POLICY DEVELOPMENTS OF DIOXIN CONTROL AND WASTE PCB MANAGEMENT IN JAPAN

Yoshida H[1] Seki S[1] Sakai S[2] Takeda N[3]
1Waste Management and Recycling Department, Ministry of the Environment, Kasumigaseki, Tokyo, Japan
2Kyoto University, Environment Preservation Center, Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501 Japan
3 Ritsumeikan University, Research Center for Eco-Technology, Nojihigashi, Kusatsu, 525-8577, Japan

Abstract
In response to the realization that dioxins are generated by waste incineration, waste management policy in Japan was significantly changed by the approval of new programs and the development of advanced treatment technologies in the 1990s. As a result, whereas flue gases of incinerators that started operation before the establishment of new urgent dioxin countermeasures have an average dioxin concentration of 0.38–0.60 ng (WHO-TEQ)/m^3N, and the concentrations are broadly distributed within the range of up to 10 ng/m^3 N, those of facilities that started operation after implementation of the permanent criteria have an average concentration of 0.05 ng/m^3 N, or about one-tenth that of facilities that began operation before their implementation. Furthermore, under the Law Concerning Special Measures against PCB Waste, destruction of stored PCBs, mainly by the Japan Environmental Safety Corporation, has been started.

Introduction
In 1977, the announcement from The Netherlands that waste incineration residues contain dioxins triggered worldwide research on the generation of dioxins by waste incineration[1)]. In Japan, dioxins were detected in residues from waste incineration facilities in Kyoto in 1979, and by 1983 dioxins had been widely detected in residues from other Japanese municipal solid waste incineration facilities, leading to the development and implementation of comprehensive countermeasures[2)]. During waste incineration, dioxins are generated unintentionally by chemical and thermal reactions, and measures to control dioxins have thus been developed along with the evolution of waste management policies in Japan and other countries. Implementation of intensive measures to prevent dioxin formation, focusing on waste management methods, and advancement of comprehensive management by enactment of the Law Concerning Special Measures Against Dioxins in 1999 resulted in the significant achievement of a 95% reduction of total dioxins emission between 1997 and 2003.
In this paper, we describe policies developed at the end of the 20th century in response to the dioxin problem, which arose as a negative heritage of our economic system of mass production, mass consumption, and mass disposal, and we evaluate policy measures related to the PCB problem.

Policy Developments of Dioxin Control in Japan
The realization that dioxins are generated by waste incineration significantly changed the policy on waste disposal in Japan, leading to the approval of new programs and the development of advanced treatment technologies (Fig. 1). The dioxin reduction program emphasizes control of the levels of waste discharge and promotion of recycling, along with wide-area waste treatment. Technical developments in dioxin control have centered on combustion control, advanced flue gas treatment, heat recovery, and proper treatment of incinerator residues. The 3Ts of combustion control are temperature, time, and turbulence: the maintenance of incineration temperature at 850 °C or higher, a residence time of 2 seconds or longer, and efficient gas turbulence; and the level of CO is used as an indicator of safe combustion. The 3Ts have been satisfied mainly by improvements in facility design. Advanced flue gas treatment involves the rapid cooling of flue gases (to approximately 200 °C or less) to prevent the *de novo* synthesis of dioxins. Rapid cooling has been combined with the use of highly efficient dust collectors, such as bag filters, and removal and decomposition technologies involving the use of such agents as calcium hydroxide, activated charcoal, and a de-NO_x catalyst to reduce dioxin emissions. For incinerator residues, practical detoxification technologies for dioxins by melting or heating have been developed. Hiraoka et al.[3)] and Sakai[4)] have described advanced dioxin discharge control technologies in detail.

The effectiveness of the new policies can be seen by comparing dioxin emissions of incinerators according to the time at which they began operation (Fig. 2). We divided incinerators into four groups—those that started operation before the formulation of the old guidelines, those that began operation under the old guidelines,

