pyrovatex CP new
	Melamine cyanurate
Properties pose no problem	Red phosphorous
	Ammonium polyphosphate
	Aluminium trihydroxide

[1] Belongs to group of PBDEs; [2] Belongs to group of PBBs
* Source: German Federal Environmental Agency

Legislation and voluntary undertakings

In various research projects, the Federal Environmental Agency evaluated a range of flame retardants in terms of their toxicology and ecotoxicology (see above table). The polybrominated flame retardants are the most highly exposed. Legislation governing the use of PBDEs and PBBs differs greatly from country to country. In Germany, for example, the respective associations of the plastics and textile-producing industries introduced a voluntary phase-out of polybrominated diphenyl ethers, replacing these with less harmful substances. European Parliament Directive 2002/95/EC prohibits the use of PBBs and PBDEs in new EE devices from 1 July 2006 on, while Directive 2003/11/EC prohibits the use of PentaBDE and OctaBDE from August 2004 on.

Information for the underwriter

Flame retardants are an essential component of many products and make a significant contribution to fire safety. When assessing the claims potential for insurers, it is important to look at the type of retardant being used (see above). From the point of view of fire protection, it must be said that alternatives do exist to flame retardants classified as potentially harmful; in some cases, changes in construction can render flame retardants redundant. In the case of fires involving products containing halogenated fire retardants, the property insurer may well face claims from clean-up operations or business-interruption claims due to the formation of poisonous dioxins.
Liability insurers may be exposed to environmental liability claims (eg class actions in the US) or via product liability policies, especially when, eg legislation has introduced new limiting values.

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