Dioxins from Waste Incinerators and Control Measures Against Them

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Dioxin Control Required for Waste Incinerators

Dioxins from waste incinerators pose so serious a problem that those incinerators may be discarded solely for that reason .

Dioxins from a municipal solid waste incineration process aroused a great concern in Japan, and experts' committee was organized in 1983 to find out whether such dioxins were safe. In 1996, a study group of the Ministry of Health and Welfare suggested a tolerable daily intake (TDI) of 10pg-TEQ/kg/day (a maximum permissible dioxin intake per day per unit human weight, kilogram , of 2,3,7,8-TCDD or its equivalent, 10 pg). This refreshed the doubt about the safety of municipal solid waste incineration. The Committee for Study of Control Measures Against Dioxins Originating in Waste Treatment Processes was formed to address the issue anew. The Risk Assessment and Study Committee of the Environment Agency came up with a reference risk assessment value of 5 pg-TEQ/kg/day in December, 1996. These TDI and reference assessment values were suggested as an index of the physiological risk from dioxins, obtained by dividing a no observed adverse effect level (NOAEL) value of 1 ng-TEO/kg/day by an uncertainty coefficient of 100 or 200.

The Committee for Study of Control Measures Against Dioxins worked out a dioxin reduction program to prevent the amount of dioxins from exceeding the suggested TDI. In January, 1997, the Ministry of Health and Welfare adopted this program as the basis for new guidelines. According to the guidelines, TDI will not be exceeded if the dioxin concentration in the exhaust gas from a municipal solid waste incinerator is 80 ng-TEQ/Nm^3 or less, and that incinerator may be considered safe. A continuous combustion type incinerator believes that dioxin reduction to 0.1 ng-TEQ/Nm^3 can be accomplished by use of the best available technology developed. It anticipates that reduction to 5 ng-TEQ/ Nm^3 can be effected by intermittent furnace operation and that reduction to 1 ng-TEQ/ Nm^3 is possible by modification or the like of all existing continuous combustion type incinerators.

Similar technical action is demanded in respect of small-scale incinerators other than municipal solid waste incinerators. In August, 1997, the Environment Agency revised part of the Enforcement Order for the Air Pollution Prevention Law, and the revised provisions require dioxin reduction action of all of the 11,556 waste incineration plants (at the end of 1995) with a fire grill space of $2m^2$ or more or an incineration capacity of 200kg/h or more under the said

Enforcement Order. Also in August, 1997, the Ministry of Health and Welfare revised the enforcement orders or enforcement rules for the waste disposed and public cleansing laws, and under the revised orders or rules, an establishment permit is a requisite for smaller-scale plants also; thus the structure standard and the maintenance and management standard were reinforced from the standpoint of dioxin emission reduction.

Basic Approach For Waste Disposal and Dioxin Emission

The fundamentals of waste management are the control of waste generation, conversion of discharged waste into resources to the maximum practicable extent, its reuse, its intermediate treatment for stabilization, detoxification and volume reduction and its sanitary final disposal. The most widely used way of intermediate treatment is incineration. Among all intermediate treatment processes, incineration is outstandingly effective. It reduces waste to 1/10 of its original weight and 1/20 of its original volume. It turns corruptive organic substances into inorganic matter and exterminate pathogenic living things by heat. Incineration, with such excellent stabilization and detoxification effects, has been extensively used in Japan. Incineration plays a key role in waste disposal. Seventy-five percent of domestic waste is incinerated in this country, and there are 1,854 incineration plants for municipal solid waste and 3,376 such plants for industrial waste. The serious hazards emotion associated with dioxin emissions from such plants, however, puts a curb on the construction and expansion of incineration plants, giving rise to doubt about the continuation of the necessary proper waste disposal.

In September, 1996, a general inspection and investigation program was undertaken to determine the dioxin concentration in the exhaust gas from incinerators, and plentiful data were collected through that program. When the new guidelines were publicized in January, 1997, data on 585 incineration plants were analyzed. Sharp dioxin reduction was noted at that time. The average value for all continuous combustion type incinerators was 14ng-TEQ/Nm^3, and the maximum value 200ng- TEQ/Nm^3. In the case of those semi-continuous combustion type incinerators and batch type incinerators to which the old guidelines were not applicable, the maximum value was as high as 990ng- TEQ/Nm^3, the average value being 51ng- TEQ/Nm^3. On the other hand, the maximum value for the incinerators to which the old guidelines were applicable was down sharply to 80ng- TEQ/Nm^3, and the average value to 8ng- TEQ/Nm^3.

