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Item 5 (a) of the provisional agenda*

Technical work: intersessional work on hexabromocyclododecane

Intersessional work on hexabromocyclododecane

Note by the Secretariat

1. At its seventh meeting, the Persistent Organic Pollutants Review Committee adopted decision POPRC-7/1 on hexabromocyclododecane.[1] In paragraph 3 of that decision, the Committee invited the ad hoc working group on hexabromocyclododecane, which had prepared the risk management evaluation, to collect further information on:

(a) Chemical alternatives to hexabromocyclododecane, especially in expanded polystyrene or extruded polystyrene foam applications, in terms of their availability, cost, efficacy, efficiency and health and environmental impact, especially with regard to their persistent organic pollutant properties;

(b) Production and use of hexabromocyclododecane, especially for expanded polystyrene or extruded polystyrene foam applications.

2. Furthermore, in paragraph 4 of the same decision, the Committee agreed to review the additional information made available to it and to consider at its eighth meeting whether to specify the annex to the Convention and possible exemptions to be considered by the Conference of the Parties in listing hexabromocyclododecane.

3. The additional information was reviewed by the intersessional working group on hexabromocyclododecane, chaired by Mr. Peter Dawson (New Zealand), and is set out in the annex to the present note. It has not been formally edited.

Possible action by the Committee

4. The Committee may wish:

(a) To review the additional information on alternatives to hexabromocyclododecane made available to it in the annex to the present note and consider including it in an addendum to the risk management evaluation on hexabromocyclododecane that was adopted by the Committee at its seventh meeting (see UNEP/POPS/POPRC.7/19/Add.1);

(b) To consider whether to specify the annex to the Convention and possible exemptions to be considered by the Conference of the Parties in listing hexabromocyclododecane.

* UNEP/POPS/POPRC.8/1.

1 UNEP/POPS/POPRC.7/19, annex I.

Annex

Additional information on alternatives to hexabromocyclododecane and use in expanded polystyrene (EPS) and extruded polystyrene (XPS)

1. Introduction

1. In 2010, the sixth meeting of the Persistent Organic Pollutants Review Committee evaluated the risk profile for hexabromocyclododecane (HBCD) (UNEP/POPS/POPRC.6/13Add.2) and concluded that HBCD is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects, such that global action is warranted.

2. At its seventh meeting, the Persistent Organic Pollutants Review Committee adopted the risk management evaluation for hexabromocyclododecane (UNEP/POPS/POPRC.7/19/Add.1), and decided, in accordance with paragraph 9 of Article 8 of the Convention, to recommend to the Conference of the Parties that it consider listing hexabromocyclododecane in Annexes A, B and/or C to the Convention. The Committee invited the ad hoc working group on hexabromocyclododecane that prepared the risk management evaluation to collect further information in respect of hexabromocyclododecane and agreed to review the additional information and consider at its eighth meeting whether to specify the annex to the Convention and possible exemptions to be considered by the Conference of the Parties in listing hexabromocyclododecane.

3. In its decision POPRC-7/1 the Committee invited Parties and observers to submit to the Secretariat information on.

(a) Chemical alternatives to hexabromocyclododecane, especially in expanded polystyrene or extruded polystyrene foam applications, in terms of their availability, cost, efficacy, efficiency and health and environmental impact, especially with regard to their persistent organic pollutant properties;

(b) Production and use of hexabromocyclododecane especially for expanded polystyrene or extruded polystyrene foam applications;

2. Responses to call for information

4. Twenty-six Parties and country Observers submitted information (Argentina, Azerbaijan, Brazil, Bulgaria, Cambodia, Cameroon, Canada, China, Germany, Guatemala, Indonesia, Ireland, Israel, Italy, Kiribati, Latvia, Mali, Mexico, Monaco, Myanmar, the Netherlands, Norway, Poland, Romania, Thailand and United States of America). In addition, six non-governmental Observers submitted information (Great Lakes Solutions, Green Chemicals Srl, International POPs Elimination Network IPEN, PS Foam Industry, Extruded Polystyrene Foam Association, and jointly the industry associations EXIBA (a Cefic sector group) and EPS (PlasticsEurope), as well as former POPRC member Ian Rae. All submissions are available on the Convention web site.

