

# Occurrence and substance flow analysis of polybrominated diphenyl ethers (PBDEs) in waste materials in South Korea

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## INTRODUCTION

Polybrominated diphenyl ethers (PBDEs) as brominated flame retardants (BFRs) have been widely used in electronics, automobiles, and textiles. Although there have been several advantages such as a flame resistance and an economical efficiency of such chemicals, some of the BFRs have been known to be toxic and environmental hazard upon exposure. For example, PBDEs have been reported to generate brominated dioxin when improperly incinerated. Therefore, PBDEs such as penta-BDE, octa-BDE and deca-BDE have been listed in the persistent organic pollutants by the Stockholm Convention. As the international regulations has begun to restrict the production and use of PBDEs, the inventory and levels of PBDEs in products in use and waste materials are issues of concern in scientific community. Therefore, the purpose of this study was to provide detailed data and levels of PBDEs in selected products and waste materials with a life cycle perspective. Based on the levels of PBDEs, substance flow analysis (SFA) for each products and waste materials was conducted. The inventory has been constructed and utilized for chemical management policy.

## MATERIALS AND METHODS

The methodology in the study included gathering data associated with import of PBDEs and annual domestic demand for electronic and electric equipment (EEE) and automobiles, survey study and sample analysis for PBDEs by site visits to recycling facilities, and the review of various statistical and relevant literature. Interviews and conversations with the waste management division of the Korea Ministry of Environment (Korea MOE) and Korea Electronic Recycling Cooperation (KEREC) were conducted to obtain the details of recent regulations, management policies and responses of PBDEs, and current recycling practices. The available literature was examined to consider PBDEs flow and waste management in Korea. A total of 287 samples were collected from

waste materials for the determination of bromine, while 184 samples were analyzed for PBDEs by using GC/MS.

## **RESULTS AND DISCUSSION**

Based on the analytical results of PBDEs in used products and recycled materials, the high levels of PBDEs were found in plastic in CRT TVs with an average detection rate of 48% (19 samples detected out of 28 samples). Recovered plastics from e-waste recycling facilities also contained relatively high levels of PBDEs, ranging from 4,869 mg/kg to 12,341 mg/kg. A few samples from end-of-life vehicles were detected with PBDEs above the detection limits. EPS from construction materials (e.g., insulation materials) also contained PBDEs and HBCD at high levels with limited number of samples. No PBDEs were found in textile samples in this study. Some facilities process end-of-life EEE, automobiles, and construction materials by manual dismantling, shredding, and density and wind separation. In the processes, recycled pellets are recovered for use as raw materials for plastic manufacturing. In order to conduct MFA of PBDEs, the weight percentages of plastic fractions in EEE (TVs) and automobiles were assumed along with the average levels of PBDEs in each product. The levels of PBDEs present in EEE, automobile, and construction materials in households were expected to have continually decreased over the next decade. Especially, the amounts of PBDEs in TVs and automobiles from the recycling process are expected to decrease mainly because fewer PBDEs were used in recently manufactured electronic and textile products.

## **CONCLUSION**

The results of this study indicate that CRT TVs and auto shredded residues after recycling processes often contained high levels of PBDEs. Much of the PBDEs in recycled plastics are reused for plastic resins without any regulations. It is therefore essential to closely monitor the mass flow of recovered plastics in the environment and properly manage the chemicals due to their toxicity and persistence. Appropriate guidelines are needed to regulate the chemicals to avoid any potential exposure to humans.

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