Outline of Measures to Control Emissions of Unintentionally Produced Persistent Organic Pollutants (UPOPs) in Japan

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Introduction

The Ministry of the Environment of Japan (MOEJ) has compiled this publication, for the purpose of disseminating to relevant business operators, information effective in reducing emissions of hexachlorobenzene (HCB), pentachlorobenzene (PeCB), polychlorinated biphenyls (PCB), polychlorinated naphthalenes (PCN), and hexachlorobutadiene (HCBD) (hereinafter referred to as "UPOPs"). These substances are considered to be less known among the substances listed in Annex C of the Stockholm Convention.

Measures to control emissions of UPOPs

A high correlation has been found between dioxins and HCB and PCB concentrations in exhaust gases. Like dioxins, PeCB, PCN, and HCBD are also produced as unintentional by-products of combustion and other thermal and industrial processes. Therefore, the Persistent Organic Pollutants Review Committee of the Stockholm Convention has reported that many of the measures to control unintentional emissions of dioxins also lead to emission control of PeCB, PCN, and HCBD.

Based on this, Japan has prepared an action plan to promote measures for UPOPs through the promotion of emission control measures for dioxins.

In Japan, waste incineration facilities are subject to structural standards and maintenance and management standards based on Waste Management and Public Cleansing Act. Taking waste incineration facilities in Japan as an example, the countermeasure technologies that have been introduced to control emissions of hazardous substances and dioxins in exhaust gases are summarized in Table 1. For waste incinerators, measures are implemented based on thermal decomposition of dioxins through the complete combustion of waste in the incinerator, suppression of dioxins resynthesis through exhaust gas cooling, and removal of dioxins through exhaust gas treatment.

As measures to reduce emissions of UPOPs, implementing measures such as generation and exhaust gas management similar to those for dioxins is expected to be effective. Therefore, efforts have been made to reduce emissions of UPOPs by promoting measures against dioxins. However, since it was suggested that generation and emission control tendencies of PCB and PCN differ in cement kilns and a significant correlation with dioxins could not be confirmed for some sources and substance types, it is considered necessary to implement additional measures beyond those targeting dioxins to control emissions of UPOPs.

Therefore, to further reduce emissions of UPOPs, surveys and analyses have been conducted on the effects of raw materials, production, and transfer mechanisms of UPOPs in manufacturing processes at multiple facilities identified as top emission sources in the atmospheric emission inventory for UPOPs (cement and secondary zinc production facilities), with the cooperation of business operators and industry groups.

Based on the survey results, exploration of specific methods for emission control beyond existing dioxin control measures, focusing on addressing the effects stemming from the properties of UPOPs, as well as those arising from the manufacturing processes and raw materials, both at the source and within individual facilities, is being carried out.

Table 1: Examples of measures against dioxins implemented in waste incinerators in Japan

