Industry Perspective on Brominated Flame Retardants – an overview

Michael Spiegelstein PhD, Chairman Bromine and Science Environmental Forum (BSEF), 118 Avenue de Cortenbergh, 1000 Brussels, Belgium

1. Introduction

Regulatory decisions on chemicals should be based on sound science. The producers of brominated flame retardants (BFRs), and members of BSEF, are fully engaged in and support scientific risk evaluations of their products. An example of scientific risk evaluations is the EU risk assessment process, which provides the most comprehensive science-based view of the environmental and health profile of selected chemicals in the world today. A range of BFRs (PentaBDE, OctaBDE, DecaBDE, TBBPA, HBCD) have been prioritised based on production volume and environmental relevance and have been thoroughly assessed in the frame of that programme.

The BFR industry recognises that the general low toxicity of its products and the full compliance with existing legislation at the time, may have resulted in emissions to the environment during production and use phases. In addition, advances in analytical chemistry enable us to detect smaller and smaller trace levels of substances in the environment. A scientific risk assessment according to internationally agreed criteria is needed to determine whether or not these levels do or do not present a risk to man or the environment.

All studies which the BFR industry has initiated on its products for such risk assessments have been carried out by leading independent scientists in their respective fields and have been based on scientific protocols approved by the EU risk assessment authorities. We see these efforts as part of our commitment to our customer chain and to regulatory authorities.

In cases where a risk assessment identifies a potential risk, appropriate actions need to be taken. This applied for Penta-BDE and Octa-BDE, for which restrictions were placed in the EU in August 2004. These compounds were generally the most identified in the environment but the limitation in the EU together with a voluntary commitment from the BSEF companies to stop production of these substances at worldwide level, has already lead to decreased findings in the environment.

On the other hand, the EU risk assessment of Deca-BDE, finalised in May 2004, did not identify any significant risks to the environment or human health and therefore had not recommended any restrictions. The BFR industry nonetheless decided to establish VECAP (Voluntary Emissions Control Action Programme for commercial brominated flame retardants) due to findings of Deca-BDE at low but increasing levels in the environment near industrial sites, which could potentially lead to a risk sometime in the future because of Deca-BDE's long-standing stability and persistency (essential to maintaining its flame retardancy properties in the long-term).

2. The EU Risk Assessment process

In the EU risk assessments of existing chemicals are carried out under regulation 793/93/EEC. The evaluations are carried out according to detailed technical guidance documents. In principle, the assessment has 4 stages:

1. hazard identification
2. dose-response assessment

3. exposure assessment
4. risk characterisation

In a first step potential hazards of the substance are evaluated to determine sensitive endpoints and, if appropriate, a recommendation for Classification/Labelling (under directive 67/548/EEC) is made. In a second step it is determined at what dose adverse effects are likely to occur.
In parallel, an exposure assessment evaluates all potential exposure pathways during the whole life cycle of the substance (e.g., production, manufacturing, use, disposal) and calculates predicted exposure levels. In the final risk characterisation step, the determined no-effect levels are compared to the predicted exposure levels. The results are typically expressed by the ratio of predicted concentrations (PEC) and predicted no-effect concentrations (PNEC). If the potential exposure is higher than the no-effect-level, or the margin-of-safety is not high enough, a potential risk is concluded and the risk assessment process concludes that there is a need for risk reduction. A PEC/PNEC ratio of higher than 1 would for example indicate a potential risk. It should be noted that the assessment operates on a "worst-case basis", ie, it always uses the most conservative no-effect level and the highest reasonable exposure and requires conservative margins of safety.

3. Overview of EU risk assessments of the main commercial BFRs

3.1 Deca-BDE

An extensive EU environmental and human health risk assessment examined some 588 studies of Deca-BDE over a 10-year period[1]. It concluded in May 2004 that "there is at present no need to reduce the risks for consumers beyond those which are being applied already". In order to address some "uncertainties", industry is voluntarily carrying out 3 programs to provide a better scientific data: a) 10-year environmental monitoring study (also addressing potential degradation issues), b) 10-year biomonitoring programme in humans, c) Developmental Neurotoxicity (DNT) study.

In table 1 a summary of the PEC/PNEC ratios of the environmental risk assessment is presented. As mentioned above, a ratio of >1 would indicate a potential risk; the smaller the ratio, the higher the margin of safety.

Table 1: PEC/PNEC ratios taken from the DecaBDE environmental RAR

	Surface Water	Sediment	Sewage Treatment	Soil	Air	Earthworm	Fish	Marine Sediment
Polymer processing	na	$<2.4\ 10^{-3}$	$<5.3\ 10^{-5}$	$<4.9\ 10^{-4}$	na	$2.8\ 10^{-5}$	$4.4\ 10^{-8}$	$<4.8\ 10^{-3}$
Polymers – recycling of electronic equipment	na			$<1.3\ 10^{-4}$	na	$1.2\ 10^{-5}$	<1	
Textiles – formulation	na	$<8.4\ 10^{-3}$	$<6.4\ 10^{-4}$	$<4.6\ 10^{-3}$	na	$2.0\ 10^{-4}$	$9.2\ 10^{-8}$	<0.048
Textile – application of backcoating	na	$<8.4\ 10^{-3}$	$<6.4\ 10^{-4}$	$<4.6\ 10^{-3}$	na	$2.0\ 10^{-4}$	$9.2\ 10^{-8}$	<0.048