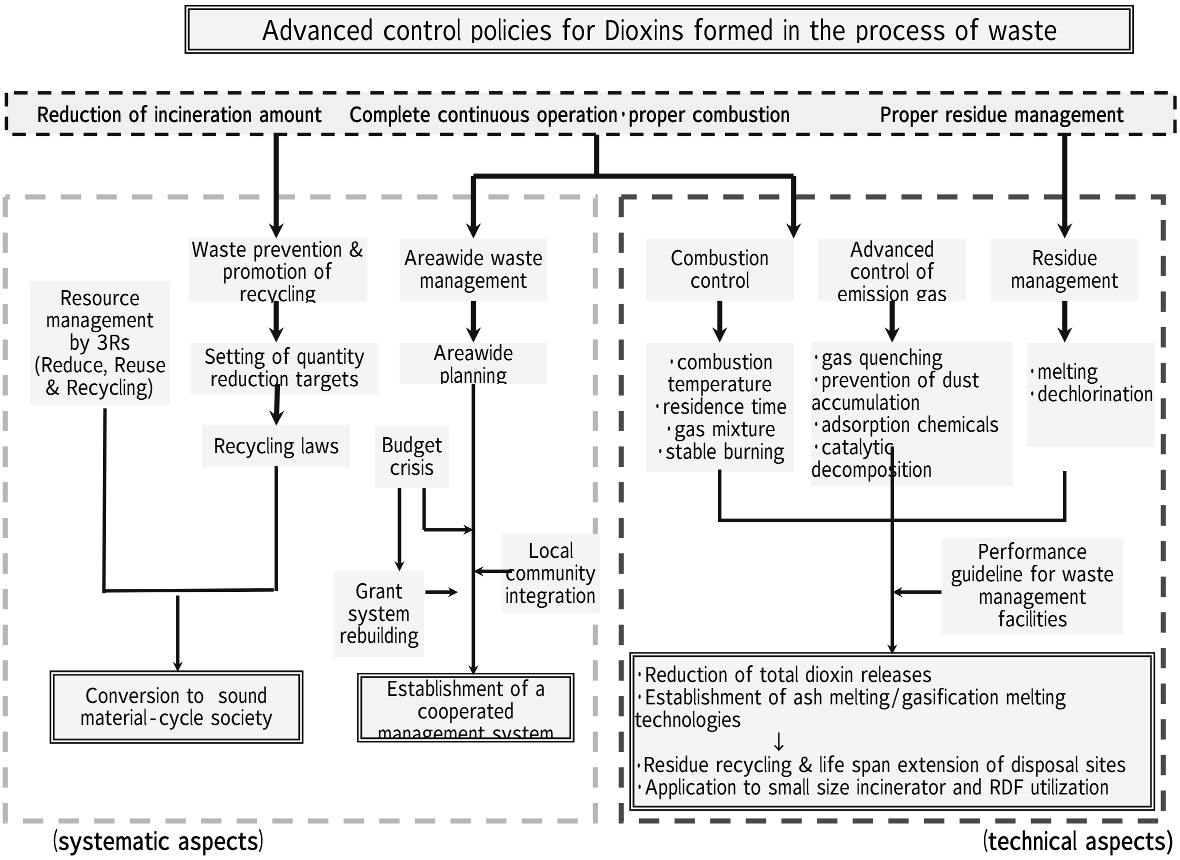

Fig. 1 Policy and technical aspects of dioxin control measures during waste incineration

those that began operation under the new urgent dioxin countermeasure guidelines, and those that began operation after implementation of the new permanent countermeasure guidelines—and investigated the concentration of dioxins in flue gases in relation to incinerator size. In incinerators that began operation before the establishment of the new urgent countermeasure guidelines, the simple average flue-gas concentration of dioxins is 0.38–0.60 ng (WHO-TEQ)/m^{3}N, and the concentrations are broadly distributed within the range of values up to the standard defined for old incinerators (10 ng (WHO-TEQ)/m^{3}N). In those that began operation after the establishment of the new urgent dioxin countermeasure guidelines but before implementation of the permanent guidelines, the simple average concentration is 0.33 ng (WHO-TEQ)/m^{3}N. In those facilities that began operation after implementation of the permanent guidelines, the simple average concentration is 0.05 ng (WHO-TEQ)/m^{3}N, which is about one-tenth that of the facilities that started operating before their implementation. The concentration of dioxins in flue gases of some incinerators is significantly lower than the regulating value for new incinerators (0.1 ng (WHO-TEQ)/m^{3}N). In particular, dioxin concentrations in flue gas from middle-sized and small incinerators significantly decreased.

Development of advanced dioxin control technology promoted the advancement and reconstruction of waste treatment technologies. To promote the development and dissemination of the new technologies, including advanced dioxin control technologies, the Japanese government established performance guidelines and required government-supported projects, which previously had been subject only to structural guidelines, to follow them. Moreover, technologies for dioxin control measures required in the new guidelines effectively controlled the discharge of other environmental pollutants such as ash dust, hydrogen chloride, nitrogen oxide, and heavy metals in addition to controlling dioxin formation, thus showing a synergistic effect. In addition, the necessity of treating incineration residues has led to advances in the technical development of gasification melting furnaces and ash-melting furnaces, which has greatly promoted recycling by residue slag formation, and has increased the life span of final disposal sites. The control technology, which had been limited to large incinerators with a capacity of approximately 100 ton/day or more, was also applied to small incinerators, leading to the development of small-scale facilities with a performance equivalent to that of large incinerators. These technologies are expected to have application to industrial waste treatment projects, and to contribute to dioxin control at remote sites such as on small islands.

