Japan's Experience in Dealing with Dioxin Problems

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1. Measures for waste incinerators

The first report that dioxins and furans are emitted from the incinerator of municipal solid waste (MSW) in Japan was made by Prof. Tatsukawa of Ehime University[1,2]. Responding to the report, the Ministry of Health and Welfare organized the "Expert Committee on Dioxin Problem in Waste Disposal". A report by the committee was released to public in May 1984[3,4]. The report refers to the environmental effect by emission gas from MSW incinerators, effect on workers by emission gas from waste incinerators, risk assessment on human health, and consideration on landfill of ash. In the same report, criteria to assess risks of dioxins generated through waste incineration is given as 0.1 ng/kg weight/day (2,3,7,8-TCDD toxic equivalenty). This value was based on the survey at that time. Based on these criteria, the dioxin concentrations reported were considered as such a level as causes no adverse effect on human health by an inhalation route even if maximum human exposure is assumed. It also referred that ash generated by incineration should be treated to prevent dispersion by covering it with soil in landfill sites, and suspended solid in dischrged water should be removed. The Ministry of Health and Welfare notified local governments of these conclusions.

Through 1984 to 1985, the Environment Agency and Ministry of Health and Welfare jointly carried out an urgent investigation of dioxin pollution caused by waste disposal. Its outcome was released in February 1986[5]. Dioxin concentrations in the ambient air around incineratos, stack gas effluent water from incinerators and landfill sites were measured.

Furthermore, through 1985 to 1989, the Ministry of Health and Welfare studied the formation mechanism of dioxins and the possible control by changing operational conditions. As some information was obtained on standardization of analytical method and the formation mechanism of dioxins, the Ministry of Health and Welfare reported through "Expert Committee on Guideline for Preventing Dioxin Generation" a guideline in December 1990, in order to promote dioxin reduction using the best available technologies[6].

The guideline was made with the general understanding that though current dioxin problems concerning waste disposal was no at such high level as to cause any direct harmful effect on human health, dioxin reduction should be pursued at the technically possible level, paying attention to the fact that dioxins persist in the environment for a long period of time. Therefore, it does not aim to provide emission standards of dioxins. It says that control of the combustion temperature, CO concentration and O_2 concentration are important. It also provides the standardiz-

ed analytical method with the calculation of TEQ (2,3,7,8-TCDD toxicity equivalents). The target value for newly established incinerators is 0.5 ng TEQ/Nm3, and it was estimated that if this target could be satisfied, total emission of dioxins would be reduced to one tenth.

The following technologies or methods are recommended in the guideline.

(a) Perfect combustion with proper construction of new incinerator.

(b) Enhanced capacity of flue gas cooling facility in order to lower the temperature of flue gas at the entrance of dust collector.

(c) As for existing incinerators, the proper control of combustion and lowering the temperature of flue gas at the entrance of dust collector, and if necessary modificating the facility.

(d) As for landfill, effluent water treatment and soil coverage.

2. Measures for paper and pulp industry

In October 1990, Prof. Wakimoto of Ehime University reported the detection of dioxins and turans in fish (striped mullet) collected around paper mills in Kawanoe City, Ehime Prefecture[7,8]. Dioxins and turans are detected in all 19 fish samples caught in the estuary of the river. The average value of dioxins in the flanks of striped mullets was 9.4 ppt as TEQ. As congener patterns of dioxins and turans detected in the fishes was similar to these detected in the discharged water of paper mills, paper mills were regarded as pollution sources.

Responding to this report, Japan Paper Industry Association published voluntary guideline to reduce dioxins emission from pulp bleaching[9]. The guideline is a voluntary target for organic chlorines in waste water discharged from paper mills to be 1.5 kg per ton or less as AOX. The measures to attain this target are as follows. a) Removal of lignin in decomposition process is to be promoted. (b) Washing should be sufficiently done in washing and screening process in order to reduce lignin brought into bleaching process. (c) Oxygen bleaching should be introduced into bleaching process or addition of chlorine should be reduced. (d) Coagulation sedimentation or biological treatment should be ensured in waste water treatment process. (e) Sludge generated through waste water treatment process is to be combusted out in principle. The Ministry of International Trade and Industry published a report on measures taken by the Paper and Pulp Industry to reduce formation of dioxins and furans[10].

