

Toxicology Topics in Brief

Brominated Flame Retardants (BFRs)

Key Facts

- Brominated Flame Retardants (BFRs) are chemicals used in the manufacture of items such as furniture and electronics to make them less flammable.
- Many BFRs do not break down easily and if released they may persist in the environment for a long time. This property of high stability ensures that BFRs continue to work for a long time (often several years) within the flammable material they protect from catching fire, but has the consequence that they may cause problems in the environment at the end of the product's life.
- Different BFRs have different structures and properties, and so cannot all be handled the same way.
- They can get into the human food chain and have been found in human tissues including breast milk.
- Some BFRs are known to be toxic.

Many regulatory authorities including the European Union (EU) are taking measures to reduce the use of BFRs that are likely to have adverse human or environmental health effects.

What are brominated flame retardants?

Flame retardants are chemicals used in the manufacture of materials such as plastics and textiles to make them less flammable. BFRs are a class of organic flame retardants that contain the chemical element bromine. More than 70 BFRs are in use but only a few of these are used in large amounts.

Uses

Some BFRs are used in electronic products found in homes, offices, and cars. To meet fire safety standards, they are used in the plastic casings of TVs and computers, as well as printed circuit boards and insulating material. They are also used in textiles, furniture, and the type of foam used in mattresses.

The use of flame retardants has increased dramatically over the last few decades. This is mainly since we are using more flammable synthetic materials, such as plastics, and is also partly due to more stringent safety standards introduced in several countries. In 1988, the UK and Irish governments put in place some of the most rigorous requirements for furniture and furnishings (Firesafe, undated).

In domestic fires, an item of furniture (or furnishing) is often the first thing that catches fire. Common sources of ignition are cigarettes and candles. Upholstered furniture and curtains, for example, provide fuel for the fire which allows it to spread rapidly. For this reason, standards require furniture and other items to be tested for resistance to cigarettes and other small flames. Manufacturers usually use flame retardants such as BFRs to meet the fire safety standards. There is, however, increasing evidence that these regulations may not offer the protection that was first intended, since it is smoke rather than flames that is responsible for most deaths.

Did you know?



Fires caused 240 deaths in the year ending March 2021 in the UK (Home Office, 2021).

There is also a growing body of knowledge which is raising concerns about these chemicals in relation to their persistence, bioaccumulation, toxicity, and the precautions needed for their long-range transport.

What are the benefits of flame retardants?

Flame retardants slow down the spread of the fire. They also help to prevent everyday items in the home or office from catching fire.

An independent investigation into the use of flame retardants, carried out at the University of Surrey in 1999 (confirmed and updated in 2005) and sponsored by the UK Department of Trade & Industry Consumer Safety Group, concluded that:

“Fire performance testing and the analysis of fire statistics show that there are significant benefits to be gained from using flame retardants, particularly in higher fire risk consumer products. Such analysis suggests that the risk of death or injury from a fire involving consumer products, such as upholstered furniture, can be reduced by 30% to 90% or more” (DTI, 1999).

A report published in 2009 by the Netherlands Institute for Safety (and funded by the Austrian Ministry for Labour, Social Affairs and Consumer Protection) estimates that 710 deaths and 5770 injuries were prevented in the UK over a period of nine years because of the increased use of fire retardants in furniture and furnishings. The report also states that the number of fire deaths and injuries in the United States decreased by 40% from 1984 to 1997 following the introduction of legislation. Widespread use of fire alarms in homes along with reductions in smoking and use of chip pans will also play key roles in the reported reductions in fire injuries and fatalities.

Should we worry about BFRs?

Concerns have been raised by scientists and environmentalists about how certain BFRs might negatively affect human health and the environment. The concerns about the risks of BFRs to human health and the environment of BFRs need to be balanced against their benefits in terms of saving lives in fires.

Are BFRs toxic?

A 2014 review of scientific studies relating to human health consequences of exposure to BFRs has shown that exposure to high levels of certain BFRs can be harmful. In the long term, BFR exposure can result in thyroid disorders, reproductive health effects (e.g. reduced sperm count), neurobehavioral and developmental disorders (e.g. autism and attention deficit hyperactivity) (Kim *et al.*, 2014). The concerns that exposure to BFRs may affect neurological development were noted in the World Health Organisation’s report on the ‘State of the Science on Endocrine Disrupting Chemicals’. Scientists agree that more research is needed to understand the human health concerns related to exposure to flame retardant chemicals. Already, some BFRs have been confirmed as being very toxic to fish, water fleas and mussels (WHO, 2012).

Did you know?

Persistent Organic Pollutants (POPs) are chemicals that persist in the environment, accumulate in animals and humans, and have the potential to cause harm to human health and the environment. POPs can also travel long distances from their source. BFRs have been measured in polar bears, probably because of they are at the top of the food chain and have a diet of fish and seals (Muir *et al.*, 2006).

