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BASEL CONVENTION

Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Thirteenth meeting
Geneva, 24 April–5 May 2017
Item 4 (b) (i) of the provisional agenda*

Matters related to the implementation of the Convention: scientific and technical matters: technical guidelines

Compilation of comments received on the low persistent organic pollutant content values

Note by the Secretariat

As referred to in the note by the Secretariat on technical guidelines (UNEP/CHW.13/6), the annex to the present note sets out the compilation of comments received from Parties and others on the low persistent organic pollutant content values. Comments submitted by Japan, Norway, the European HBCD Industry Group and IPEN pursuant paragraph 7 of decision OEWG-10/4 are compiled in the annex to the present note. A further compilation of comments on the same matter prepared for the tenth meeting of the Open-ended Working Group of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal pursuant to paragraphs 9 of decision BC-12/3 is set out in document UNEP/CHW/OEWG.10/INF/23. The present note, including its annex, has not been formally edited.

* UNEP/CHW.13/1.

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Annex

Compilation of comments on low persistent organic pollutant contents

Country/Organization	General Comments
Japan	It is desirable to destruct or irreversibly transform POPs in wastes as thoroughly as possible since POPs have high toxicity, persistency, and bioaccumulation in human body and the environment. For this reason, the LPC values should be determined at the lowest level that can be implemented by the member states. In doing so, the actual data related to POPs wastes must be taken into account comprehensively, as clearly defined in the current POPs general technical guidelines under the Basel Convention, including the generation, destruction technologies and analytical capacity of such wastes. In Japan, considering the generation and conditions of POPs waste, appropriate measures have been taken for the POPs wastes that are confirmed to be waste products containing intentionally used POPs and wastes contaminated with unintentional POPs such as dioxins and PCBs.
Norway	Norway would like to respond to the invitation in decision OEWG 10-4 to share our views on the low POPS limits and share some views and experience from Norway. When establishing or revising low POPS limits Norway believe its important to highlight that Article 6 of the Stockholm convention states that waste containing POPS must be disposed of in such a way that the POP content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of POPs. Furthermore, that POP wastes is not permitted to be subject to disposal operations that may lead to recycling or alternative uses. POPs are some of the most toxic organic pollutants and therefore we believe it is important to get them out of circulation, and avoid recycling them into new products. Norway welcome the shift towards a green economy where materials are recycled and move in a closed loop, the so called Circular Economy. We believe that this economy should be non-toxic. The Circular economy requires more waste to be recycled. Recycling with the aim to replace new resources, as a more sustainable source than new resources, requires recycling with a focus on quality. One important aspect of quality is that hazardous substances are removed from the material cycle. In Norway waste containing pops-BDE, and deca-BDE at or above **0.25%** (2,500 mg/kg) must be handled as hazardous waste. This has led to investments in sorting technology at several treatment plants. Different technologies including sensor-based sorting and sink float separation are employed to allow automatic sorting of fractions. This reduce the need for analysis prior to sorting and allow the POPS-free plastics to be recycled while the POPS-containing plastics is incinerated with energy-recovery. In this way the POPS content is destroyed while most of the plastics can be recycled in a non-toxic manner. We need a high rate of recycling, but at the same time we also need to ensure that hazardous substances not become part of the resource cycle and be unintentionally spread to eg. childrens toys or food contact materials. We must aim for more and more resources to be recycled safely. This can be achieved through synergies between waste and chemicals regulations. This requires the chemicals and waste regulations to develop in parallel. The requirement of Stockholm is elimination of the POPs, and Basel should focus on how to operationalize this requirement. In our view this means that the levels for low POPS should be as low as possible, to ensure the elimination of POPS in waste.

Country/Organization	General Comments
European HBCD Industry	Submitted two documents, which are entitled: - European HBCD Industry Group and EUMEPS position on the appropriate low POP content limit for HBCD in Polystyrene Foam waste - HBCDD Hexabromocyclododecane in Polystyrene Foams Product Safety Assessment 2016 edition Both documents are reproduced hereafter.
International POPs Elimination Network (IPEN)	Submitted two documents, which are entitled: - HIGH LEVELS OF PCDD/F, PBDD/F AND PCB IN EGGS AROUND POLLUTION SOURCES DEMONSTRATES THE NEED TO REVIEW SOIL STANDARDS - Toxic Toy or Toxic Waste: Recycling POPS into New Products - Summary for Decision-Makers Both documents are reproduced hereafter.

European HBCD Industry Group and EUMEPS position on the appropriate low POP content limit for HBCD in Polystyrene Foam waste

European HBCD Industry Group and EUMEPS response to the Basel Convention request for comments on the concentration levels to define the low persistent organic pollutant content

Brussels, December 2016

1. Introduction and Summary

The European HBCD Industry Group and EUMEPS would like to respond to the invitation specified in Annex C on decision OEWG-10/4 and submit complementary comments and information on the low persistent organic pollutant (POP) content values for hexabromocyclododecane (HBCD) included in the General Technical Guidelines on the Environmentally Sound Management of Wastes consisting, containing or contaminated with POPs[1].

The European HBCD Industry Group and EUMEPS are of the opinion that for HBCD the most appropriate low POP content limit would be 1000 mg/kg. A low POP limit of 1000 mg/kg is practical, pragmatic and environmentally sound. It would ensure both the protection of human health and of the environment. It could be implemented by the stakeholders in the waste management sector and effectively enforced by the Parties.

- A low POP content of 1000 mg/kg for HBCD would capture all flame retarded polystyrene foam wastes from demolition[2], since such foams contain HBCD above 5000 mg/kg (EPS contains on average 5000-10000 mg/kg HBCD and XPS contains on average 8000-25000 mg/kg HBCD). A limit of 1000 mg/kg would therefore allow the destruction of HBCD incorporated in such flame retarded polystyrene foams.
- A low POP limit any lower than 1000 mg/kg would make the analysis of the substance in polystyrene foam waste unnecessarily challenging and costly. Specifying a POP limit level lower than 1000 mg/kg cannot be easily enforced, controlled and reported.
- A 1000 mg/kg limit would allow for the recycling of polystyrene foams which are not expected to contain HBCD. Packaging polystyrene foams typically do not contain HBCD, as flame retarded properties are generally not required in these applications. Levels of HBCD in such waste streams, due to possible contamination, are expected to be far less than 1000 mg/kg. Combined with the cost of analysis, a low POP limit of 1000 mg/kg will therefore contribute in maintaining the economic viability of recycling of polystyrene foams.
- HBCD, being firmly incorporated in the stable polystyrene matrix, is not readily released from PS foam waste and hence the impact on the environment and human health is negligible[3,4].

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[1] UNEP/CHW.12/5/Add.2/Rev.1. Available at: http://www.basel.int/Implementation/POPsWastes/TechnicalGuidelines/tabid/5052/Default.aspx

[2] For Parties that have registered to make use of the exemption, the same would apply for HBCD-containing waste from construction

[3] ECHA 'Data on Manufacture, Import, Export, Uses and Release of HBCDD as well as information on potential alternatives to its use'. 2009 https://echa.europa.eu/documents/10162/13640/tech_rep_hbcdd_en.pdf

- A 1000 mg/kg limit ensures alignment with the limit values deemed safe in national or international regulations, such as the EU POP Regulation[5] which specifies a low POP limit of 1000 mg/kg for HBCD and the EU REACH Authorisation that also defines a level of 0.1% w/w for articles containing substances of very high concern (SVHC) listed as Annex XIV substances (including HBCD).

