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National strategy and action plan on HBCD control in China to fulfill the obligation of Stockholm Convention

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Introduction

Hexabromocyclododecane（HBCD, $C_{12}H_{18}Br_6$）, which is used as a flame retardant additive, could delay the ignition and slow the following fire growth during the use of vehicles, building, or articles and the storage of certain materials. The majority use of HBCD is in flame-retarded expanded polystyrene (EPS) and extruded polystyrene (XPS) foam in the field of insulation materials of construction. HBCD also could use as flame retardant in the back-coatings for upholstery and other interior textiles, including automotive applications. The electric and electronic appliances (high impact polystyrene/HIPS) is also one application of HBCD. [1]

The sixth meeting of Conference of the Parties to the Stockholm Convention, which held at May 2013, adopted an amendment to Annex A to the Convention to list HBCD with specific exemptions for production and for use in EPS and XPS in buildings. [2] Each Party that has registered for the exemption shall take necessary measures to ensure that EPS and XPS containing HBCD can be easily identified by labelling or other means throughout its life cycle.

On 2 July 2016, the Standing Committee of the National People's Congress of China reviewed and ratified "The Amendment to 'Stockholm Convention' Newly Listed HBCD". China has banned the produce, use, import and export HBCD except for specific exemptions of production and use for EPS and XPS in buildings. The Amendment came into force since December 27, 2016. [3]

With limited management and control regulatory instruments and the information of substitutions, the regulations, production, consumption, and substitution were investigated and analysis in this study. The National strategy and action plan of control HBCD were proposed to fulfill the obligation of Stockholm Convention.

Materials and method

In this study, the management and control regulatory instruments of developed countries, such as European countries, United States, Canada, and Japan, were thoroughly investigated. The substitutions and best available techniques and best environmental practices for HBCD were achieved in Draft guidance on best available techniques and best environmental practices for the production and use of hexabromocyclododecane listed with specific exemptions under the Stockholm Convention.[4]（UNEP/POPS/COP.8/INF/16）. With comparison of the production,

consumption, and substitution in China, the gaps and challenges between China and developed countries were evaluated and the strategical suggestions for China were proposed.

Results and discussion

Nations and regional action taken on regulatory instruments

The regulatory instruments on HBCD in most of developed countries could be divided into two categories, forbidden and control, which represented by EU and US, respectively. Japan eliminated the production and use of HBCD by 2014. US completed the substation of major applications now. Canada completed elimination of HBCD at December 2016. EU set up the date of August 2017 of HBCD elimination.

The regulatory instruments of most of nations and region are illustrated in following table 1.

Table 1 the regulatory instruments of most of nations and region[1,5]

Nations and region	*Act/ Regulation/ Catalog*	*Main Content*
EU	Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)	List HBCD into the list of a Substance of Very High Concern (SVHC) Taking effect in 2015, HBCD can no longer be used without authorisation.
	CLP (classification, labelling and packaging) Regulation (CLP)	Products contain HBCD, which sales in EU market, need to apply CLP Regulation for classification, labelling and notification.
	Restriction of Hazardous Substances Directive (RoHS)	List HBCD into the list of high priority substances
	Priority substances under the Water Framework Directive	Require limitation of the discharge of HBCD into waterbody, and take appropriated measure to eliminated HBCD in waterbody
Norway	Prohibition on Certain Hazardous Substances in Consumer Products（PoHS）	Prohibition on consumer products that contain certain hazardous substances
US	Toxic Substances Control Act（TSCA）	Require notice USEPA 90 days before produce, import or process HBCD. USEPA will decide whether to prohibit or restrict the activities (expect the textile for automobiles).
	Maine state Kid Safe Product Act（KSPA）	List HBCD into Chemicals for High Concern（CHC）the limit of HBCD in kids products should not exceed 100ppm
	Washington State Children's Safety Product Act（CSPA）	List HBCD into Chemical High Concern to Children（CHCC） Require the enterprises which use HBCD in kids products to notify authorities the application of HBCD in products
Canada[6]	CANADIAN ENVIRONMENTAL PROTECTION ACT（CEPA） Prohibition of Certain Toxic Substances Regulations, 2012	Include HBCD into CEPA in 2012 By January 1, 2017, the manufacture, use, sale, offer for sale or import of HBCD, as well as expanded and extruded foams and intermediary products containing HBCD used in building/construction applications will be prohibited.

Nations and region	*Act/ Regulation/ Catalog*	*Main Content*
Japan	Chemical Substances Control Law	Designated as a Monitoring Chemical Substance
China	Hazardous Chemicals Catalog[7] (2015) Product Catalog of High Pollution, High Environmental Risk (2015)	Include HBCD into Hazardous Chemicals Catalog. The production, storage, use, transportation and operation of HBCD should follow the Regulations on the Safety Administration of Hazardous Chemicals
	Chinese Strictly Restrict Import and Export of Toxic Chemicals Catalog[8]	Since January 1, 2017, the enterprises of import or export of HBCD should apply to MEP for environmental management registration of import toxic chemicals and the environmental management release notice of import and export toxic chemicals

Production, consumption, use and substitution

HBCD has been on the world market since the late 1960s. Historically, HBCD was produced in China, Europe, Japan, and the USA. The historical annual production globally is approximately 28,000 tonnes per year around 2010[1].

HBCD was introduced to China at 1990s, the production and application increased gradually. The annual production of HBCD was 9,000 to 10,000 tonnes in 2009 and 15,000 tonnes in 2010[1]. To adapt the requirements of energy saving of constructions, the demand for flame retardant EPS and XPS has increased rapidly. The accumulated production of HBCD is about hundreds of thousands tonnes. In China, HBCD was only used for the production of flame-retarded EPS and XPS foam in the field of insulation materials of construction, in which 80% HBCD uses in flame-retarded EPS foam and 20% HBCD uses in flame-retarded XPS foam, respectively. The additive amount of HBCD in EPS foam is 0.9%-1.5%. The additive amount of HBCD in XPS foam is 2.5%-4%.

The substitution techniques include the substitution of flame retardant additive and the substitution of flame-retardant insulation materials. Companies from US and Israel has developed Butadiene-styrene brominated copolymer as alternatives and it is commercially available in the international market. The equivalent cost of alternatives might be 15-25% higher than HBCD's. Non-flame retarded EPS and XPS insulation foams with the feature of prevent catching fire are also developed for the market.[4] However, the performance and environmental risk of alternative techniques need to be further evaluated.

Conclusions

Comparing with developed countries and region, there is limited regulatory instruments were applied in China. There is no discharge limit, environmental quality standard and monitoring methods of HBCD developed in China. China face the challenges not only in regulation but also in risk management, substitution/techniques, labelling, public awareness, and etc. The strategical suggestions for China is proposed that:

1. Strengthen the management of HBCD production and application enterprises. Carry out compulsory cleaning production audit nationwide.
2. Develop HBCD limit in construction insulation board. Establish the labelling method of HBCD in EPS and XPS foam.
3. Strengthen the import and export management of HBCD.
4. Establish the environmental risk evaluation system for substitutions. Encourage the research and development of substitutions.
5. Carry out the monitoring and evaluation of HBCD in environmental media. Establish correspondent environmental monitoring standard and method.

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