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National strategy and action plan on PBDEs control in China to fulfill the obligation of POPs Convention

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Introduction

The polybrominated diphenyl ethers (PBDEs) are a class of brominated flame retardants (BFRs)[1]. In 2009, Stockholm Convention listed "hexaBDE(BDE153/154) and heptaBDE(BDE175/183)" and "tetraBDE(BDE47) and pentaBDE(BDE99)" into Annex A of the amendments with specific exemptions for recycling of articles that contain or may contain those BDEs, and the use and final disposal of articles manufactured from recycled materials that contain or may contain those BDEs[2]. In December 2016, the Persistent Organic Pollutants Review Committee decided to recommend to COP8 for consideration of listing decabromodiphenyl ether (BDE-209) of c-decaBDE in Annex A to the Convention, with specific exemptions for some critical spare parts, to be further defined, for the automotive and aerospace industries[3].

China had some production of c-pentaBDE[4] and c-decaBDE, and was a big consumer of BFRs in the field of electrical and electronic applications, motor vehicles, textiles, etc[5]. As a party of the Stockholm Convention, China was taking measures to fulfill its obligation according to the current status. In this study, the current regulation, historical data of production, consumption, usage and substitution and environmental existence of dedicated PBDEs were investigated, analyzed and discussed to propose a strategical action plan for PBDEs-POPs control in China.

Materials and methods

The historical data of production, consumption, use and substitution were achieved from relevant stakeholders, referring to the preliminary investigation approaches in the "draft guidance for the inventory of PBDEs under Stockholm Convention"[6]. The environmental existence data was mined from archives of researches[7]. The SWOT analysis was applied to propose strategical suggestions.

Production, consumption, use and substitution

The use of PBDEs in electric and electronic products was banned from 1 March 2007 in China[8,9]. China had ever had a small amount of experimental production and use of c-pentaBDE, which had been produced in 4 plants with small scale production and was ceased before 2004. No production, consumption, use and storage of c-octaBDE were found reported in China, nor the dedicated policy and regulation[10]. After Chinese government approved the Stockholm Convention amendments, the production, consumption, use and import/export of "hexaBDE and heptaBDE" and "tetraBDE and pentaBDE" were banned from March 26th 2014 in China[11]. Because

c-pentaBDE was used in electrical and electronic equipment (like plastic, wire, cable, plastic shell, circuit board and so on) and China is a main world disassembling country, the e-waste disassemble site should be the hotspot for the pollution prevention and control of c-pentaBDE in China[4].

China was the main producer of c-decaBDE among the Asian countries, and the production of China was up to 13,500 tons per annum in 2001 and up to 30,000 tons in 2005[5], by estimate reaching the peak before 2017. After the rules of RoSH came into force in 2007[8], c-decaBDE are gradually decreasing in electronic and electrical equipment (EEE), and due to competition of quality and price a dozen companies closed their production lines. About 3/4 of the c-decaBDE was consumed in domestic, and most of them was used in some other flame retardant products, such as plastic (EEE, wire, cable, plastic shell, circuit board and so on), rubber and textile products (clothing, pipeline, toys, shoes). On the basis of 10% of additive amount, about 150,000 tons of flame retardant plastic were produced and used in various national economic forms and household appliances. To replace c-decaBDE, decabrominated dipheny ethane (DBDPE) was developed and produced as substitute with minor economic and technique influence to the industries in China. In consideration of brominate-based flame retardant such as DBDPE might have the risk to be verified to cause potential negative impact to the environment, some phosphate-based flame retardants are in R&D process[12]. As the recent published EU Regulation announced that decaBDE, its mixture or an article containing decaBDE in a concentration equal to or greater than 0,1 % by weight shall not be manufactured or placed on the market as a substance on its own after 2nd March 2019[13], the products containing decaBDE for export to EU will seek for the flame retardant substitute accordingly.

Environmental existence

The consumption and use process of c-pentaBDE and c-octaBDE were reported to exist “relatively low risk” to the environment and human health. The disassembling process of e-waste might cause “relatively high risk” to the environment and human health in respect of c-pentaBDE and c-octaBDE, especially at the illegal sites[7].