This document lists a number of arguments in support of a 1000 mg/kg low POP limit for HBCD, based on the key considerations included in the 'Supporting document for the development of section III of the General Technical Guidelines'[6].

2. Analytical methods for HBCD in Polystyrene Foam waste

In the absence of an agreed standard methodology to accurately assess and measure HBCD levels in PS foams, the European industry has been engaged in developing and validating a robust, cost-effective and accessible analytical methodology, which allows operators to identify HBCD with confidence and accuracy to a level of 1000 mg/kg. Work has been completed to provide for such a method and related information has been made available on the website of the Basel Convention[7]. The methodology has been forwarded for international standardisation[8].

Having to measure and quantify HBCD at a level of 100 mg/kg would require much more sophisticated and hence less accessible and affordable analytical technology. At these low levels accuracy will become much more critical, because standard deviations have a greater impact at such levels. Therefore, specifying a low POP limit level of 100 mg/kg cannot be easily enforced, controlled and reported.

3. Environmental impact of Polystyrene Foam waste

HBCD, being firmly incorporated in the stable polystyrene matrix, is not readily released from PS foam waste (containing HBCD) to the environment, be it to air, water or soil, and hence the environmental impact is minimal[9]. Therefore, the dismantling, transport or disposal of the waste foams is not expected to have relevant negative impacts for the environment. The industry's 7-year environmental monitoring programme provides further evidence for a trend of decreasing levels of HBCD found in the environment in support of the minimal environmental impact of PS foams containing HBCD[10].

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[4] PlasticsEurope, Exiba, EFRA, CEFIC: 'HBCDD Hexabromocyclododecane in Polystyrene Foams Product Safety Assessment' 2016 (submitted to UNEP Secretariat together with this paper)

[5] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:JOL_2016_055_R_0003&from=EN

[6] UNEP/CHW/OEWG.9/INF/9/add.1. Available at: http://www.basel.int/TheConvention/OpenendedWorkingGroup(OEWG)/Meetings/OEWG9/MeetingDocuments/tabid/3684/Default.aspx

[7] http://www.basel.int/Implementation/POPsWastes/TechnicalGuidelines/tabid/5052/Default.aspx

[8] Standard EN 62321-9 being developed under IEC TC111 WG 3

[9] ECHA (ibid); and PlasticsEurope, Exiba, EFRA, CEFIC (ibid)

[10] H. Rüdel et al Rüdel, J. Müller, M. Quack, R. Klein, 2012: *Monitoring of hexabromocyclododecane diastereomers in fish from European freshwaters and estuaries*. Environ. Sci. Pollut. Res. 19, 772-783; and Rüdel H, Nowak J, Müller J, Ricking M, Quack M, Klein R: 'HBCD diastereomer levels in fish and suspended particulate matter from European freshwater and estuary sites - environmental quality standard compliance and trend monitoring', presentation at SETAC 2014 (A final publication summarising all the data from the environmental monitoring programme is expected to be published soon)

Hence, a POP limit of 1000 mg/kg provides for the necessary margin of safety and can be regarded as appropriate for meeting environmental concerns. A low POP limit value of 1000 mg/kg will suffice to maintain the downward trend of HBCD in the environment, given that following the listing of HBCD under the Stockholm Convention, the use of HBCD in products is being discontinued worldwide.

4. Potential health considerations from handling Polystyrene Foam waste

As concluded in the 2008 EU risk assessment[11] PS foam waste containing HBCD can be handled without any particular risk to workers and to consumers.

When taking a building down it is advisable to identify the categories of foams beforehand, to remove the foams intact and to collect the foams for further handling according to best practice. This prevents the dispersion of foam particles from EPS or XPS containing HBCD.

5. End of Life scenarios for Polystyrene Foam waste

The options for the end of life management of PS foams very much follow the generic hierarchy applied for (plastic) waste materials: prevention, preparing for re-use, recycling and other recovery. Landfill is considered the least sustainable option for PS Foam waste.

For PS foams containing HBCD, Advanced Solid Waste Incineration (ASWI) represents one of the disposal methods of choice for the elimination of HBCD, as acknowledged in the General Technical Guidelines adopted in May 2015[12] and supported by the EU[13]. To this end, European industry carried out an extensive investigation in a state of the art ASWI which shows a destruction efficiency for HBCD of 99.999%[14].

A low POP limit of 1000 mg/kg will be adequate to capture all HBCD-containing PS foams from demolition waste, since such foams have POP levels in excess of 5000 mg/kg, and will ensure their destruction applying a recognised destruction technique.

6. Economic considerations

A low POP level of 1000 mg/kg represents a solid basis to ensure that all PS foam waste from demolition containing HBCD are channelled to destruction, providing for a sound and responsible end of life management of the HBCD-containing PS foam waste.

On the other hand, the low POP content limit ought to be such that it allows for the recovery and recycling of PS foams which do not contain HBCD. Even though investigations have shown that waste fractions of EPS packaging can contain HBCD, levels of contamination are comparatively low.

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[11] ECHA 'Risk Assessment: Hexabromocyclododecane. Final Report'. May 2008, Conclusion 5.2.3

[12] http://www.basel.int/Implementation/POPsWastes/TechnicalGuidelines/tabid/5052/Default.aspx

[13] Letter by the European Commission to Mr Edmar Meuwissen, Secretary General of EUMEPS of 10 July 2014, states that: *"Incineration in an incinerator complying with BAT (with energy recovery) shall be the main disposal option as the results of studies show that a high destruction efficiency can be achieved and the flue gas emissions would comply with EU legislation"*.

[14] Mark, F.E. et al, 2015. "Destruction of the flame retardant hexabromocyclododecane in a full-scale municipal solid waste incinerator", *Waste Management & Research*, vol. 33 No. 2, pp. 165–174; and Vehlow, Jurgen 'End-of-Life Treatment of HBCD-containing polystyrene insulation foams: Technical Summary Report' PlasticsEurope, 2015

Considering the cost and the logistics of analysis, a low POP limit of 1000 mg/kg should allow for a cost-effective recycling of PS foams which are not meant to contain HBCD. A level lower than 1000 mg/kg is likely to bring such recycling operations economically off balance. Additional costs will result from an increase of the amounts of PS foams that would have to be incinerated, including also valuable foams that do not contain any HBCD. Therefore, lower levels than 1000 mg/kg might hinder the achievement of recycling targets and the transition to a circular economy.

7. Conclusion

A low POP level of 1000 mg/kg is practical, pragmatic, environmentally sound and enforceable. It achieves the destruction of demolition waste foams that contain HBCD (since such foams contain HBCD above 5000 mg/kg) while it supports the economic viability of recycling polystyrene foam wastes that do not contain HBCD.

Any limit lower than 1000 mg/kg will pose significant and possibly disruptive challenges for the polystyrene value chain and would create a negative precedent for the whole plastics recycling industry. Such impacts should be carefully considered.

Yours sincerely,

Dr Smadar Admon

Chair of the European HBCD Industry Group

Edmar Meuwissen

Secretary General of EUMEPS

The European HBCD Industry Group gathers HBCD producers and users in the polystyrene insulation foam sector, the major application of HBCD. The HBCD producers are represented by EFRA (the European Flame Retardants Association) and the HBCD users in the polystyrene insulation industry are members of PlasticsEurope (for expandable polystyrene) and Exiba (for extruded polystyrene).

The European Manufacturers of Expanded Polystyrene (EUMEPS) is an association which supports and promotes the European EPS industry through National Associations. It is divided into two interest groups, reflecting the main applications for Expanded PolyStyrene (EPS): Packaging and Building & Construction. Membership of EUMEPS is open to the National Associations, raw material producers and multinational converters of EPS.