Policy Development of PCB Management

In addition to programs and technical systems for the eradication of unintentionally generated dioxins, proper policies for the treatment of PCBs are also essential (Fig. 3). An increase in losses of PCB waste during 30 years of storage became evident, and the development of facilities for the proper treatment of PCB waste had not been promoted. In order to promote PCBs destruction, the Law Concerning Special Measures Against PCB Waste was established in 2003, and policies in accordance with the new law were implemented and advanced treatment technologies were established based on the detailed regulations of the Waste Management Law. For proper treatment of PCB wastes, not only environmental emission of undecomposed PCBs but also dioxin formation during treatment processes must be minimized. Under the Special Law, achievement of total treatment of stored PCB waste by 2016 is obligated, and storage has been continued under strict conditions. To secure proper treatment of PCB waste stored by medium-sized and small businesses, many of which cannot undertake treatment themselves by the time limit, the Japan Environmental Safety Corporation (JESCO) was established to develop and operate five area-wide treatment facilities for PCBs in Japan. Under the Special Law, PCB storage facilities are required to report storage conditions and to ensure proper treatment of the stored PCBs by JESCO, by treatment companies, or by their own facilities. To promote PCB treatment by small or medium-sized storage facilities, a PCB waste

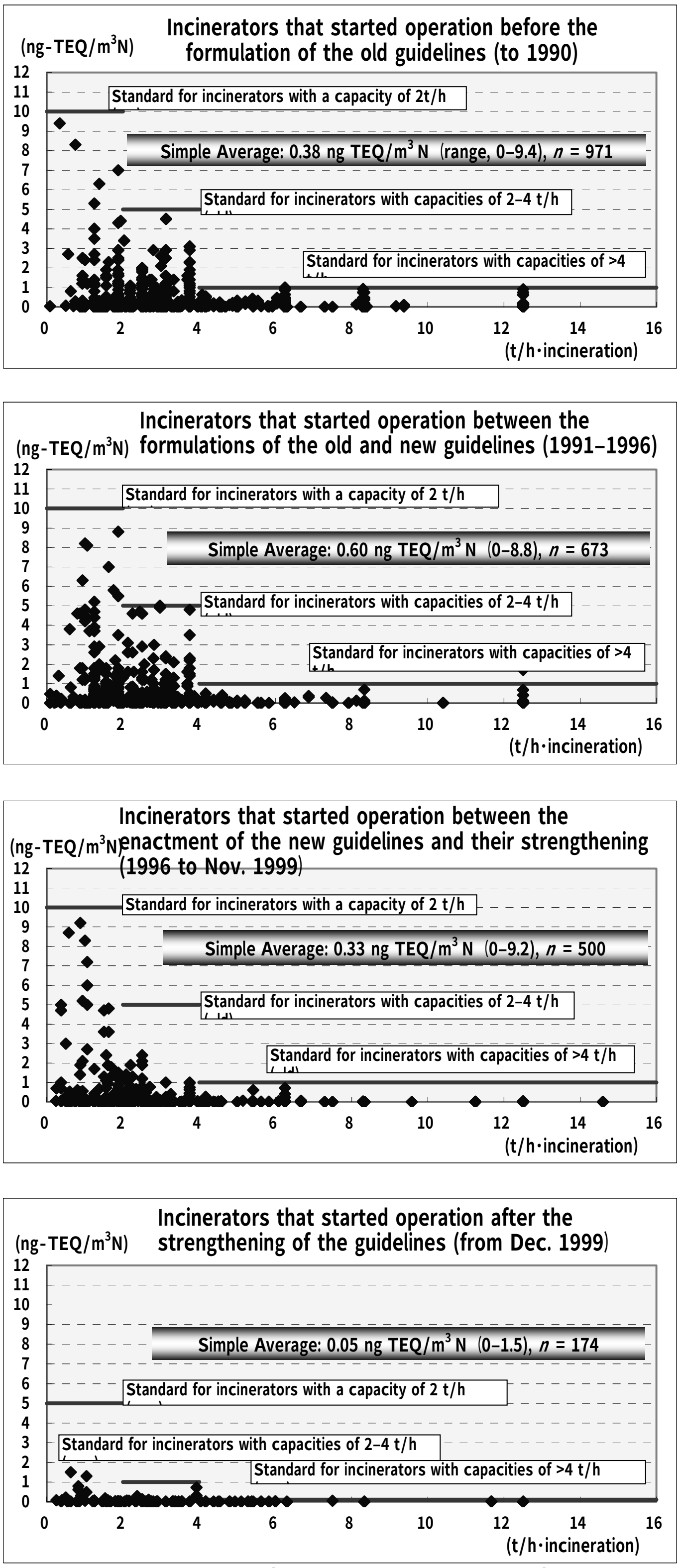

Fig.2 Distribution of the concentration of dioxin by incinerators built during each period of emission control