On the other hand, the Environment Agency, Ministry of Health and Welfare and Fishery Agency, considering it to be urgent to understand the level of dioxin pollution, conducted a national-wide surveillance jointly, and released the result in November 1991[11].

Within the surveillance effluent water from 60 paper mills was analyzed. As for some factories, dioxin emissions from black liquor burning boilers, dioxin levels in air, water and fish around paper mills were also measured.

The main results of the investigation were as follows.

(a) Effluent water contained dioxins, and furans which were mainly generated in bleaching process.

(b) Emission gases from boilers also contained dioxins and furans.

(c) Air pollution and fish contamination levels were almost at the same level as those in control areas. Thus, air and fish leuels were cousidered not to cause aduerse effects on human health.

Based on these results, in order to reduce formation of dioxins and furans the Environment Agency has released the following guideline and has requested promotion of measures to industry associations, local governments and the Ministry of International Trade and Industry[12].

(1) Reduction measures to be taken at paper mills

(a) Dioxin reduction in effluent water

The principal measure is to reduce the amount of chlorine used in processes. Thorough decomposition and washing of lignin, and the introduction of alternative bleaching agent should be pursued. Furthermore, suspended solid should be thoroughly removed through introduction of advanced water treatment system or the proper operation of these facilities.

(b) Dioxin reduction in stack gas

Burning black liquors in boilers should be run under the proper incineration control, and emission gas treatment facilities should be managed properly.

(c) Other general matters

Effects should be done to clarify conditions of dioxin formation and to develop technologies for dioxin reduction as well as reduce transiter of dioxin to solid waste.

(2) Research activities to be promoted by the national government

(a) Effective alternative index for dioxins with a simple and fast measurement method should be developed.

(b) Research by national research institutes to understand the formation mechanism of dioxin and to promote the development of dioxin reduction technologies.

(3) General measures to promote countermeasures against dioxin pollution.

Progress in dioxin countermeasures should be monitored, and further measures could be planned based on the result.

3. Monitoring activities to evaluate the dioxin pollution level in the general environment[13,14]

Other than those described above, the Environment Agency has measured sediments, fish and shellfish in order to evaluate dioxin pollution level in the general environment since 1986. These samples were taken in some rivers, lakes and seas. The results are shown in Table 1.

Another activity by the Environment Agency is the measurement of dioxin concentration in the air, which has been carried out since 1986, representing typical sites from four categories of area; residential area close to industrial plants, residential area in large city, residential area in small and medium city, and background area. The results are shown in Table 2.

4. References

1 *Asahi Shimbun* (November 19, 1983)

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7 *Asahi Shimbun* (October 24, 1990)
8 T. Wakimoto, T. Sakiyama and M. Matsuda; The Coastal Contamination by Polychlorinated Dibenzofurans (PCDFs) from Paper and Pulp Bleaching, *Proceedings of the annual conference of Society of Environmental Science, Japan*, 2B21, 92 (1990)
9 Japan Paper Industry Association; Guidelines for Controlling Dioxins in Paper and Pulp Industry (December 20, 1990)
10 Consumer Goods Industries bureau, Ministry of International Trade and Industry; Controlling Dioxins in the Japan Paper Industry (December 1990)
11 Planning and Coordination Bureau, Enviroment Agency; Investigation on Dioxins from Paper and Pulp Industry (November 1991)
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14 Air Quality Bureau, Environment Agencky; *Kankouchou Kougai Senmon Shiryou*, 25(1), 66–70 (1990)

Table 1. Results of Dioxin Monitoring (sediments, fish and shellfish) (ppb)