HBCDD
Hexabromocyclododecane
in Polystyrene Foams
Product Safety Assessment

2016 edition

1. Introduction

Polystyrene foam is used in a wide range of insulation applications, in the residential, commercial, institutional and industrial building sectors as well as for civil engineering. From roof to floors to walls, from cavity fill to perimeter insulation and anti-frost layers, polystyrene foam provides versatile insulation solutions, adapted to every situation. The largest application is thermal insulation to prevent heat transfer. Buildings last longer and have less maintenance because of the durability and moisture resistance of PS foam. Due to its insulation performance, light weight, rigidity and flexible shape design, PS foam reduces space requirements for walls and roofs, and hence maximizes internal volume. This is especially important when existing buildings are being renovated to meet improved insulation standards. Polystyrene foams contain small amounts of hexabromocyclododecane – HBCDD.

HBCDD has been listed in Annex A of the Stockholm Convention and its use is forbidden with exemptions for Polystyrene (PS) foams in certain applications. National implementations follow suit such as for the EU where the POP Regulation sets the boundaries for any future use of HBCDD.

The aim of this document is to provide a general basis for the safety assessment of polystyrene foam products and to demonstrate it for the overall exposure scenario of insulation foam. The document provides background information demonstrating that polystyrene foams containing HBCDD, when properly handled in-use and disposed of, do not represent a risk neither to man nor to the environment. Worse case exposure scenarios have been investigated for the purpose of this report. Together with toxicity testing to aquatic organisms, proof could be delivered that in the exposure scenarios described neither adverse effect nor exposure and hence no risk to man and to the environment have to be expected. The investigations have further shown that the flame retardant HBCDD is retained in the polystyrene foam matrix, thus preventing migration and exposure via surface contact. The scenarios chosen reflect primarily the use-phase but can be read-across to the end of life situation

2. Exposure assessment

During service life, the foams might be exposed to **air, water and soil**. Therefore, the potential release of HBCDD during service life of Expanded PolyStyrene-EPS and Extruded PolyStyrene-XPS used in applications representing worst case scenarios has been assessed.

The following relevant applications have been considered:

- ***Exposure to air and light:*** External walls
- ***Exposure to (rain) water.*** Inverted roof, cellar, perimeter, railways and under roads
- ***Exposure to soil:*** Cellar, railways and under road

a) Exposure to light (degradation) - External walls

In typical applications like external walls and facades EPS or XPS foam is not exposed to light since the foam is covered with a facing or layer so that light is not able to access. In Europe the foam is used quickly meaning that it is normally not stored for long periods of time outside before construction, which limits access to light. Experience from long-term results (up to 32 years service life) indicates that the foam is durable during service life when the foam is covered according to the technical rules.

To further illustrate the case, measurements of bromine content have been made in uncovered XPS foam specimens for a period of approximately 19 years. The specimens were cubes of approximately 8 cm^3 volume with a HBCDD content in the range of 0.3% to 5.8 weight-%. The cubes were stored in natural light and under standard laboratory conditions with respect to temperature and humidity. Total bromine content was measured in 1987/8 using the neutron activation method and in 2007 using X-ray fluorescence. According to these measurements it could be concluded that levels of HBCDD remained stable in all the cubes for a period extending over approximately 19 years.
To be noted that solely in the case of agricultural building the foam being exposed on the walls there is however only limited access to light.

b) Exposure to water - Inverted roof.

The Inverted roof (upside-down roof) is considered to be the worst-case application scenario for potential emissions of HBCDD to water. This is because there is direct contact with water in the form of rain, and the water run-off may lead to exposure to the environment via drains and directly to the soil compartment.

An examination of an XPS foam board from an inverted roof (25 years of service life) has been made by measurements of the bromine level in samples taken in different points across the board. Total bromine content was measured and compared to the original levels detected immediately after the production of the foam. The original concentration of HBCDD in 1982 was 0.61%. In 2007, concentrations across the foam were between 0.59% and 0.62%, with an average of 0.61%. The standard deviation for the total 12 analyses was 0.01%. This study shows that the HBCDD was equally distributed in the foam and the levels remained at a similar level (within the experimental error of 0.01%) compared to the initial levels.

c) Emissions to air - Emission test chamber experiment

The emission test chamber experiment can, similarly to the inverted roof case, be considered to be the worst-case scenario for potential emissions of HBCDD to, in this case, the (indoor) air compartment. This is because of the relatively small volume of the test chamber and the high air exchange rate.

Polystyrene boards with an emitting surface of 0.931 m^2 were incubated in an emission test chamber with a volume of 200 L and an air exchange rate of 0.4 m^3 / h for 90 days at room temperature. The air was directed through a glass wool adsorber for 42 and 48 days, respectively (total duration 90 days) and the latter extracted with dichloromethane. For both collection periods no HBCDD could be found in the dichloromethane extract (limit of quantification 20 ng/m^3).

d) Emission modeling

In 2012 an emission modeling investigation on the simulation of specific air emissions of HBCDD from EPS/ XPS foams was undertaken. Applying a generally recognized diffusion model cumulative emissions to the air compartment during the long-term use of HBCDD containing PS insulation board could be made.
Based on an assumed diffusion behavior of HBCDD in polystyrene for an EPS/ XPS insulating panel with an estimated service time of 100 years a cumulated total emission of 175 µg /m^2 HBCDD after 100 years at 23^{0}C would result, if no boundary resistance at the surface exists i.e. HBCDD evaporates readily to air. In other words, due to the very low diffusion rate of HBCDD in polystyrene it would take approximately 100 years to deplete 0.1

µm of the polystyrene skin layer of the EPS/XPS insulating panel. Should a slower evaporation rate compared to the diffusion rate apply as boundary resistance at the foam/ air interface the HBCDD emission would be even lower. The investigation provides further proof that HBCDD releases by means of air emissions from PS foams are practically inexistent due to extremely slow evaporation rate with the foam/air interface acting very much as the rate determining step.

3. Hazard/ toxicity assessment

The assessment of possible releases of HBCDD during service life of EPS and XPS foams under worst case conditions could be validated in a series of biotests conducted for the evaluation of the environmental waste classification of EPS and XPS foam boards containing HBCDD as flame retardant.

a) The Water Accommodated Fractions (WAFs) of extruded and expanded polystyrene materials (XPS and EPS), containing up to ca. 2 weight-% HBCDD as flame retardant, were experimentally tested for possible acute aquatic toxicity. As test organisms the green alga *Desmodesmus subspicatus* (Method C.3 Commission Directive 92/69/EEC (SafePharm Laboratories, Project number: 2631/0002 and2631/0004, unpublished studies, 2008) and *Daphnia magna* (Method C.2 Commission Directive 92/69/EEC (SafePharm Laboratories, Project number: 2631/0001 and 2631/0003, unpublished studies, 2008) were used.
The test organisms, conditions and procedure were based on UK Environmental Agency Technical Guidance Document WM2 (Hazardous Waste; Interpretation of the Definition and Classification of Hazardous Waste – Appendix C: C14-H14 Ecotoxicity) amended 2006. This allows for testing to prove whether a hazardous property is present or not.

b) Corresponding to this procedure a Water Accommodated Fraction (WAF) was generated by stirring samples of the test materials (foam cubes of XPS and EPS) for 48 hours in the test medium at 20 °C corresponding to an initial loading rate of 100 mg/l. The test organisms were then exposed to the aqueous eluent of the test material without further dilution (limit test).
After 48 and 72 hours exposure, no adverse effects on Daphnia mobility/mortality and algae growth, respectively, were observed at a loading rate of 100 mg/l for both XPS and EPS foam tested. No corresponding chemical analysis was performed.

c) The results confirm the findings of previous studies. In one of these studies flame retarded EPS, in the form of beads, was tested at a loading rate of 100 mg/l for acute toxicity towards daphnids and freshwater algae, using an even longer period of elution. Also in those studies no lethality in daphnids or growth inhibition in algae was observed. In another series of tests with 20 hours WAFs of XPS and EPS foams with up to 2 weight-% HBCDD no adverse effects on the growth of the marine alga *Skeletonema costatum* was observed.