2.1. Chemical alternatives to hexabromocyclododecane

5. Several chemical alternatives to HBCD for expanded polystyrene (EPS), extruded polystyrene (XPS), high impact polystyrene (HIPS) and textile applications were identified in the responses from Parties and Observers. These are presented in Tables 1 and Table 2 below. Information has been presented generally as received and separately checked to the extent possible. According to the POPRC guidance on alternatives, a "safer alternative" is an alternative that either reduces the potential for harm to human health or the environment or that has not been shown to meet the Annex D screening criteria for listing a chemical under the Convention as a persistent organic pollutant. The health and safety information available for some of the alternatives below is very limited.

6. The Polymeric FR is offered only for providing flame retardancy in PS foams, not for other HBCD uses.

7. The U.S. E.P.A. is assessing HBCD and its alternatives for use on XPS and EPS. Stakeholders are providing hazard and efficacy information for the report, which will be available at http://www.epa.gov/dfe/pubs/projects/hbcd/index.htm.

8. U.S.EPA is currently assessing alternatives to decaBDE and will issue a report on uses of this and alternatives. See: http://www.epa.gov/dfe/pubs/projects/decaBDE/index.htm.

Table 1. Chemical alternatives[1] to HBCD in EPS/XPS

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
Benzene, ethenyl-, polymer with 1,3-butadiene, brominated (brominated co-polymer of styrene and butadiene) Synonym: Polymeric FR CAS No: 1195978-93-8	Emerald 3000 FR122P	EPS via one-step process, likely also suitable in two-step process And XPS	Currently pilot scale quantities are being submitted to downstream users for testing. Plant scale production trials successfully run. Commercially available in 2012 from Great Lakes Solutions-Chemtura Corporation. ICL-Industrial Products recently announced they are aiming for commercial production by 2014 (10 000 MT). Albemarle (US) will have the chemical commercially available in 2014. Anticipated to be sufficient capacity to replace HBCD within 3-5 years. See also para 6.	No independent evaluation of properties is available. According to industry information: Potentially persistent (not biodegradable) but low potential for bioaccumulation and low potential for toxicity. Not classified for carcinogenicity due to lack of data. No data available on toxicity to fish. See also para 7.	Diverging information received (see para 17). Responses reported: According to a manufacturer, cost of manufacturing EPS products containing Emerald 3000 is not anticipated to have significant impact on cost competiveness with other products. Some Parties expect higher costs than HBCD. One Party suggests the costs of using the alternative are 90 % (EPS) to 120% (XPS) higher than when using HBCD. Separately to any cost differences between the FRs are the costs to re-certify flame retarded EPS resins/products for all of the foam applications. Canada has estimated this at a few million dollars.	Pilot tests conducted by customers of one of the manufacturers have reportedly confirmed that FR122P delivers the required level of fire safety to their products. Emerald 3000 is reported to have essentially equivalent flame retardant efficiency to HBCD when used at equivalent bromine content. XPS producers report efficacy is 83% of HBCD. Good thermal stability and compatibility with polystyrene. In higher temperature processing conditions Polymeric FR needs to be stabilized, similar to HBCD.

[1] For other alternatives, such as alternative materials and building techniques, see Risk Management Evaluation for HBCD (UNEP/POPS/POPRC.7/19/Add.1).