treatment fund was created with contributions from central and local governments, and a part of PCB treatment expenses is paid from this fund.
PCB treatment technologies have been developed by electric companies, which store PCBs, and by plant engineering companies pursuing the introduction and practical use of overseas technologies. The former Environmental Agency, former Ministry of International Trade and Industry, and former Ministry of Health and Welfare investigated the development and improvement of new technologies. The new technologies, which mainly involve chemical dechlorination treatments, were first standardized with regard to design and maintenance of PCB waste treatment facilities in accordance with the treatment standard newly established by the amendment of the Waste Management Law, before being put into practical use. Currently, in addition to high-temperature incineration methods, technologies such as decomposition by subcritical water oxidation, gas phase chemical reduction, mechanochemical decomposition, and melting decomposition have been introduced. These chemical and physical decomposition technologies all involve the dechlorination of chloride compounds and, therefore, some are also applicable to buried pesticide waste.

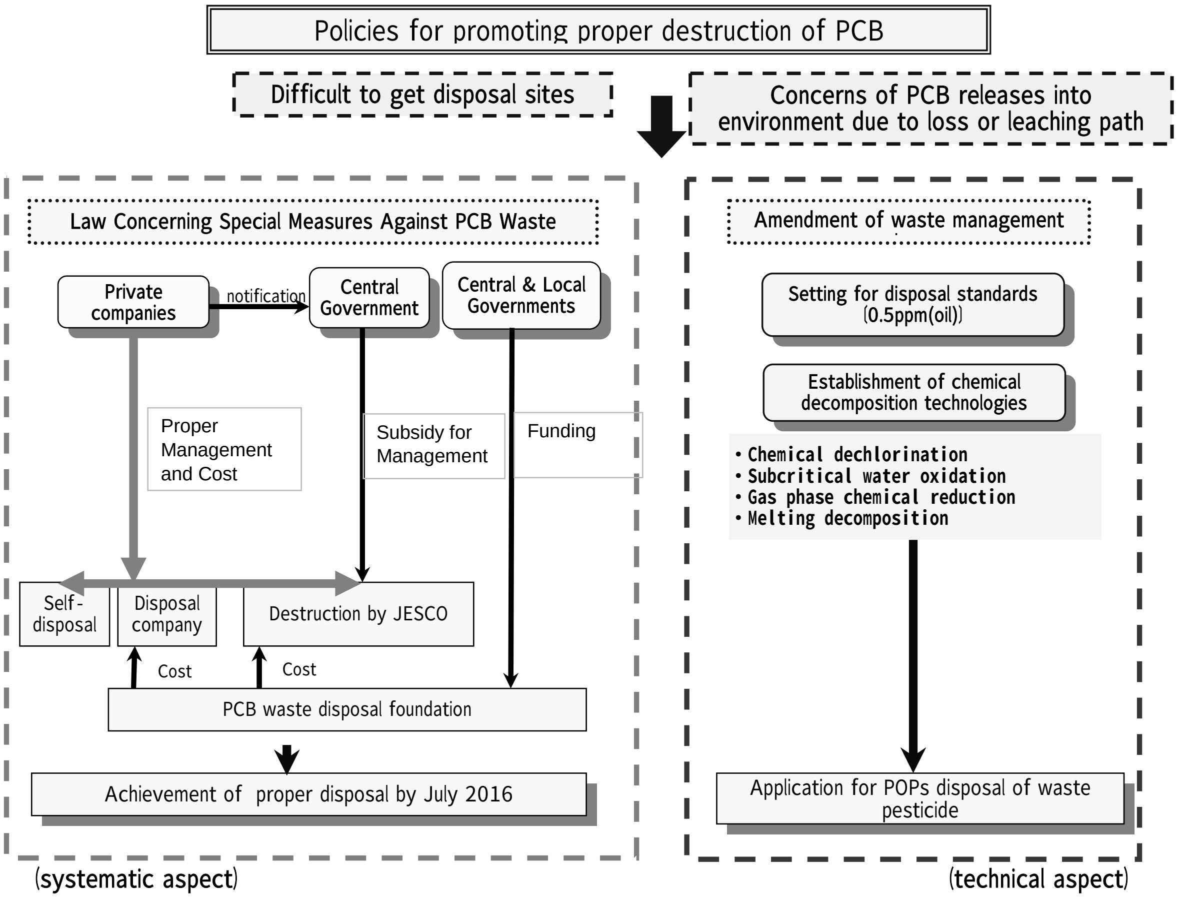

Fig. 2 Policy and technical aspect of the measures for promoting PCB treatment

Acknowledgements
This abstract does not necessarily represent the policy of Japanese Ministry of Environment.

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