4. End-of-life

At the end-of-life stage it is equally critical that HBCDD will not become released to the environment, be it to air, water and soil. Since the exact composition of polystyrene foams obtained from building demolition is usually unknown and, as some of these foams (XPS) may contain (H)CFCs (used in past production processes as blowing agent), it is highly recommended that the foam should not be compacted, but transported to the nearest suitable municipal solid waste incinerator. By the same token, the HBCDD incorporated and retained in the PS Foam matrix remains unexposed to the environment, whilst being safely destroyed through incineration with energy recovery in state of art municipal solid waste

PlasticsEurope Association of Plastics Manufacturers   exiba   EFRA   cefic sector group

incinerators. It follows that during the deconstruction steps care should be taken to minimise foam breakage and to divert PS foams to outlets that limit the release of fine particles and of dust. Landfilling does not represent a viable option anymore, since POP and other EU waste legislation demand the destruction of HBCDD at the end of its service life in PS foams.
To be noted that the exposure assessments carried out on the service life scenarios do equally apply for end of life scenarios including (existing) landfilling. No specific investigations have been carried out to that effect.

Municipal solid waste co-incineration

In support of the end of life scenario industry has carried out a controlled one-week co-incineration investigation that was conducted by a broad consortium of stakeholders to evaluate the effects of polystyrene foams containing HBCDD on the performance of the large-scale energy recovery incinerator in Würzburg, Germany (MHKW) in 2013. Besides plant operations where the stable performance of the incinerator throughout the trial was noted, with no impact on energy balance and boiler efficiency, the results of the co-incineration investigation at the MHKW facility in Würzburg:

- Have demonstrated that HBCDD is very efficiently destroyed in normal state of art MSWI operations with a confirmed destruction efficiency of 99,999%, confirming, beyond earlier laboratory investigations, the excellent destruction performance in an advanced commercial scale incinerator[1].
- Have shown that the regulated dioxins/furans are well below the limit values set for these compounds.
- Have confirmed that HBCDD-containing PS foam waste can be treated alongside other municipal solid waste at standard state of art MSW incineration conditions; hence no special high temperature hazardous waste incineration is required.
- Have demonstrated the successful addition of up to 2 weight- % of PS foam with HBCDD concentrations typical for the insulation materials EPS and XPS, to the normal municipal waste stream.

The use of a modern large-scale incinerator for municipal solid waste, such as the plant in Würzburg, Germany, has been shown to be suitable for the safe and effective treatment of HBCDD containing PS foam obtained from the Building and Construction market (B&C). Advanced Solid waste Incineration (ASWI) represents one of the disposal methods of choice for the elimination of HBCDD, as acknowledged in the General Technical Guidelines adopted in May 2015[2].

5. Best practice considerations

When taking a building down it is advisable to identify the categories of foams beforehand, to remove the foams undestroyed, to prepare the foams for recovery and to organise the end-of-life options according to best practice. In this context foams should neither be destroyed i.e. broken nor reduced/crushed into small pieces or compacted. This to avoid the release of potential (H)CFCs in the case of XPS and any dispersion of foam particles/ dust containing HBCDD. Recovery and recycling of PS foams from building deconstruction is complicated by

[1] Mark, F.E. et al, 2015. "Destruction of the flame retardant hexabromocyclododecane in a full-scale municipal solid waste incinerator", *Waste Management & Research,* vol. 33 No. 2, pp. 165–174;
and Vehlow, Jurgen 'End-of-Life Treatment of HBCD-containing polystyrene insulation foams: Technical Summary Report' PlasticsEurope, 2015

[2] http://www.basel.int/Implementation/POPsWastes/TechnicalGuidelines/tabid/5052/Default.aspx

the fact that these may be contaminated with concrete and other materials, and that related processing will require (dust) emission control in state of art installations. Therefore, since during deconstruction it is often not possible to separate the different categories of foams, incineration with MSW offers today the only possibility to soundly manage on a large scale the waste streams that arise from building demolition. As far as incineration with MSW is concerned, the mixing of foams does not matter. Most insulants, whether foams or fibres, will eventually be excluded from landfill, principally because of organic content and/ or stability requirements of the landfill sites.

6. Conclusion

On the basis of the available data and the application of conservative assumptions, for the scenario of insulation of a polystyrene foam, no adverse health effects and environmental impacts are anticipated as a result of the use and disposal of HBCDD containing PS foams, since it could be demonstrated in a number of independent studies that HBCDD is immobilized within a stable PS matrix and as such is not released into the environment. Equally once the PS foam has reached its end of life stadium, the boards containing HBCDD do not need to be classified as hazardous waste (unless specific national rulings concerning POP substances per se are being applied) and can be safely destroyed in MSW incinerators without incremental emission burdens to the environment.

The information, analysis, methods and recommendations herein are presented in good faith, are believed to be accurate and reliable, but may well be incomplete and/or not applicable to all conditions or situations that may be encountered.

No representation, guarantee or warranty is made as to the accuracy, reliability or completeness of this report, or that the application or use of any of the information, analysis, methods and recommendations herein will avoid, reduce or ameliorate hazards, accidents, losses, damages or injury of any kind to persons or property.

HIGH LEVELS OF PCDD/F, PBDD/F AND PCB IN EGGS AROUND POLLUTION SOURCES DEMONSTRATES THE NEED TO REVIEW SOIL STANDARDS

Weber R[1]*, Watson A[2,3], Petrlik J[2,4], Winski A[5], Schwedler O[6], Baitinger C[6], Behnisch P[7]

[1]POPs Environmental Consulting, D-73527 Schwäbisch Gmünd, Germany; [2]International POPs Elimination Network (IPEN), Göteborg, Sweden: [3]Public Interest Consultants, Uplands Court, Eaton Crescent, Uplands, Swansea, Wales, UK SA1 4QR; [4]Arnika, Chlumova 17, Prague, Czech Republic; [5]BI Sauberes Grundwasser, Siedlung 7, D-79331 Teningen, Germany, [6]Bund für Umwelt und Naturschutz (BUND) Nordrhein-Westfalen, Germany; [7]BioDetection Systems BV (BDS), Science Park 406, 1098 XH Amsterdam, The Netherlands.

Introduction

There have been an increasing number of reports on contamination of eggs with PCDD/Fs and particularly dl-PCBs in recent years[3-7]. Eggs have been found to be sensitive indicators of PCDD/F and PCB contamination in soils and are an important exposure pathway from soil pollution to humans and eggs from contaminated areas can readily lead to exposures which exceed thresholds for the protection of human health [1-4]. Chickens and eggs might therefore be ideal "active samplers" and indicator species for contaminated soils but there are, as yet, few systematic studies linking pollution sources, related soil exposures and concentrations of contaminants in eggs.
In this study, therefore, eggs were sampled at sites suspected of being impacted by PCDD/Fs or PCBs in Germany and in China and the relationship between the sources and contamination levels has been examined. Furthermore it has recently been established in a UK food survey that polybrominated dibenzo-p-dioxin and dibenzofurans can also contribute significantly to total dioxin exposure for the UK population[8]. This is possibly linked to the UK having set exacting flammability standards for furniture and thus having been a major user of brominated flame retardants including PBDEs. China is currently the largest producer of brominated flame retardants and is a major importer of BFR treated plastic for recycling. Therefore PBDD/Fs were measured in the eggs from China in addition to PCDD/Fs and dl-PCBs.