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
Benzene, 1,1'-(1-methylethylidene)bis[3,5-dibromo-4-(2,3-dibromo-2-methylpropoxy)] CAS No: 97416-84-7	Pyroguard SR-130 SR-130	EPS XPS	Not available in the USA	See para 7.		
Tetrabromobisphenol A bis (allyl ether) CAS No: 25327-89-3	BE 51, FG 3200, Fire Guard 3200, Flame Cut 122K, Pyroguard SR 319, SR 319	Two-step EPS process	Used in the two-step EPS process only	Substance is a derivative of TBBPA (ECB 2006). Little information is available on HSE properties. According to the information reviewed in KLIF (2009) it can be characterised with low toxicity, potential immunotoxin, not easily hydrolysed, may be resistant to environmental degradation (see KLIF 2009 for details).		
1,2,5,6-tetrabromocyclo-octane (TBCO) CAS No: 3194-57-8	Saytex BC-48 (Albemarle Corporation)	Two-step EPS process Additive FR	Used in the two-step process only This substance may no longer be commercially available. No information is available on production volumes in the US or in the EU. TBCO is also on the Canadian Non-Domestic Substances List with as much as 10 tons/year reported as being imported into Canada.	A report by the UK Environment Agency (Fisk et al. 2003) indicates that TBCO is hazardous to the aquatic environment (i.e. chronic NOEC < 0.1 mg/l or acute L(E)C50s < 10 mg/l), and potentially PBT/vPvB. Due to poor availability of HSE information further analysis could not be carried out.		

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
2,4,6-tribromophenyl allyl ether CAS No: 3278-89-5	Pyroguard FR 100, Great Lakes PHE-65, Bromkal 64-3AE	Two-step EPS process		Proposed as one of the 120 HPV chemicals structurally similar to known Arctic contaminants (Brown & Wania 2008). Likely bioaccumulative and subject to long range transport since the substance is found in Arctic seals in both blubber and brain (Von der Recke & Vetter 2007).		
Tetrabromobisphenol A bis(2,3-dibromopropyl ether) (TBBPA-DBPE), CAS No: 21850-44-2 with dicumene for XPS and dicumyl peroxide for EPS, as usual synergists	STARFLAME PS SAM 54: masterbatch for XPS STARFLAME PO SAM 55: masterbatch for XPS GC SAM 55 E: powder blend for EPS	EPS XPS	For EPS only laboratory scale experience, not yet in wide use. All raw materials, however, are worldwide commodities and thus GC SAM 55 E is reported to be immediately available for up-scaling on a commercial scale. For XPS the alternative is already in use in commercial scale.	According to the KLIF (2009) review, TBBPA-DBPE has low toxicity. No endocrine effects have been observed, but it has a high potential to inhibit estradiol sulfotransferase and have a moderate competition with the thyroxine for the binding to the plasma protein transthyretin. TBBPA-DBPE is poorly absorbed through the gastrointestinal tract in rats, but the absorbed quantities accumulate in liver and slowly metabolize. The available information does not allow assessing the environmental	According to the manufacturer, comparable to HBCD solution in EPS (costs around 6.5 €/kg). Slightly more expensive than HBCD in XPS.	Flame retardant properties, 20-30% less than HBCD. Reportedly good thermal stability, easily dispersible and compatible with polystyrene, insoluble in water and soluble in Toluene and Xylene.

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
				persistence (Washington State 2006). According to KLIF (2009) and the information from the manufacturer, TBBPA-DBPE has low biodegradability but appears to be susceptible to hydrolysis. Contradicting conclusions on bioaccumulation are reported in Washington State (2006) and KLIF (2009). According to the manufacturer bioaccumulation is not expected. The National Toxicology Program (NTP) believes that the substance might have a carcinogenic potential. Positive for mutagenic activity with and without metabolic activation in Salmonella typhimurium strains (NIEHS 2002). TBBPA-DBPE has also been found in house dust in Belgium and UK (Ali et al. 2011).		