On the basis of the conclusions of the Deca-BDE EU Risk Assessment, the European Commission decided on 15 October 2005 to exempt Deca-BDE from the RoHS Directive[2]. When

[1] See European Chemicals Bureau website: http://ecb.jrc.it/esis/index.php?PGM=ora
[2] http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2005/l_271/l_27120051015en00480050.pdf

considering the exemption for Deca-BDE, the European Commission took into account the potential impact of Deca-BDE on the environment and human health, benefits to consumers, and the feasibility of replacing Deca-BDE with alternatives. The Commission recognized that whilst alternatives to Deca-BDE exist for some applications, unlike Deca-BDE, none of the potential alternatives have an equivalent amount of scientific data supporting their use, nor had any of them been subject to an extensive risk assessment.

3.2 TBBPA

TBBPA is a brominated flame retardant whose major use is in laminates for >95% of FR-4 printed wiring boards. Its long history of extensive use makes TBBPA regarded as the most reliable and acceptable flame retardant for printed wiring board laminates in use today. Since TBBPA is a starting material that is fully reacted into the crosslinked backbone of the epoxy resin matrix the final product, printed wiring boards, do not contain free TBBPA and that therefore consumer exposure to TBBPA from these applications is nonexistent.

TBBPA is currently under-going a full EU risk assessment[3] which is due to be completed early 2007. Already now, the human health part of this assessment has been completed in March 2005 and concluded that TBBPA does not present a risk to human health and that consumer exposure is negligible. On this basis, the EU authorities concluded last year that no risk reductions measures are needed as regards its human health risk assessment.

TBBPA's environment assessment is almost completed and is expected to be finalized early 2007. The draft conclusions indicate that emissions of TBBPA from reactive use (in printed circuit boards) do not pose a risk to the environment; when used as an additive in plastics TBBPA can cause risks in some scenarios (surface water, sediment and soil).

3.3 HBCD

HBCD is a flame retardant mainly used in expanded and extruded polystyrene (EPS & XPS) for thermal insulation foams in the building and construction sectors so as to meet with the required high fire safety standards in a large number of countries. HBCD is proven to be a highly effective, durable and insoluble flame retardant and it has no technically suitable alternative.

Currently the European Union is conducting a scientific risk assessment with its final conclusions expected in early 2007[4]. Initial conclusions indicate no risk to human health from HBCD; some potential risks to the environment have been identified. HBCD is also currently under discussion by the EU PBT working group, a sub-group of the EU risk assessment group.

4. Risk Management

4.1 Deca-BDE

Despite the fact that the risk evaluations did not identify a risk from DecaBDE, its manufacturers and user industries established a voluntary emissions reduction program (VECAP)[5]. It is a cost-effective environmental management system for users of Deca-BDE and is designed to reduce emissions of Deca-BDE to the environment. It allows industry to monitor emissions to the environment and report the results to relevant authorities[6]. The VECPA is discussed in more detail in a separate presentation.

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[3] See European Chemicals Bureau website: http://ecb.jrc.it/esis/index.php?PGM=ora
[4] See European Chemicals Bureau website: http://ecb.jrc.it/esis/index.php?PGM=ora
[5] For more information on VECAP: http://www.vecap.info
[6] For a copy of the first VECAP Annual Progress Report, click on:

4.2 TBBPA

We believe that most of the risks identified for additive application in the EU risk assessment are manageable through a Voluntary Emissions Control Action Programme (VECAP). The objective of the programme is to control emission levels of TBBPA during industrial usage. In this context, BSEF is developing a Code of Good Practice that will support TBBPA users all over Europe in their efforts to reduce emissions including advice on best ways to store, handle and use of TBBPA. To date, more than 2/3 in volumes of TBBPA additive customers in Europe have already committed to control and reduce their emissions.

Finally, several studies, included in TBBPA's EU risk assessment demonstrate that TBBPA is fully compatible with integrated waste management processes as mechanical and feedstock recycling and energy recovery methods. Because of its chemical structure, TBBPA has very low potential for formation of significant levels of dioxins and/or furans.

4.3 HBCD

As in the case of other brominated flame retardants, levels of HBCD found in the environment can be managed through proper voluntary action. VECAP covers textile applications of HBCD. For its EPS/XPS applications, a similar programme entitled "SECURE" has been developed.

This product stewardship programme will progressively be rolled out on a global basis. Indeed the industry is currently actively cooperating with the Japanese government authorities to make this program a reality in Japan in the future.

5. Brominated Flame Retardants – Perspectives for the Future

Scientific assessments should provide industry with the choice of materials to enable innovation and meet legitimate demands on environment, health and fire safety.

Science sometimes may not suffice to meet public expectations. For that reason voluntary partnerships throughout the whole manufacturing chain, such as the ones currently being set up in Europe for the main commercial BFRs through VECAP and SECURE, should be encouraged so as to provide the public with confidence on industry's actions and its commitment to the responsible production and use of chemicals.

The introduction of the REACH will undoubtedly result in the identification of many more essential chemicals which are persistent or have properties which make their release into the environment undesirable. The pioneering development by the brominated flame retardant industry of voluntary emission control and reduction schemes through the supply chain could provide a basis for the future risk management of chemicals.

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http://www.bsef.com/newsmanager/uploads/2006_vecap_annual_progress_report.pdf