Materials and methods

Eggs were sampled at two potential hot spots in Germany. The first site was close to a condenser factory and the second close to a hazardous landfill site. For both sites two individual chicken flocks were sampled.
The two sites from which eggs were sampled in China were both from flocks from close to one municipal waste incinerator. Reference samples of eggs were also analysed after being purchased from a Chinese supermarket.
The egg samples were pooled in each case. For each of the German sites 10 to 20 eggs were pooled and for each flock in China 3 or 4 eggs were pooled for analysis.
Bioassay. All samples were analyzed at Bio Detection System for dioxin-like activity according to the standard procedures of the DR CALUX® method from BDS[10]. The procedure for the BDS DR CALUX bioassay has previously been described in detail[9] but, briefly, H4IIE cells stably transfected with an AhR-controlled luciferase reporter gene construct, were cultured in α-MEM culture medium supplemented with 10% (v/v) FCS under standard conditions (37°C, 5% CO_2, 100% humidity). Cells were exposed in triplicate on 96-well microtiterplates containing the standard 2,3,7,8-TCDD calibration range, a DMSO blank Following a 24 hour incubation period, cells were lysed. A luciferine containing solution (Glow Mix) was added and the luminescence was measured using a luminometer (Berthold Centro XS3).
Instrumental analysis. All samples were analysed by gas chromatography high resolution mass spectrometry (HRGC/HRMS) in ISO 17025 accredited laboratories with a resolution >10,000 using ^{13}C isotope labelled standards. PCDD/F and dl-PCB analysis followed the European Union's methods of analysis for the control of levels of PCDD/Fs and dl-PCBs for levels in certain foodstuffs in Commission Regulation (EC) No 252/2012[9]. Selected samples from China were also analysed for PBDD/F using ^{13}C isotope labelled standards.

Results and discussion

Levels of PCB in chicken eggs around a former capacitor factory (Germany)

Hens eggs were sampled from two private chicken farmers (A and B) close to a factory in Teningen, a small town in South-West Germany which was used for the production of capacitors from 1932 on including PCB containing capacitors for some time. The groundwater below the former production site and the associated dumping area is contaminated with PCBs and a PCB plume contaminates the ground water of the nearby town[11].

Bioassay screening for dioxin-like toxicity was conducted for eggs from the two flocks/sites with DR CALUX. The BEQs from the bio-assays were 18 pg BEQ/g fat at both sites. PCBs were the main contributor to the BEQ for both samples and the levels considerably higher than the regulatory limit of 5 pg TEQ/kg fat for the sum of PCDD/F and dl-PCB. For confirmation the eggs were also analysed by instrumental analysis (HRGC/HRMS). The same egg samples from chicken holder A were highly contaminated (36.4 pg TEQ/kg fat) mainly from dl-PCB (25 pg TEQ/g fat). The levels in eggs from chicken farmer B were nearly as highly contaminated with 31.9 pg TEQ/kg fat. Again this was mainly due to dl-PCB (25.5 pg TEQ/g fat).
The competent authority tested the soils in the area for PCDD/F and PCB and found 2.3 ng PCB-TEQ (0-5 cm) and 3.3 ng/kg (5-10 cm) at farm A and 4.4 ng/kg PCB-TEQ (0-5 cm) and 3.8 ng/kg (5-10 cm) at farm B - significantly above German background levels of approx. 0.5 ng PCB-TEQ/kg. The upper levels of the soil contamination would be sufficient to explain the PCB-contamination in the chicken eggs via exposure from soil ingestion at high soil intakes.

Levels of PCB in soil and chicken eggs around a hazardous landfill (Germany)

The BEQ levels in chicken eggs from two farms (C and D) close to the Eyller Berg hazardous waste landfill close to the city of Kamp-Lintfort in Germany were found to be 7.1 pg BEQ/g and 6.4 pg BEQ/g fat in a screening with DR CALUX. Both samples exceeded the EU limit for egg consumption of 5 pg TEQ/g fat. The instrumental analysis (HRGC/HRMS) in these cases samples confirmed the contamination with levels of 10.4 and 8.7 pg TEQ/g fat (sum of PCDD/F and dl-PCB) in the two pooled egg samples respectively.
The competent authority of the federal state had already conducted a soil screening for PCDD/F around the hazardous landfill in 2012 and found dl-PCBs between 3.1 und 6.6 ng WHO-PCB-TEQ/kg dm[12] which was therefore about 6 to 10 times above background soil levels in German pasture land. These PCDD/F and PCB levels in the soils were sufficiently elevated to explain the contamination levels in the eggs (see below).

Levels of dl-PCBs and chlorinated and brominated dioxins/furans in eggs around an incinerator (China)

The egg sample from a Chinese supermarket showed low levels both in the DR CALUX bioassay (1.2 pg BEQ/g fat) and from instrumental analysis (total TEQ of PCDD/F and dl-PCB of 0.66 pg TEQ/g fat) and were comparable to, for example, the background levels in Europe.
Eggs in China were sampled from two private chicken farms in the vicinity of an incinerator Guoding Shan in Wuhan. The closer location (site E) was <0.3 km away from the incinerator and the second (site F) was approx. 1 km Northwest of the incinerator. The bio-TEQ in eggs from site F was 8.8 pg BEQ/g fat and the samples were therefore also analysed by instrumental analysis. The instrumental analysis showed levels of 13.3 pg TEQ/g fat for the sum of PCDD/F and dl-PCB with major contribution coming from PCDD/F with 8.6 pg TEQ/g fat.
The bio-TEQ in eggs from site E was 35 pg BEQ/g fat and instrumental analysis showed levels of 16 pg TEQ/g fat for the sum of PCDD/F and dl-PCB with major contribution coming from PCDD/F with 12.2 pg TEQ/g fat.
Due to the discrepancy between the BEQ and the TEQ the 17 brominated 2,3,7,8-PBDD/F congeners were also screened in these eggs and high levels of PBDD/F contamination were found (29 pg TEQ/g fat). This additional PBDD/F contamination is likely to be responsible for part of BEQ in the free-range eggs from site E and explains the large gap between BEQ and instrumental PCDD/F and dl-PCB TEQ in this case.
This example demonstrates also that also PBDD/F are bio-accumulating in eggs.