Table 2. Alternatives to HBCD in HIPS and textiles

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
Ethylenebis (tetrabromophthalimide) (EBTPI) CAS No: 32588-76-4	BT93, BT93W, BT93WFG, Citex BT 93, Saytex BT93, Saytex BT93W	HIPS Additive FR	Commercially available and used extensively It is mostly used in HIPS, polyethylene, polypropylene, thermoplastic polyesters, polyamide, EPDM, rubbers, polycarbonate, ethylene co-polymers, ionomer resins, and textiles.	The available data is insufficient for a comprehensive environmental assessment of EBTPI. The few studies reported indicate that EBTPI is not readily biodegradable, does not bioaccumulate and has a low aquatic toxicity (Danish EPA 2007). Indications are that EBTPI is of low mammalian toxicity (KLIF 2009). The EU Technical Committee of New and Existing Chemicals Substances (TCNES) considered EBTPI very persistent. However, the bioaccumulation criterion was not met based on molecular properties of the substance and EBTPI was not listed as a vPvB substance. The only available study of the aquatic toxicity of EBTPI indicates that acute toxic effects occur at levels much higher than the estimated water solubility. Long-term NOEC values are not found in the literature. More ecotoxicology data are required for assessment of the toxicity (T) criterion. (Pakalin et al. 2007).		Technically feasible and used extensively
Decabromodiphenyl ether (DecaBDE) CAS No: 1163-19-5	SAYTEX 102E FR-1210 DE-83R	HIPS Textiles	Commercially available and used extensively. Many manufacturers have phased use out since the early 2000's	Decabromodiphenyl ether was considered toxic according to criteria 64 (a) under the *Canadian Environmental Protection Act, 1999*, along with other PBDEs in this class (tetra to decaBDEs). A State of Science Report for this substance found that this substance transforms to persistent and bioaccumulative substances (Environment Canada 2010). The POPRC has concluded that there is an increasing number of studies related to the potential of highly brominated congeners,		Technically feasible and used extensively

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
				including decabromodiphenyl ether, to be reductively debrominated in the environment and thus contribute to the formation of those brominated diphenyl ethers listed in Annex A (Decision POPRC-7/1). In the EU RAR (European Commission 2002) DecaBDE was not expected to degrade biologically, but was not considered bioaccumulative nor toxic. A later review (Pakalin et al. 2007) concluded as well that DecaBDE does not meet the toxicity (T) criterion. However, there is some indication that DecaBDE can cause behavioural disturbances in mice when they are exposed at a sensitive stage of brain development (possibly via a metabolite). This apparent toxicity makes the presence of DecaBDE in the eggs of top predators a serious finding that is relevant in any assessment of long-term risk. Pakalin et al (2007) also notes that the normal PEC/PNEC comparison methods described in the EU Technical Guidance Document do not apply to this situation. See also para 8.		
Decabromodiphenylethane (DBDPE) CAS No: 84852-53-9	SAYTEX 8010 Firemaster 2100 Planelon BDE S8010	HIPS Textiles Additive FR	Commercially available and used extensively. DBDPE was introduced in the mid-1980s and became commercially important as an alternative to DecaBDE formulations in the early 1990s. Europe does not	Available evidence indicates decabromodiphenylethane (DBDPE) is potentially persistent. It is not susceptible to abiotic degradation (e.g., hydrolysis) and is not readily biodegradable under aerobic conditions in the aquatic environment (viz: 2% according to OECD 301C). Persistence is linked to low water solubility (0.72 µg/L). (Environment	According to one Party, DBDPE is commonly used in HIPS and textiles, with better effect than HBCD and approximately equal price as HBCD, and	Technically feasible and used extensively

