

## WHAT ARE THEY?

Brominated flame-retardants (BFRs) are chemicals containing bromine which are added to materials such as plastics and textiles to make them less flammable. Over 30 compounds are in use although only a few of these are used in large amounts. The most common BFRs (both current and historic) are *tetrabromobisphenol A (TBBPA)*, *polybrominated diphenyl ethers (PBDEs)*, *hexabromocyclododecane (HBCDD)* and *polybrominated biphenyls (PBBs)*. The various BFRs vary widely in their chemical structure, uses and toxic properties.

## USES

The use of flame retardants has grown dramatically over the past 30 years in response to concerns about the increasing use of flammable plastics and textiles in homes and offices. EU and British legislation now require that many textiles and certain other materials meet stringent fire safety standards. These standards can often only be met by the incorporation of flame retardants. In 2001, BFRs accounted for approximately 32% of the total use of flame retardants of all types.

BFRs are now used in almost all types of electrical and electronic products typically found in homes, offices and motor vehicles. They are used in the plastic casing of equipment such as TVs and computers and in components such as plastic circuit boards and insulating materials. They are also widely used in textiles, furniture and polyurethane foams for other uses.

## HOW DO THEY WORK

Fire is a chemical reaction between oxygen and a fuel in the gas phase. It is thought that BFRs act by releasing active bromine atoms (called free radicals) into the gas phase as the polymer is decomposed in the fire. These bromine atoms effectively quench the chemical reactions occurring in the flame, reducing the heat generated and so slow or prevent the burning process.

## BENEFITS

BFRs reduce or prevent the chances of ignition of products in the home or office and reduce the rate of combustion of the product if it does ignite. It is widely accepted that the use of flame retardants has resulted in significant benefits by saving lives, reducing injuries and reducing the damage caused by fire. Indeed it is estimated that around 1,150 lives have been saved and 13,500 injuries have been prevented between 1988 and 2002 as a result of

*This Note was produced by a Working Party of the Environment, Health and Safety Committee [EHSC] of the Royal Society of Chemistry.*

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Environment, Health and Safety Committee  
Royal Society of Chemistry  
Burlington House  
Piccadilly  
London  
W1J 0BA

Tel: +44 (0) 207 440 3337  
Fax: +44 (0)207 734 1227  
Email: [ehsc@rsc.org](mailto:ehsc@rsc.org)

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**15 December 2008**

fire safety legislation introduced in the UK on furniture and furnishings (Brominated Flame Retardants: A Burning Issue. W. P Kucewicz. American Council on Science and Health, August 2006).

## **RISKS ASSOCIATED WITH MANUFACTURE, USE AND DISPOSAL**

The BFRs in common use vary widely in their toxicity. Most are not very acutely toxic to humans. However, some laboratory studies have indicated that exposure to relatively high doses of certain compounds can result in damage to, for example, the liver, hormone system or reproduction, in the longer term. It is widely recognised that more research is needed to understand the true extent of health concerns associated with flame retardant chemicals. There is a similar lack of information about the long-term toxicity of BFRs to animals, although some compounds have been confirmed as being very toxic to some aquatic organisms such as fish, water fleas and mussels.

## **EXPOSURE ROUTES**

BFRs can enter the environment from manufacturing facilities through emissions to the atmosphere or by discharge of contaminated wastes to sewers and rivers. There is limited evidence that BFRs can contaminate air through evaporation from the surface of treated products or by dispersion of dust particles when products are disposed of or dismantled. However, contaminant levels produced by these routes have been shown to be generally extremely low. Some brominated flame retardants are chemically bound into a polymer matrix and so have a very low potential for contamination by such routes.

Most commercially produced BFRs are chemically very stable and, therefore, have a strong tendency to persist once released into the environment. In addition, many BFRs have a high affinity for fats and consequently tend to accumulate in the body tissues of animals. This can result in larger predators being exposed to higher concentrations when they capture and eat smaller prey. However a Food Standards Agency investigation (see <http://www.food.gov.uk/science/surveillance/fsisbranch2006/>) on the levels of certain BFRs in the human food chain in the UK in 2003 and 2004 found dietary intake levels to be well below those that would have implications for health. Another study in Sweden found PBDEs in human breast milk, however again only in trace quantities.

## **CONTROL MEASURES**

Present EU policy initiatives have sought to ban or restrict the use of the most hazardous materials (certain PBDEs and PBBs), particularly for applications where alternative flame retardants are available. Other brominated flame retardants are undergoing in-depth EU risk assessments in order to establish whether control measures are needed. Voluntary initiatives by the main EU suppliers are in place for some brominated flame retardants aiming to reduce emissions to the environment. Hexabromocyclododecane (HBCDD) has been included in the first "candidate list" of substances that may be subject to authorisation (Annex XIV) for specific uses under the REACH Regulation. Once included in Annex XIV, a company wishing to market or use such a substance must submit an application to the European Chemicals Agency (ECHA) for an authorisation. Substances cannot be placed on the market or used unless the company is granted an authorisation. Annex XIV also places responsibilities on industry to provide information in response to requests from consumers, (usually in the form of a safety data sheets) on the safe use of these substances on their own or in preparations and in articles.

## **ALTERNATIVES**

A number of other types of flame retardants are available including chlorinated compounds (e.g. chlorinated paraffins), compounds containing phosphorus (e.g. aryl phosphates and chloroalkyl phosphates) or nitrogen (e.g. melamine-based products) and inorganic flame retardants (e.g. aluminium trihydroxide (commonly known as aluminium trihydrate or ATH), magnesium hydroxide and boron compounds). Some of these can be used as alternatives for some applications of BFRs. The choice of flame retardant for any particular application

depends on many factors, such as its suitability to the material to be treated, the fire safety standards that need to be complied with, cost and the health and environmental impact of the final product. BFRs are often the most cost effective flame retardants for many applications. Where flame retardants are used, it is generally accepted that the reactive type (covalently bound to the polymer) is less likely to release contaminants into the environment than the additive type (mixed into the polymer). Alternatives do not currently exist for all applications, particularly for a number of electronic components. Knowledge of the environmental impact of the alternatives is often also very limited.

## **UNCERTAINTIES**

Exposure of the general population to brominated flame retardants is very low. Information about the health effects and environmental impact remains limited, particularly at the low concentrations that residues have been detected (including for alternative flame retardants). For some brominated flame retardants, concerns for humans and the environment have been identified but this needs to be balanced against the proven benefits of flame retardants in terms of saving lives in fires. Based on current knowledge, in many cases the benefits are likely to outweigh the risks. There are also uncertainties in the hazards posed by some of the alternatives.

This Note was prepared by a Working Party of the RSC Environment, Health and Safety Committee.

The members of the Working Party were: Dr I Wrightson (Chairman), Sara J Cooper, Dr M Crookes, Dr C L Grundy, Dr N King, Dr P Lewis, Dr D H Lohmann, Dr C Maxwell, Dr G V McHattie, D Perry, D M Sanderson and Dr S Lipworth (Secretary).