Need for further assessment and management - currently assessed sites and potential contamination around emission sources

The surroundings of the four sites investigated need further assessment. The PCDD/F, PCB and PBDD/F levels in soils around the Chinese sites have not yet been measured. As the sites were both close to incinerators and no other obvious potential pollution sources it is likely that the PCDD/F contamination detected in the eggs arose from the incinerator. However the PBDD/F seems only present at the flock of site F and is unlikely to stem from the incinerator. Therefore further studies are needed to clarify the contamination levels in the respective soils before any definitive conclusion can be reached about whether the incinerator was the source. It remains also possible that the contamination of the chickens and their eggs could have originated from their feed or bedding.
The case study around the German factory demonstrate that soils around PCB using industries are likely to be polluted with PCBs at levels where eggs contamination exceeds regulatory limits and is thus of concern for human health impacts. The egg contamination around the hazardous waste landfill site indicates that PCB and PCDD/F levels in soil around these landfills might be impacted by these contaminants at levels of concern for human exposure via chicken/egg pathways.
For both sites in Germany, however, further assessment of the scale of the pollution is needed. For the former production site a key question is the extent of the pollution of the soils and the distance over which soils have

been impacted by either atmospheric PCB deposition over the decades of production and/or also by migration of PCBs in the ground water. It therefore needs to be established at what distance from the site the soil is polluted to the extent that chickens (and other livestock) can not be safely kept - or can only be kept with particular management measures including, for example, special feeding regimes, restrictions on movement or substitution of the upper soil layer. Another study showed high level of PCBs (259 pg PCB-TEQ/g)[13] in an eel from a creek receiving drainage water from the former German factory. Fish and eels from the creek are consumed by members of a local fishing club which is worrying when it is considered that a single (200 g) portion of eel would exceed the Tolerable Daily Intake (TDI) for a whole year in a 70 kg adult. This case also demonstrates that in spite of contamination of the site being well known for 35 years - and whilst Germany has had adequate PCDD/F and PCB monitoring capacity for more than 30 years - there has still been no assessment of potential human exposure through the multiple pathways from this high risk PCB site.

It is clear that low levels of PCDD/F and dl-PCBs contamination in soils can result in chicken eggs being contaminated above regulatory limits and above levels relevant to TDI and health. This means that chickens around present and former PCDD/F and PCB emission sources are likely to be the most sensitive exposure pathways for contamination of humans and exposure assessments are urgently needed for many of these sites. A recent assessment of a former factory in Slovakia has shown that humans were affected at distances of up to approx. 50 km from a PCB production facility[15]. Therefore the distances of concern could be very large depending upon the source strength and the local dispersion. A recent German study showed that more than 50% of smaller chicken flocks raised in an industrialised areas in South Germany had PCDD/F and PCB levels above EU limits while most of the flocks from rural areas were significantly below regulatory limits[2] with only two exemptions both of which were likely a result of high PCB levels from point sources at the farms[2]. Another study in the Netherlands similarly warns that PCB contamination from historic PCB use in open applications such as paints and sealants can be responsible for exceedance of regulatory limits in eggs and potential on farm contamination sources should be carefully assessed[6]. Therefore when assessing contamination sources for a flock, potential local sources on the farm should be considered together with larger emission sources in the vicinity. It is therefore useful to assess at least two independent flocks around pollution sources together with detailed soil investigations including assessments of fingerprints of sources and soils before any firm conclusions are reached.

Indication of critical soil levels from other studies and consequences for soil limit values

The initial IPEN global egg study on PCDD/F levels from developing countries sampled eggs around industrial emission sources including incinerators and revealed that in many areas soils are already polluted with PCDD/F levels at which eggs can be highly contaminated. Other studies on chicken eggs such as those in the Netherlands have indicated that eggs from free-range chicken on soils with levels of 2 to 4 ng PCDD/F-TEQ/kg dm frequently exceed EU limits[4]. Calculations taking into account the soil intake of chicken (up to 36 g/day) and the regulatory levels of the eggs indicate that soil levels around and even below 2 ng TEQ/kg for PCDD/F or dl-PCB can be sufficiently high to reach the EU standards of 2.5 pg TEQ/g fat for PCDD/F or 5 pg TEQ/g fat for the sum of PCDD/F and dl-PCB. This is particularly relevant for flocks of chickens spending a lot of time outside with associated higher soil exposures/intake.

The soil-chicken-egg exposure pathway is therefore probably the most sensitive exposure path for PCBs and PCDD/Fs from soil to humans. This pathway is relevant in many contaminated sites in both developing and industrial countries and it needs to be carefully considered in the development of regulatory soil limits for PCDD/Fs and PCBs. People – and especially young children - consuming contaminated eggs can easily exceed health based standards and may be subject to very high exposure levels. In conclusion the contamination levels in soil used for the production of free-range eggs should ideally be less than 2 ng TEQ/kg dm for the sum of PCDD/F and dl-PCBs (and certainly less than 5 ng TEQ/kg dm). Further studies for generating larger datasets are recommended for determining statistically validated limits. There are different bio-accumulation factors for dl-PCBs and PCDD/F in eggs and the current EU legislation for eggs has an individual limit for PCDD/F but a combined limit for PCDD/DF and dl-PCB. Therefore soil limits for PCDD/F and dl-PCB might have to be determined individually for PCDD/F and for dl-PCB. Furthermore the particular sensitivity of dl-PCB accumulation in beef[14] reinforces the importance of defining dl-PCBs limits in soils independently of PCDD/F limits and not just as the sum of both. To our knowledge there is not yet any soil standard for dl-PCBs.

Monitoring approach using bioassay

This study demonstrates the utility of using bioassay for monitoring of chicken eggs. Specifically bioassays have the dual benefit of being both a cheap and useful tool to measure PCDD/F and PCB in eggs and are also a sensitive tool to measure pollution in soils via the egg levels. Furthermore the bioassay approach can also detect PBDD/F and mixed-halogenated PXDD/F in eggs (and associated soils). Due to the complexity of instrumental analysis of the mixed halogenated PXDD/F currently only total dioxin-toxicity measured by appropriate bioassays can adequately address this challenge. Therefore the bioassay approach is the only method yet available to assess overall environmental and food contamination with dioxin and dioxin-like contamination in a comprehensive way at reasonable costs.

The chicken eggs from China show that brominated dioxins, in particular, can be a main contributor to total Dioxin-toxicity. PBDD/F and PXDD/F are not yet regulated in foodstuffs or soils and this is a major and serious regulatory omission which needs to be addressed especially considering the increase in PBDD/F precursors.

Consequences for industrial emissions and for controlling ashes from thermal processes

The low PCDD/F and PCB levels in soil at which chicken/eggs can become contaminated above regulatory limits and health based limits highlights the need to strictly control industrial and other emissions. It is also particularly important to ensure the safe treatment and disposal of residues from waste incinerators and even ashes from residential sources where waste plastics/PVC or contaminated wood are co-incinerated. Residual ashes with contamination levels as low as 50 ng TEQ/kg can be a risk sources. Even if such ash is "diluted" on soils the PCDD/F can re-accumulate over time with repeated applications. In this respect it needs to be highlighted that the current provisional low POPs limit established by the Basel Convention for dioxin contaminated waste of 15,000 ng TEQ/kg is much too high and needs urgently to be re-evaluated and reduced. A single kilogram of ash meeting the Basel "low POPs" level could contaminate 7 tonnes of soil to a level where eggs would not meet EU regulatory limits if laying chickens were kept on it.

Need for compensation of farmers and private owners considering polluter pays principle

A major challenge is that the levels of contamination in the soil which result in excessive levels of contamination of chicken/egg (and other livestock) are below the current regulatory soil limits. In Germany, for example, the regulatory limit for soil for residential areas/private estate is 1,000 ng PCDD/F-TEQ/kg dm. If chickens were kept on land with these levels this could result in eggs with approx. 800 pg TEQ/g fat! For a 16 kg child a single egg (10 g fat) would exceed the TDI by 250 times. Farmer and private owners have legitimate grounds to expect the original polluters to compensate them for loss of the use of land and in some cases for historic (and current) exposure. The regulatory framework therefore needs to be updated by the establishment of much lower thresholds for soil contamination reflecting the levels at which land uses need to be restricted if excessive exposure via soil-chicken-egg pathways are to be reduced. More stringent emission standards and residue treatment can reduce long-term costs associated with the loss of productive land close to emission sources.