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
			produce DBDPE, but imports in 2001 were estimated to be between 1000 and 5000 tons, primarily to Germany. DBDPE is the second highest current use additive BFR in China with production increasing at 80% per year (http://www.polymer.cn/). It is produced by at least two Chinese companies: The production volume of DBDPE in China in 2006 was 12,000 tons (Xiao, 2006). In Japan, there has been a clear shift in consumption away from DecaBDE to DBDPE.	Agency 2007, Pakalin et al. 2007). DBDPE has a relatively low hazard potential to aquatic organisms due to its low water solubility. It is also of low toxicity to mammals (Environment Agency 2007). DBDPE alters gene expression in chicken embryos (Egloff et al. 2011), is acutely toxic to *Daphnia magna*, reduces the hatching rates of zebra-fish eggs, and significantly raises the mortality of hatched larvae (Nakari & Huhtala 2010). In the risk assessment made by the UK, conclusions on bioaccumulation were not possible in the absence of reliable data (Environment Agency 2007). Recent information shows that in fish DBDPE bioaccumulates one order of magnitude higher than DecaBDE which indicates it can significantly accumulate in fish (He et al. 2012). DBDPE is found in predator avian species such as falcons and their eggs (Guerra et al. 2012) and in piscivorous water birds (Luo et al. 2009). In a Lake Winnipeg food web DBDPE was found to biomagnify (Law et al. 2009). DBDPE is widely detected in environmental samples; sewage sludge, air, sediments, fish and birds, as well as in house and office dust (La Guardia et al. 2012). In a recent Nordic screening study (NCM 2011), DBDPE was found in 100% of air, 50% of sediment, 100% of sludge and 70% of biota samples. The concentrations were often comparable with BDE-47 and BDE-209 levels found.	basically replaced HBCD in 2011 in this application in China.	

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
				DBDPE has also been found in house dust in the US (Stapleton et al. 2008), Belgium, UK (Ali et al. 2011) and Sweden (Karlsson et al. 2007). The chemical is the main BFR in human hair in non-e-waste recycling areas in China. Significant correlations were found between hair levels and dust levels (Zheng et al. 2011) suggesting endogenous pathways to hair.		
Triphenyl phosphate CAS No: 115-86-6		HIPS	Commercially available and used extensively	According to a review published by the Danish EPA (2007), TPP is highly toxic to algae, invertebrates and fish with typical L(E)C50 values <1 mg/L. Two studies of the chronic toxicity in fish report NOEC values in the range 0.014-0.23 mg/L, however, the validity of the studies are questionable. BCF values >100 have been reported in several long-term studies with different species of fish, and TPP is considered to be potentially bioaccumulative. This is supported by the log Kow value for TPP (range 4.58-4.67). TPP is inherently biodegradable, and is furthermore found to biodegrade under both aerobic and anaerobic conditions in water/sediment and soil systems under various conditions. The log Kow and log Koc values indicate that the availability and the mobility of TPP in the environment is limited. No data was found with respect to acute or repeated human exposure. The only parameter affected in the Danish review in subacute and subchronic dietary studies in rats was retardation in weight gain (Danish EPA 2007). US EPA (2005) reports moderate systemic toxicity and high acute		Technically feasible and used extensively

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
				and chronic ecotoxicity of TPP as two characteristics of concern. The US Occupational Safety and Health Administration (OSHA) reports inhibition of cholinesterase as a health effect of triphenyl phosphate exposure (US OSHA 1999). Danish EPA (2007) concluded that triphenyl phosphate (TPP) does not meet the persistency and bioaccumulation criteria in the PBT assessment. Triphenyl phosphate is considered environmentally hazardous in Germany due to its toxicity to aquatic organisms (Leisewitz et al. 2000). In a recent study, triphenyl phosphate was associated with a substantial 19% decrease in sperm concentration in men (Meeker & Stapleton 2010).		
Bisphenol A bis (biphenyl phosphate) (BDP) CAS No: 5945-33-5	Fyrolflex BDP	HIPS Additive FR	Commercially available and used extensively	Bisphenol A bis (biphenyl phosphate) (BDP) is a phosphoric trichloride reaction product with bisphenol A and phenol. It may contain bisphenol A as an impurity. According to Washington State (2006) the results of the industry toxicity studies indicate low toxicity concern for humans, and low to medium toxicity concern for aquatic organisms. There are no animal cancer studies available for this chemical and no information on potential human exposures. The chemical does show a tendency to persist in the environment. Bioaccumulation could not be assessed.		Technically feasible and used extensively

