EMISSION INVENTORY OF DIOXINS, FURANS AND COPLANAR PCBS IN JAPAN

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Introduction

An emission inventory of dioxins* is annually prepared by the Government in Japan according to the provision of *the Basic Guidelines for the Promotion of Measures against Dioxins* that was established by *the Ministerial Council on Dioxin Policy* in March 1999. One of the important remarks of the Japan's emission inventory is that it is listed by the source which is confirmed to emit dioxins and whose emission amount can be estimated. This implies that dioxins from open burning, forest fires, stored waste PCB, and other unknown sources are excluded in the inventory.

The emission inventory was published in June 1999 for the first time before the Special Law was established. In the first inventory, the emission amounts of PCDDs and PCDFs for the years 1997 and 1998 were estimated using the international toxic equivalency factors (I-TEF (1988)). The second emission inventory was published in June 2000 after the Special Law was established. Therefore, the emission amounts of dioxins including coplanar PCBs were estimated for the 1999 and re-estimated for the years 1997 and 1998 using WHO-TEF (1998), respectively.

The emission inventory is utilized for measuring the achievement of the policy goal of about 90 % reduction by the end of March 2003 that was declared in the above Basic Guidelines and deciding the priority sources for regulations.

In this paper, the methods and materials to estimate emission amount from each major source in the second emission inventory will be introduced, and then, their results and some discussion with regard to them will be shown.

(*) Usually dioxins mean PCDDs and PCDFs, however, after *the Law concerning Special Measures against Dioxins* (hereinafter, the Special Law) was established in July 1999, they get to mean PCDDs, PCDFs and coplanar PCBs according to the definition given by the Special Law.

Methods and Materials

Outline:

Dioxin sources are roughly classified into three categories in the inventory; waste incinerators, industrial sources and other miscellaneous sources. Among these dioxin sources, emission gases from waste incinerators more than 200 kg/h in incineration capacity have been regulated since 1997 based on the Waste Treatment Law. Emission gases from small-scale waste incinerators more than 50 kg/h in incineration capacity and four major industrial sources as well as emission waters from several facilities were regulated quite recently after January 2000 when the Special Law was enacted for existing facilities. Therefore, the availability of the data on emission concentration differs from the kind and scale of the facility concerned and the time because the owners of regulated facilities must measure emission concentration at least once a year according to the above two laws.

In principle, total emission amount from the source having individual emission data is calculated using such data as the sum of emission amount from each facility, whereas total emission amount from the source having no individual emission data is estimated by multiplying relevant emission factor and activity quantity.

Waste incinerators:

Waste incinerators are classified into three classes; municipal waste incinerators and industrial waste incinerators more than 200 kg/h in incineration capacity, and small-scale waste incinerators less than 200 kg/h. Since emission data are available for the first two classes, their total emission amounts were calculated as the sum of the emission amount from each facility. Each emission amount was derived with multiplying dioxin concentration in the flue gas, flue gas volume per unit incineration weight (flue gas volume factor) and annual incineration weight, together. Flue gas volume factor was set 5,000 m3/t for municipal wastes, but several factors were prepared in accordance with the kind of waste for industrial wastes.

As for small-scale waste incinerators less than 200 kg/h in incineration capacity, two methods were applied. One was the method using emission factor per hour and average operation hours and annual operation days. Another was the method using emission factor per unit incineration weight and annual incineration weight. In both cases, the number of incinerators was estimated based on the sample survey on the number ratio of unregulated (less than 200 kg/h)/regulated (more than 200 kg/h) incinerators. The number ratio used here was 1.73.

Industrial sources:

Emission amounts from industrial sources were estimated for 19 business categories including 4 major industrial sources that are regulated. Its method is as follows: First, calculate emission factor per unit production volume using available emission data for some limited number of plants, and then, extrapolate total emission amount with multiplying the emission factor calculated and national annual production volume.

Other miscellaneous sources:

Emission amounts from crematoriums, cigarette smoke and automobile exhaust as well as emissions to aquatic environment were estimated as other miscellaneous sources. They were calculated with multiplying emission factor and activity quantity. For example, emission amount from crematoriums was calculated with multiplying emission amount per body and the number of cremations conducted annually. As for automobile exhaust, dividing into two types of gasoline and diesel automobiles, each emission amount was estimated with multiplying emission factor per fuel consumption derived from exhaust gas concentration and annual fuel consumption. Emissions to aquatic environment were also estimated from emission gas cleaning facilities and wet dust collecting facilities, pulp industry, aluminum production facilities, cleaning facilities for vinyl chloride production and final disposal sites. Estimation methods differ from facility to facility, however, explanations are omitted in this paper since they are quite minor sources less than 1 g-TEQ per year.