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TOXIC TOY OR TOXIC WASTE: RECYCLING POPS INTO NEW PRODUCTS

SUMMARY FOR DECISION-MAKERS

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October 2015

ARNIKA

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TOXIC TOY OR TOXIC WASTE: RECYCLING POPs INTO NEW PRODUCTS

Summary for Decision-Makers

Brominated flame retardants from electronic waste are present in plastic children's toys

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October 2015

IPEN is a leading global network of 700 non-governmental organizations (NGOs) working in more than 100 developing countries and countries with economies in transition. IPEN works to establish and implement safe chemicals policies and practices to protect human health and the environment. It does this by building the capacity of its member organizations to implement on-the-ground activities, learn from each other's work, and work at the international level to set priorities and achieve new policies. Its mission is a toxics-free future for all.

In 1998, IPEN focused on advancing the development and implementation of the Stockholm Convention on persistent organic pollutants (POPs). IPEN began engagement in the POPs Review Committee process for evaluating candidate chemicals for addition to the treaty when the Committee began operating in 2005. Today, its mission also includes promoting safe chemicals management through the SAICM process, halting the spread of toxic metals, and building a movement for a toxics-free future.

INTRODUCTION

Brominated flame retardants have been widely added to foam and plastics used consumer and electronic products. PentaBDE has been used extensively in polyurethane foam, but also appears in electronics. OctaBDE has been used in ABS and other plastics used in electronics such as office equipment. DecaBDE is widely found in plastics used in electronics and is a common component of electronic waste. In 2009, delegates at Stockholm Convention 4th Conference of the Parties (COP4) agreed to list commercial PentaBDE and OctaBDE in Annex A for global elimination (Stockholm Convention 2009). The COP also agreed to create an exemption that permitted recycling of plastics, foam, and other materials containing these substances until 2030. Due to concerns about the possible impacts of this recycling exemption, the COP requested the treaty's expert committee to examine its implications. Subsequently, the expert committee known as the POPs Review Committee developed recommendations on the recycling exemption for COP5. The Committee warned against the practice and recommended to "...eliminate brominated diphenyl ethers from the recycling streams as swiftly as possible" noting that,

> " *Failure to do so will inevitably result in wider human and environmental contamination and the dispersal of brominated diphenyl ethers into matrices from which recovery is not technically or economically feasible and in the loss of the long-term credibility of recycling."*
> *(Stockholm Convention 2011)*

Currently DecaBDE is under evaluation by the Stockholm Convention POPs Review Committee for addition to the Convention. The Committee has been examining risk management options, socio-economic considerations, alternatives, and waste management issues and will make a recommendation to the 8th Conference of the Parties about the listing of DecaBDE in the Convention at its meeting from 19 – 23 October 2015. Despite previous Committee recommendations against the practice, a small number of countries have suggested the possibility of recommending a recycling exemption for DecaBDE. We conducted a brief survey of PBDE flame retardants in Rubik's cubes, a children's product often made of recycled plastic, along with a few other plastic toys. We asked whether OctaBDE and DecaBDE commonly found in the plastic parts of electronic waste were present in the toys as predicted by a previous Committee technical report.

METHODS

The black parts of Rubik's cubes were tested because manufacturers often blacken the colour of recycled plastics for aesthetic reasons. Samples were analyzed for PBDEs at the Institute of Chemical Technology, an accredited laboratory in the Czech Republic. Brominated flame retardants were extracted by n-hexane and the leachate transferred into isooctane. Identification and quantification of flame retardants was accessed via gas chromatography/mass spectrometry in the mode of electron ionization (GC-MS/MS-EI). The limit of detection for was 0.1 ppb and the main components of congeners listed in the Stockholm Convention were analyzed.

RESULTS

Laboratory analysis of fifteen Rubik's cube and six additional samples (thermo cup, hair clip and hand band, finger skateboard, toy robot and hockey stick) from six EU member states including Czech Republic, Germany, Hungary, Poland, Slovakia, and Sweden found that seventeen samples (81%) contained OctaBDE at concentrations ranging from 1 to 95 ppm (see Table 1). Three samples (14%) contained OctaBDE at levels greater than 50 ppm – the low POPs content limit in wastes for PCBs (which PBDEs resemble) and one of the low POPs content levels recently approved at the Basel Convention COP12. Nineteen samples (90%) contained DecaBDE, a common toxic chemical found in electronic waste. Six of the samples (29%) contained DecaBDE at levels greater than 50 ppm. Taken together, nine samples (43%) exceeded 50 ppm.

TABLE 1: CONCENTRATION OF PBDEs IN PRODUCTS FROM CZECH REPUBLIC, GERMANY, HUNGARY, POLAND, SLOVAKIA, AND SWEDEN (PPM)

Type	Name, made in	Country of purchase	OctaBDE (ppm)	DecaBDE (ppm)
Rubik's cube	Toys-Cubic, China	Czech Republic	0	2
Rubik's cube	Toys-Cubic, China	Czech Republic	17	6
Rubik's cube	QJ Magic Cube, China	Czech Republic	4	4
Rubik's cube	Toys, China	Czech Republic	4	17
Rubik's cube	Not labeled	Czech Republic	47	82

Type	Name, made in	Country of purchase	OctaBDE (ppm)	DecaBDE (ppm)
Rubik's cube	I Love You Magic Cube, China	Czech Republic	75	96
Hair headband	Not labeled	Czech Republic	9	33
Thermo cup	Banquet, Akcent Bike, Travel Mug 400 ml, China	Czech Republic	3	6
Hair clip	Not labeled	Czech Republic	19	18
Toy - finger skate-board	Finger Skate Board, China	Czech Republic	95	121
Hockey stick	Not labeled	Czech Republic	6	9
Toy - robot	Not labeled	Czech Republic	0	1
Rubik's cube	Games & More, Simba, China	Germany	1	3
Rubik's cube	Games & More, Simba, China	Germany	1	4
Rubik's cube	Kocka Rubik's/Cube Buvos original 3x3	Hungary	6	58
Rubik's cube	4x4x4, China	Poland	1	3
Rubik's cube	QJ Magic Cube, China	Poland	0	0
Rubik's cube	Toys-Cubic, China	Poland	51	79
Rubik's cube	Toys-Cubic, China	Poland	22	35
Rubik's cube	Toys-Cubic, China	Slovakia	26	98
Rubik's cube	Robetoy ab	Sweden	0	0

CONCLUSION AND RECOMMENDATIONS

This brief survey indicates that the Stockholm Convention POPs Review Committee correctly predicted the dispersal of flame retardant chemicals into products where they should not be present as a result of recycling materials such as plastics that contain them. The results add to concerns about the existing Stockholm Convention recycling exemption for PentaBDE and OctaBDE and provide a warning against a recycling exemption for DecaBDE.