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
				One of the BDP degradation products is bisphenol A (Washington State 2006), a substance declared by Canada to meet the criteria for persistence and toxicity concerns regarding permanent alterations in hormonal, developmental or reproductive capacity (Environment Canada 2008). Based on the potential of its degradation product bisphenol A for endocrine disruption, bisphenol A bis (biphenyl phosphate) was scored as high for the endocrine disrupting attribute in an EU assessment draft (JRC 2011). The same assessment found that BDP was highly persistent and moderately to highly bioaccumulative with BCF values ranging from 300 to 3000 and log Kow of 4.5 – 6.		
Diphenyl cresyl phosphate CAS No: 26444-49-5		HIPS	Commercially available and used extensively	Diphenyl cresyl phosphate is poorly characterized but appears to be toxic to aquatic organisms and not readily biodegradable (OECD SIDS). According to Washington State (2006) half-life in water is 4.86 years, BCF 980 and it has moderate aquatic toxicity, has developmental and reproductive toxicity but is not mutagenic and has low oral toxicity.		Technically feasible and used extensively

Chemical	Trade names	Claimed suitability	Availability	HSE properties	Costs	Efficacy
Chlorinated paraffins (C10-13) –CAS No: 85535-84-8		Textiles	Available and used extensively	Short-chain chlorinated paraffins (Alkanes, C10-13, chloro) with greater than 48% chlorination have been nominated for listing as a POP under the Stockholm Convention and are currently under review of the POPRC. Chlorinated paraffins (C10-13) assessed as short chain chlorinated paraffins (SCCPs) met the definition of toxic under criteria 64 (a) under the Canadian Environmental Protection Act, 1999 and the Persistence and Bioaccumulative criteria and was subject to Virtual Elimination. In Canada, these substances were included in the proposed Prohibition of Certain Toxic Substance Regulations in 2012 (http://www.ec.gc.ca/lcpe-cepa/eng/regulations/detailreg.cfm?intReg=87).	Used extensively	Technically feasible and used extensively
Ammonium polyphosphate – CAS RN 68333-79-9		Textiles	Available and used extensively	Little data is available on properties. There is no data on bioaccumulation. In Canada the chemical is categorized as Persistent and inherently Toxic.	Used extensively	Technically feasible and used extensively

2.2. Additional information on production and use of hexabromocyclododecane

9. Recently the availability of HBCD has been restricted due to problems in production of the HBCD precursor cyclododecatriene. The HBCD supply problems may increase the speed with which the industry using HBCD will take alternatives into use.

10. The following new production and import data was received:

(a) China reported producing 18 000 tonnes of HBCD in 2011, of which 5500-6000 tonnes was exported.

(b) Mexico reported import of 467 tonnes HBCD in 2011.

11. The following new information on use of HBCD was received:

(a) In North America all XPS produced currently contains HBCD. There are four producers. The concentrations currently used are between 0.7%-1.0%.

(b) According to the U.S.EPA Chemical Data Reporting (CDR) database of 2006, less than 1% of the total commercial and consumer use of HBCD was used for fabrics, textiles and apparel. http://www.epa.gov/iur

(c) Of the HBCD used in China, 9000 tonnes is used for EPS and 3000 tonnes for XPS.

(d) Poland reported use of 364 tonnes of HBCD in EPS and 90 tonnes in XPS in 2011.

(e) Mexico reported import of 467 tonnes HBCD in 2011.

3. Summary information relevant to the risk management evaluation

12. The estimated global production of HBCD in 2011 was 31 000 tonnes – slightly higher than estimated in the risk management evaluation (UNEP/POPS/POPRC.7/19/Add.1) due to a 20% increase in Chinese production in 2011.

Availability

13. Some chemical alternatives to HBCD have been developed, including a drop-in alternative for one-step EPS, and XPS production. The alternative will become commercially available gradually starting in 2012. In 2014 this brominated Polymeric flame retardant will be available from two companies in the US (Chemtura, Albemarle) and one in Israel (ICL-IP). Their combined production is expected to be sufficient to replace HBCD in 3-5 years.