Items		Description of measures
Complete combustion in incinerators		In order to ensure complete combustion of waste, the structural standards for waste incineration facilities require the installation of a combustion chamber capable of maintaining a combustion chamber temperature of 800°C or higher (850°C according to the Guidance on BAT/BEP under the Stockholm Convention) for at least two seconds. The "Guidelines for the Prevention of Dioxin Generation from Waste Disposal, etc." stipulate that the combustion chamber temperature shall be "850°C or higher (preferably maintained at 900°C or higher)" for newly installed furnaces.
Exhaust gas cooling		The installation of a cooling system capable of reducing the temperature of combustion gas entering the dust collector to approximately 200°C or lower is mandatory. The two main purposes of exhaust gas cooling are to lower the temperature of the exhaust gas, thereby reducing gaseous substances to particles and improving collection efficiency of the dust collector, and to prevent the resynthesis* of dioxins and other substances in the dust collector. *Dioxins are said to be resynthesized in exhaust gas from incinerators under certain conditions in the presence of unburnt carbon particles and polycyclic aromatics (referred to as "de novo synthesis"). The reaction temperature is typically between 200°C and 500°C. It is believed that reducing the exhaust gas temperature effectively suppresses such resynthesis reactions.
Exhaust gas treatment	Exhaust gas dust collection	Dust collectors are installed to remove particulate matters from exhaust gases. In waste incineration facilities, electrostatic precipitators (ESPs) were mainly used in the past. However, since the enforcement of the Act on Special Measures against Dioxins, bag filters, which have superior removal performance, are often installed (This shift is due to several reasons, including the ability of bag filters to capture finer particles. Additionally, by spraying chemicals before the bag filters, various types of hazardous substances can be simultaneously removed through adsorption reactions within dust layers adhered to the filter cloth).
	Catalytic treatment	In catalytic treatment, dioxins are decomposed on catalysts that exhibit decomposition activity for dioxins. Various catalysts exist for dioxin decomposition, each with differing performance characteristics.
	Adsorption treatment	Treatment is carried out with adsorptive substances, typically activated carbon. Hazardous substances in exhaust gases are removed by adsorbing them onto activated carbon.

Furthermore, in order to investigate the production and transfer mechanisms of UPOPs in the cement manufacturing processes, a measurement survey of PCB and other substances at several cement manufacturing facilities by collecting samples of raw materials and gases at several points during the manufacturing processes have been conducted.

At present, the following measures have been found to have the potential to contribute to the reduction of PCB and other emissions (Table 2).

Table 2: Examples of measures that may contribute to the reduction of PCB, etc. in cement manufacturing processes in Japan

Types of measures	Outline
Accelerated agglomeration and adsorption of gaseous PCB by reducing exhaust gas temperature	It is believed that a decrease in exhaust gas temperature will result in flocculation of gaseous PCB and promotion of PCB adsorption on the feedstock in the feedstock mill, thereby reducing the total emission from the chimney. An effective measure for reducing the exhaust gas temperature could be the installation of an exhaust heat recovery boiler. The effect of PCB adsorption to the feedstock is generally considered more effective in vertical mills with higher contact efficiency between raw materials and gas than in conventional tube mills.
Dust collection of particulate PCB	Increasing the efficiency of the dust collector is expected to increase the dust collection efficiency of particulate PCB. For example, in terms of dioxin control, bag filters (BFs) are considered to have higher dust collection efficiency than electrostatic precipitators (EPs).
Reduction of the amount of chlorine circulating in the system	Reducing the amount of chlorine circulating in a cement kiln system is believed to help control by-products such as PCB. A chlorine bypass system is considered an effective method for reducing chlorine concentration in cement kilns.

Summary and future measures to control emissions of UPOPs

In Japan, as part of measures to control emissions of UPOPs, the concentrations of UPOPs in exhaust gases have been measured through sampling surveys at facilities currently in operation. Emission factors have been calculated using these survey results to develop an atmospheric emission inventory. As a result, the annual emissions in FY 2021 are estimated to be 131 kg of HCB, 371 kg of PCB, 310 kg of PeCB, 385 kg of PCN, and 6.9 kg of HCBD.

Furthermore, as part of emission control measures, efforts to address UPOPs will be promoted alongside measures targeting emissions of dioxins. Survey results indicate that concentrations of UPOPs are lower in facilities with lower dioxin concentrations, suggesting that conventional measures against dioxins may also be effective as measures against UPOPs. On the other hand, certain substances and sources that behave differently from dioxins have been identified. For those substances and sources, ongoing studies are focused on understanding substance-specific formation mechanisms and developing source-specific emission control measures.

Japan hopes to contribute in the future to worldwide reduction of emissions of UPOPs by reviewing emission factors for UPOPs and examining emission control measures, and by disseminating knowledge obtained from such reviews and examinations domestically and internationally. We hope that relevant industry groups and business operators in Japan will continue to work on measures to control emissions of UPOPs by using this document as a reference.