When materials containing BFRs burn, chemical combustion products are released, and some of these have toxic properties. However, in most fires, the highly hazardous combustion products are the poisonous gases carbon monoxide and hydrogen cyanide which are found in smoke and produced whether BFRs are present or not (Jones *et al.*, 1987). And of course, the fire itself also presents a significant hazard.

Are BFRs endocrine disrupting chemicals (EDCs)?

Endocrine disrupting chemicals are chemicals that can interfere with the body's hormone system and have the potential to cause harm (RSC Toxicology Group, 2022). The mechanism of the health impacts from BFR exposure appears to be altered hormone regulation, which will be most damaging during key developmental stages in infancy.

How do BFRs get into our bodies?

BFRs are persistent and some bioaccumulate i.e., they don't break down easily and may remain in the environment and the human body for long periods of time. Chemicals with these characteristics are known as Persistent Organic Pollutants (POPs).

BFRs may be released into the environment through emissions and waste from manufacturing sites and from the improper disposal of electronic and electrical equipment or furniture.

BFRs can get into soil, water and air and can then enter the food chain. The main route of exposure is via the diet. BFRs are mainly found in low amounts in foods of animal origin such as meat, fish, and milk.

The European Food Safety Authority (EFSA) reviewed the possible health effects that may result from food being contaminated with small amounts of BFRs in a series of six scientific publications published between 2010 and 2012. For the vast majority of BFRs examined, EFSA concluded at that time that it is unlikely that they were a cause for concern to health. Since then, new data has become available and EFSA are updating these opinions which are expected to be published soon. The 2021 update advised that current dietary exposure to hexabromocyclododecanes (HBCDDs) across European countries does not raise a health concern except for some breastfed infants with high milk consumption (EFSA, 2021).

What is being done about BFRs?

Due to the concerns associated with some BFRs over their persistence in the environment and tendency to bioaccumulate in the body, the EU and its Member States have taken measures to control the risks. This has been done by restricting the use and production of some BFRs.

Did you know?



BFRs are not always chemically bonded to the materials they are used in and can be emitted into indoor dust and air through use and volatilisation (Rauert and Harrad, 2015). BFRs are present in household dust, an additional source of exposure which is especially significant for young children.

In 2016 the UK government held a consultation on ‘Updating the Furniture and Furnishings (Fire) (Safety) Regulations 1988’ which resulted in the proposed development of a new approach to address different sources and chemical risks posed by fire (BEIS, 2019).

The use of certain BFRs, ‘PBDEs’ (polybrominated diphenyl ethers) and ‘PBBs’ (polybrominated biphenyls) in electrical and electronic equipment has been restricted by the EU directive on the “Restriction of certain hazardous substances in Electric and Electronic Equipment” (RoHS), which was introduced in 2003. The limit for these BFRs is <0.1% by weight and has been set to allow the safe recycling of plastics that contain trace amounts of the BRFs. A European Commission blanket ban on all halogenated flame retardants (included BFRs) in electronic displays came into force in March 2021 (EFSA, 2021).

Two other BFRs, hexabromocyclododecane (HBCDD) and bis(pentabromophenyl)ether (DecaBDE) have been put on the list of Substances of Very High Concern (SVHC) under the European REACH regulation (Registration, Evaluation, Authorisation and restriction of Chemicals). The use of these chemicals is likely to decrease dramatically over the next few years in the EU, though it takes longer for environmental levels to reflect decreasing usage due to the long shelf-life of products where they are used, and due to release into the environment at end-of-life processes such as recycling, uncontrolled burning or landfill.

As a result of the Stockholm Convention on POPs, the production of some of the most environmentally persistent and bioaccumulative BFRs has stopped in many countries, including all EU Member States.

What are the alternatives?

Other chemicals can be used instead of certain BFRs that are of concern, but substitutes are not always available for all their applications.

- The choice of flame retardant for any particular application depends on many factors such as:
- Its suitability for the material to be treated (e.g. technical requirements like impact resistance)
- The fire safety standards involved
- Cost
- The health and environmental impact of the final product
- Its short-, medium- or long-term stability to ensure the substance will remain ‘active’ in its ability to prevent fire during its shelf life.

From a technical, performance, and economical point of view, BFRs are often viewed by manufacturers to be the most favourable flame retardants for particular applications.

Alternatives to the restricted BFRs can include other brominated organic compounds which are also likely to have characteristics of persistence, bioaccumulation and toxicity, or other organophosphorus compounds (or organic compounds with both phosphorus and halogen substituents). However, these alternatives also give rise to serious health concerns.

Further Reading

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