14. Two other brominated flame retardants (Benzene, 1,1'-(1-methylethylidene)bis[3,5-dibromo-4-(2,3-dibromo-2-methylpropoxy)] CAS No: 97416-84-7 and Tetrabromobisphenol A bis(2,3-dibromopropyl ether) (TBBPA-DBPE), CAS No: 21850-44-2 with dicumene for XPS and dicumyl peroxide for EPS as usual synergists i.e. Starflame/GC SAM) appear to be suitable for replacing HBCD in the one-step EPS process. However, there is no information whether the first chemical is available and the latter has not yet been commercialized. The less common two-step production process for EPS is already using alternative flame retardants to HBCD. Suitability of the Polymeric FR for the 2-step EPS process is being tested.

15. The existing availability of chemical alternatives to HBCD in HIPS and textiles was reiterated in the responses. Alternative flame retardant materials and building techniques have been identified in the risk management evaluation for hexabromocyclododecane (UNEP/POPS/POPRC.7/19/Add.1).

Transition time

16. After any alternative becomes available in commercial quantities, it will take some time for the industry to seek qualification and re-certification of polystyrene bead and foam products for fire-rating. According to the industry information from Canada, a period of at least 5 years is needed to fully convert to an alternative. However, although the Polymeric FR is not yet available at a commercial scale, the downstream users have already been testing this alternative and the results reported have been positive.

Costs

17. Some Parties indicated in their responses higher costs of the Polymeric FR compared to HBCD. However, no financial values were included to support this. According to one producer of the Polymeric FR, manufacturing flame retarded products with the alternative to HBCD is not anticipated to have any significant impact on the cost competitiveness of EPS or XPS. It remains unclear whether the flame retardant represents a significant factor in the price of the final product (EPS/XPS insulation

board). More precise cost estimates will not be available until the Polymeric FR is fully commercialized.

18. There will be additional one-off costs to the industry from e.g. plant pilot trials and product qualification. However, these costs are irrespective of the alternative and have been considered, for instance in Canada, to be in the low millions of Canadian dollars.

Efficacy

19. Polymeric FR is reported to have essentially equivalent flame retardant efficiency to HBCD when used at equivalent bromine content. According to Great Lakes Solutions, 1.7% of Emerald 3000 (trade name) is required to pass the EN Class E flammability test. The required load is thus comparable to that of HBCD (0.5-2.5% HBCD w/w) in PS foams. Tetrabromobisphenol A bis(2,3-dibromopropyl ether) (TBBPA-DBPE), CAS No: 21850-44-2 with dicumene for XPS and dicumyl peroxide for EPS as usual synergists (i.e. Starflame/GC SAM) is reported to have 20-30% lower flame retardant properties compared to HBCD.

20. Decabromodiphenylethane and other alternatives appear to have largely replaced HBCD in HIPS and textiles, with higher efficacy and equal price to HBCD.

Health and environmental impact

21. The objective of promoting the use of alternatives under the Convention is to protect human health and the environment. Replacing persistent organic pollutants with other hazardous chemicals should therefore be avoided and safer alternatives should be pursued (UNEP/POPS/POPRC.5/10/Add.1).

22. According to the MSDS information and the industry hazard assessment, Polymeric FR is potentially persistent, but not bioaccumulative or toxic. However, there are no independent reviews about its properties yet. No HSE information is available for Benzene, 1,1'-(1-methylethylidene)bis[3,5-dibromo-4-(2,3-dibromo-2-methylpropoxy)] (CAS No: 97416-84-7). A third chemical alternative, based on TBBPA-DBPE (CAS No: 21850-44-2), has low toxicity and is unlikely to bioaccumulate. It may, however, have carcinogenic potential and its persistence has not been thoroughly studied. It has also been found in house dust.

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