Results and Discussion

The result of the estimations of dioxin emission amounts based on the above methods and materials is summarized in the following table. As for small-scale waste incinerators, crematoriums and cigarette smoke, the figures indicated with width mean the difference of estimation methods or emission factors, not the confidence limit.

Table Emission Inventory of Dioxins (PCDDs + PCDFs + coplanar PCBs)

Source	Emission Amount		
	1997	1998	1999
Municipal waste incinerators	5,000	1,550	1,350
	0.037*	0.037*	0.028*
Industrial waste incinerators	1,500	1,100	690
	0.51*	0.51*	0.50*
Small-scale waste incinerators	340 – 591	340 – 591	279 – 481
Crematoriums	2.1 – 4.6	2.2 – 4.8	2.2 – 4.8
Industrial sources			
Electric steel-making furnaces	228	139.9	141.5
Steel industry: sintering facilities	135	113.8	101.3
Zinc recovery facilities	42.3	20.4	18.4
Aluminum production facilities	21.3	19.4	13.6
Others	26.3	25.7	17.6
Cigarette smoke	0.1 – 0.2	0.1 – 0.2	0.1 – 0.2
Automobile exhaust	1.12	1.12	1.12
Final waste disposal sites	0.093*	0.093*	0.093*
Total	7,300 - 7,550	3,310 - 3,570	2,620 – 2,820

Note 1: Unit is g-TEQ/year using WHO-TEF (1998).

Note 2: * indicates emission to aquatic environment.

As shown in the table, waste incinerators are found to be major dioxin sources, especially municipal waste incinerators, the share of which is nearly a half of total emission amount in 1999. Compared with waste incinerators, industrial sources are relatively small and roughly equivalent to small-scale waste incinerators. Other miscellaneous sources, above all, emissions to aquatic environment turn out to be negligibly small. Therefore, emissions to aquatic environment from some industrial sources (pulp industry, aluminum production facilities, cleaning facilities for vinyl chloride production) are not shown in the table even though they are regulated and their emission amounts were estimated.

Another observation is that more than 60 % reduction was achieved during past two years. This result is well reflected in the monitoring result, where the ambient air quality dropped down from 0.55 pg-TEQ/m3* in 1997 to 0.21 pg-TEQ/m3* in 1999. The remaining less than 30 % reduction will be needed to attain the goal of about 90 % reduction by the end of March 2003, however, it is likely to be realized through the compliance with the strengthening of emission standards** after December 2002.

As regards the accuracy of the inventory, it is difficult to make a comment because there are no other information or data to be compared with. It is sometimes pointed out by environmental NGOs that emission data taken by incinerator owners give underestimates because they tend to measure dioxin concentration at the best operation so as to meet the emission standard. However, even once a year, this is the most reliable method as long as estimations are based on actual measurement. More accurate estimation on small-scale waste incinerators between 50 and 200kg/h in incineration capacity will be made in the third emission inventory this year, utilizing the dioxin concentration data of flue gas that is supposed to be measured according to the provision of the Special Law.

Lastly, in connection with the utilization of the inventory as mentioned in the introduction, this inventory shows emission amounts, in other words, "flow to the environment". The dioxin problem is shifting from pollution in the atmosphere and water to contamination in soil, food and human body. Considering such a trend, it is expected a new type of inventory showing material balance, in other words, "stock and flow in the environment" will be needed near future.

(*) The figure is the average concentration in the ambient air of PCDDs + PCDFs at 46 continuous monitoring stations all over the Japan.

(**) For example, emission standard for existing waste incinerator will be changed from 80 ng-TEQ/m3 for all capacity classes to 1, 5 or 10 ng-TEQ/m3 depending on its incineration capacity.

Acknowledgments

The author would like to express great appreciation for the efforts made by the colleagues who worked with the author in the then Environment Agency as well as persons in charge of the then Ministry of International Trade and Industry for industrial sources and the then Ministry of Health and Welfare for waste incineration sources and crematoriums.

References

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2. "Report of Expert Meeting on Emission Control" (June, 1999), *Japanese*