Toxic recycling

The data shows that OctaBDE and DecaBDE used in plastics for electronics are being recycled into plastic children's toys. This finding is in accordance with the study of Chen et al. (2009) and an analysis of the POP-BDE stream in the Netherlands by Leslie et al. (2013) illustrating that 22% of the POP-BDE in waste electrical and electronic equipment is expected to end up in recycled plastics. This survey also complements a recent study by Samsonek and Puype (2013) which found flame retardants from electronic waste recycled into plastic food contact materials such as thermo cups and kitchen utensils. The problem of recycling materials containing POPs and contaminating "new products" also occurs in recycled foam products such as carpet padding. (DiGangi J, Strakova J, and Watson A, 2011)

Substances listed in the Stockholm Convention such as PentaBDE and OctaBDE should not be present in children's products, consumer products, food contact materials, and other products. These articles should also not contain DecaBDE due to its toxic properties and since the Stockholm POPs Review Committee in 2014 agreed that DecaBDE, "...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." (Persistent Organic Pollutants Review Committee 2014)

The draft Risk Management Evaluation of DecaBDE warns against a recycling exemption for DecaBDE noting that, "recycling of materials containing c-decaBDE will inevitably result in wider human and environmental contamination and dispersal of PBDE. It should be avoided if the aim is to eliminate emissions and exposure to c-decaBDE." (Persistent Organic Pollutants Review Committee, 2015) In addition, the draft Risk Management Evaluation notes that the socio-economic impacts of not allowing recycling of materials containing DecaBDE are "limited" since recycling rates are very low (Persistent Organic Pollutants

Review Committee, 2015). Finally, the report notes that a recycling exemption may provide a loophole for export of DecaBDE-containing materials to developing countries that do not have the infrastructure to deal with it; "It was recently reported that plastic pellets from recycled material contaminated with c-decaBDE is subject to export and that this recyclate may end up in products where they can pose a hazard to human health." (Persistent Organic Pollutants Review Committee, 2015)

On 10 September 2015, the Committee for Socio-Economic Analysis of the European Chemicals Agency (SEAC) agreed with tightening the regulation of DecaBDE in plastics and textiles (European Chemicals Agency 2015). On the recycling issue, the Agency committee warned that, "Articles made from recycled materials containing decaBDE will generally have the same risk profile as articles made from virgin materials that are intentionally treated with decaBDE, in terms of their potential for decaBDE emission" (European Chemicals Agency 2015). The European Chemicals Agency Committee concluded that it, "has not identified the need for derogating any other uses (including recycling)" and notes that "the existing practice in the recycling sector is to separate wastes containing brominated flame retardants, regardless of the proposed restriction" (European Chemicals Agency 2015). The latter point is exactly what the previous Stockholm Convention POPs Review Committee decision recommended.

Recommendations against a recycling exemption for PBDEs have now been made by the Stockholm Convention POPs Review Committee in 2011, the draft Risk Management Evaluation of DecaBDE by the Stockholm Convention POPs Review Committee in 2015, and the European Chemicals Agency Committee for Socio-Economic Analysis in 2015. The data in this brief survey support these recommendations and illustrate that recycling materials containing toxic flame retardant chemicals can distribute them into children's products.

Action levels for triggering POPs destruction

The Stockholm Convention requires that after the treatment of POPs waste, it should no longer exhibit POPs characteristics. This has resulted in an effort by the Conference of the Parties to define low POPs content thresholds above which treatment is required. At the recent COP12 of the Basel Convention, Parties strangely decided on two optional low POPs content threshold limits for the sum of HexaBDE, HeptaBDE (congeners in commercial OctaBDE), PentaBDE and TetraBDE (congeners in commercial PentaBDE) of 50 ppm or 1000 ppm (Basel Convention 2015). The ineffectiveness of the 1000 ppm level is clearly illustrated by a study performed by ESWI/BiPro (2011) which illustrates that for a limit of 1000 ppm, a negligible proportion of waste containing POP-PBDEs would be actually be classified as POPs waste. This runs counter to the objectives of the Stockholm Convention. Basel Convention Parties recognized that having two low POP content levels created confusion and that "knowledge limitations have posed challenges to the setting of such values and that therefore a review of all provisional low persistent organic pollutant content values would be timely" (Basel Convention 2015).

The survey data shows that three toy samples (14%) contained OctaBDE at levels equal to or greater than 50 ppm. In addition, six products contained DecaBDE at levels greater than 50 ppm (29%). These levels raise concerns because PBDEs are very similar in structure to PCBs. The POPs Review Committee has noted that, "There is an increasing evidence suggesting similar toxicological profiles and therefore, equivalent hazards and concerns, between PBDEs and PCBs..." (UNEP/POPS/POPRC.3/20/Add.6).

Substances such as PBDEs that resemble PCBs should not have weak low POPs content limits. The low POPs content limit should be 50 ppm or less for POP-BDEs and DecaBDE. In addition, the 50 ppm low POPs content limit should be tightened as it is not a health-based standard and should be much lower considering the properties of POPs.

An inappropriate definition of low POPs content creates a loophole that allows responsible parties to select disposal options that may be less costly, but that leave behind substantial POPs residues. This is inconsistent with the intent of the Convention and permits the use of POPs waste disposal options that cannot truly be considered environmentally sound. Such disposal options result in significant new releases of POPs to the environment which are harmful to human health and ecosystems. A weak low POPs content limit such as 1000 ppm opens the door for permitting the production and sale of products that contain unacceptably high levels of POPs as contaminants. It also further facilitates the export of hazardous, POPs-contaminated wastes from developed to developing countries. Finally, as long as these less costly options are allowed by using weak low POPs content limits, superior POPs waste disposal technologies that are able to destroy all the POPs content of the waste, and that leave behind virtually no POPs residues may remain economically non-viable.

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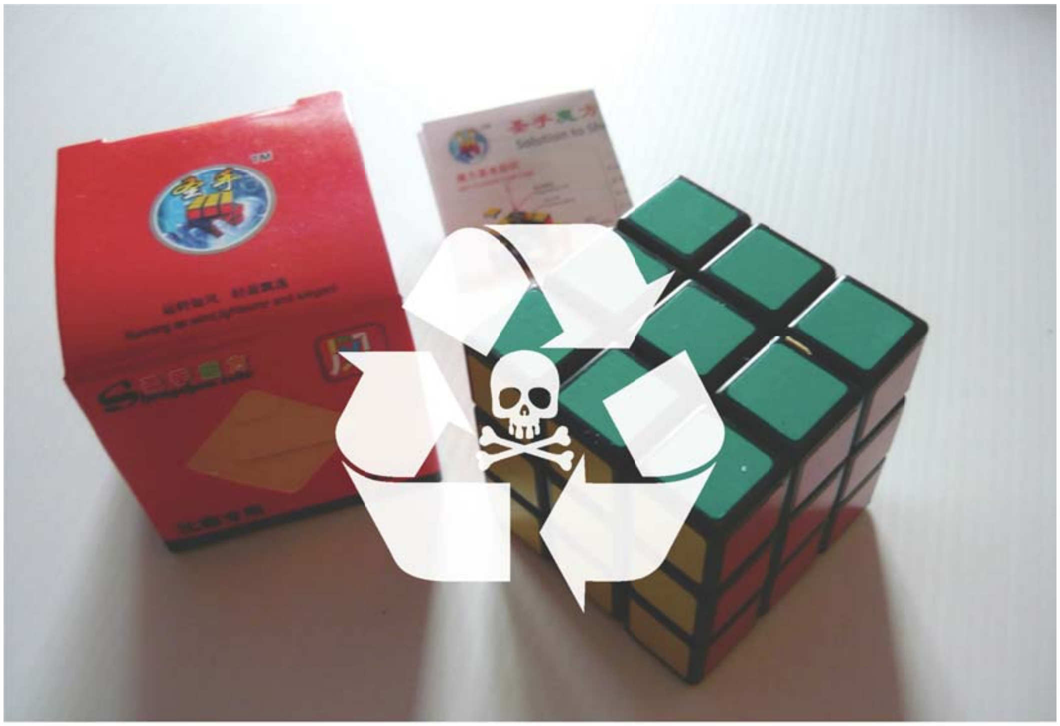

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