Results and discussion

Table 1: SWOT analysis matrix for national strategy of POPs-PBDEs control in China

Substance: c-pentaBDE and c-octaBDE	Strengths 1. POPs-PBDEs banned. 2. Production had been small and already ceased. 3. Have basic monitoring capacity and data.	Weaknesses 1. E-waste disassembling had relatively high risk. 2. Lack of specific regulation and standard. 3. Low public awareness.
Opportunities 1. “hexaBDE/heptaBDE and tetraBDE/pentaBDE” were listed into SC. 2. Production was widely ceased in OECD.	S-O Strategies 1. Include requirements for POPs control in the environ. management. 2. Strengthen supervision for imported products. 3. Regular monitoring on	W-O Strategies 1. Strengthen supervision for the import of e-waste and plastic with PBDEs 2. Enhance relevant regulation and standard. 3. Capacity building.

	environ. and products.	
Threats 1. Lots of E-waste and plastic were exported to China for recycling. 2. There might have been some sites contaminated.	S-T Strategies 1. Develop standards with specified limitation for products and waste. 2. Investigate and identify contaminated sites, i.e. former manufacture and dismantling sites.	W-T Strategies 1. Regulate dismantling and recycling processes. 2. Raise public awareness.

Table 2: SWOT analysis matrix for national strategy of decaPBDEs control in China

Substance: c-decaBDE (The following analysis is based on the assumption that decaBDE will be listed into SC.)	Strengths 1. Production deacreasing. 2. Banned use in EEE. 3. Have some mature substitute i.e. DBDPE.	Weaknesses 1. Still have production. 2. Historical leftovers. 3. Lack of non-halogenate based substitutes.
Opportunities 1. DecaBDE to be listed into SC by COP8. 2. EU will ban decaBDE before 2 March 2019, with an exemption for aircraft and spare parts of used vehicles till 2027.	S-O Strategies 1. Facilitate the central government to approve the amendments. 2. Make an inventory and update the national plan. 3. Promote replacement of decaBDE with technical and financial assistance.	W-O Strategies 1. Cease production. 2. Strengthen supervision for the import and export of decaPBDE contained products and waste. 3. Promote R&D of non-halogenate based substitutes.
Threats 1. OctaBDE and nonaBDE are still not POPs. 2. USEPA has identified DBDPE as high hazard for developmental toxicity and for bioaccumulation by predictive models and professional judgement. 3. Legacy waste.	S-T Strategies 1. Promote R&D of non-halogenate based substitutes. 2. Make action plan for the in-use products and its obsoleting. 3. Make action plan for the disposal of PBDEs waste.	W-T Strategies 1. Regulate dismantling and recycling processes. 2. Investigate and identify contaminated sites, i.e. former manufacture and dismantling sites.

Conclusions

For hexaBDE/heptaBDE and tetraBDE/pentaBDE, the action plans for the POPs-PBDEs control and reduction are suggested as follows:

1. Integrated the requirements for POPs-PBDEs control into the current environmental management system.
2. Promote BAT/BEP to POPs-PBDEs contained e-waste dismantling and plastic recycling for environmentally sound management.
3. Strengthen supervision for the import and export of POPs-PBDEs contained e-waste, waste plastic and products.
4. Deploy regular monitoring on environment and products for risk precaution.
5. Enhance capacity building and raise public awareness.

For decaBDE, it still awaits for the approval of the COP, and the main risk from decaBDE is caused by its de-brominated derivatives (like tetraBDE, pentaBDE, hexaBDE, heptaBDE, octaBDE and nonaBDE). In this respect, some other PBDEs like octaBDE, no matter as one of the main ingredients of c-octaBDE or the impurity and the de-brominated derivative of decaBDE, should have higher priority than decaBDE to be listed as POPs, which should be kept further attention. Anyway, as China is still producing and using decaBDE as flame retardants, the intimate concern should be kept on the decisions of the upcoming COP8.

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