substance	year	sediments		fish		shellfish		detection limit
		detection ratio	detection range	detection ratio	detection range	detection ratio	detection range	
2,3,7,8-TCDD	1985	0/51	–	0/51	–			0.01
	1986	0/39	–	2/32	0.001			0.001
	1987	2/37	0.001	0/37	–			0.001
	1988	0/30	–	0/30	–	0/2	–	0.001
	1989	3/33	0.002–0.004	2/32	0.001–0.003	0/3	–	0.001
	1990	7/33	0.001–0.008	5/32	0.001–0.005	0/3	–	0.001
	1991	6/35	0.001–0.006	3/34	0.003–0.005	0/3	–	0.001
	1992	4/36	0.002–0.003	0/34	–	0/3	–	0.001
Octa CDD	1985	37/51	0.1 - 7.6	0/51	–		0.01	
	1986	38/39	0.019–61	7/32	0.006–0.1		0.005	
	1987	37/37	0.008- 2.8	0/37	–			0.005
	1988	29/30	0.011- 2.5	0/30	–	2/2	0.009–0.011	0.005
	1989	31/33	0.014–15	3/32	0.120–0.28	3/3	0.008–0.021	0.005
	1990	30/33	0.010–11	0/32	–	1/3	0.010	0.005
	1991	33/35	0.008–11	1/34	0.019	3/3	0.006–0.027	0.005
	1992	34/36	0.019–14	0/34	–	3/3	0.006–0.018	0.005
2,3,7,8-TCDF	1985	5/51	0.01 –0.05	0/51	–			0.01
	1986	13/39	0.001–0.018	15/32	0.001–0.005			0.001
	1987	18/37	0.001–0.006	7/37	0.001–0.004			0.001
	1988	10/30	0.001–0.009	19/30	0.001–0.008	2/2	0.002	0.001
	1989	20/33	0.001–0.016	9/32	0.001–0.008	0/3	–	0.001
	1990	21/33	0.001–0.020	23/32	0.001–0.020	1/3	0.001	0.001
	1991	22/35	0.001–0.015	8/34	0.001–0.008	1/3	0.001	0.001
	1992	22/36	0.001–0.035	10/34	0.001–0.002	1/3	0.001	0.001

Table 2. Results of Dioxin Monitoring (Air) (ng/m³)

substances	year	residential areas close to industrial areas			residential areas in large cities			residential areas in small or medium cities			background areas		
		samples	minimum-maximum	mean value	samples	minimum-maximum	mean value	samples	minimum-maximum	mean value	samples	minimum-maximum	mean value
T_4CDDs	1986	24	N.D. –0.0049	0.0016	20	N.D. –0.0042	0.0015	28	N.D. –0.0032	0.0009	8	N.D.	–
	1988	24	N.D. –0.0167	0.0049	24	0.0006–0.0078	0.0031	16	N.D. –0.0136	0.0037	16	N.D. –0.0091	0.0025
	1990	24	N.D. –0.0060	0.0022	24	N.D. –0.0094	0.0029	16	N.D. –0.0157	0.0048	16	N.D. –0.0091	0.0031
	1992	24	0.0008–0.0112	0.0031	24	0.0007–0.0274	0.0046	24	N.D. –0.0179	0.0048	12	N.D. –0.0007	N.D.
2,3,7,8-TCDD	1986	24	N.D.	–	20	N.D.	–	28	N.D.	–	8	N.D.	–
	1988	24	N.D.	–	24	N.D.	–	16	N.D.	–	16	N.D.	–
	1990	24	N.D.	–	24	N.D.	–	16	N.D.	–	16	N.D.	–
	1992	24	N.D.	–	24	N.D.	–	24	N.D.	–	12	N.D.	–
PCDDs	1986	24	0.0012–0.0685	0.0342	20	N.D. –0.0861	0.0326	28	0.0021–0.0487	0.0185	8	N.D. –0.0121	0.0068
	1988	24	0.0020–0.1053	0.0288	24	0.0020–0.0558	0.0208	16	0.0054–0.0630	0.0220	16	0.0013–0.0315	0.0108
	1990	24	0.0014–0.0532	0.0216	24	0.0023–0.0923	0.0235	16	0.0009–0.242	0.0376	16	N.D. –0.0401	0.0130
	1992	24	0.0024–0.0637	0.0227	24	0.0021–0.1210	0.0259	24	0.0012–0.1853	0.0256	12	N.D. –0.0061	0.0014
PCDFs	1986	24	0.0021–0.1050	0.0455	20	0.0011–0.1357	0.0447	28	0.0008–0.0604	0.0183	8	N.D. –0.0093	0.0049
	1988	24	0.0033–0.1370	0.0439	24	0.0023–0.1030	0.0337	16	0.0005–0.0723	0.0219	16	N.D. –0.0545	0.0104
	1990	24	0.0005–0.119	0.0336	24	N.D. –0.248	0.0415	16	N.D. –0.255	0.0469	16	N.D. –0.0570	0.0123
	1992	24	0.0015–0.0846	0.0312	24	N.D. –0.1060	0.0308	24	N.D. –0.0776	0.0199	12	N.D. –0.0035	0.0012