The highest among all dioxin emission concentration measurements made of the 1,150 incineration plants subjected to the Ministry of Health and Welfare's investigation was above 1,000ng- TEQ/Nm^3. At some exceptional plants, the concentration did not drop below 80ng-TEQ/Nm^3, a specified marginal level demanding emergency remedial action, although the combustion temperature was 800℃ or more. Thus there was no definite correlation between the combustion temperature and the dioxin concentration in the exhaust gas. The concentration measurement was over 80ng- TEQ/Nm^3 at 72 out of the 1,150 plants, that is, a little below 6%. It was also discovered that the measurement at a very small number of plants was 0.1ng-TEQ/Nm^3 or less. Incidentally, the emission concentration exceeded the marginal level of 80ng- TEQ/Nm^3 at 105 out of the 1,496 plants covered by the investigation according to the summary completed at the end of May, 1997.

If the dioxin emission concentration of a waste incineration plant is 80ng- TEQ/Nm^3, the exposure of a person living in an area with the highest dioxin ground-level to the dioxin emissions from the particular plant is estimated at approx. 1% of that person's total dioxin

intake from all sources. The human exposure outside that area is supposedly far smaller. Hence the greater part of man's dioxin intake comes from food. Accordingly, so long as the dioxin emission concentration in the exhaust gas is not above the marginal level of 80ng- TEQ/Nm^3, there is no need to worry about the physiological hazard from dioxin emissions from a local waste incineration plant. But dioxins are carcinogenic, and no definite threshold value is known. It is therefore obviously advisable to avoid large dioxin intake. It is expected that the dioxin emissions can be reduced to the level prescribed by the guidelines using the best available technology in such a way as to reduce dioxins to the maximum technically practicable extent. In some European countries, a concentration of 0.1ng- TEQ/Nm^3 was suggested as that maximum extent.

Control Measures Against Dioxins

To reduce dioxin emissions, both structure standard and maintenance and management standard were reinforced, and the new standards were put in force on December 1, 1997.

The aim common to these standards is the reduction of dioxin emissions by thorough performance of the following three actions:

Control of dioxin generation by complete combustion of waste matter, quick cooling of the combustion gas to prevent re-generation of dioxins and high-grade processing of the combustion gas to lower the dioxin concentration in the exhaust gas.

The measures necessary for implementation of the above at an incineration plant are indicated in the standards.

Table 1 presents the revised dioxin emission concentration standard applicable to new and existing incineration plants. Control levels of 5, 1,0, 1ng- TEQ/Nm^3 were prescribed for certain specified substances according to plant scale in respect of new incineration plants. It is hard for a fixed-bed incineration plant to meet this requirement. It will be necessary to equip the plant with a stoker furnace or an equivalent with a relatively sophisticated structure.

A control level of 80ng- TEQ/Nm^3 was prescribed as the requirement for specified substances to be met by existing incineration plants by December 1, 1998. Proper combustion control, improvement or modification of plant facilities or the like will have to be carried out at individual plants. For those plants where existing facilities are to be kept in operation as at present, plant manufacturers are in competition among them to develop a technique to reduce the dioxin emissions to the prescribed control level in order to meet the requirement, 10, 5, 1ng- TEQ/Nm^3 based on the plant scale, by November 30, 2002. Only a very few developments have been brought into practical use so far, but more of such developments will be tried in the future.

Under the present governing law, the structure standard and the maintenance and management standard are not applicable to incineration plants with a capacity of less than 200kg/h or a fire grill space of less than $2m^2$. An incinerator structure and a combustion method are specified in the "Procedural Standard Concerning Incinerator and Combustion Method" for those plants. Stricter regulation was introduced against a set-up for nothing more than outdoor burning.

Matters To Be Studied

It is believed that a human being's exposure to dioxins, even if he or she lives in the area with the highest ground-level dioxin concentration, does not exceed the tolerable daily intake if the dioxin emission concentration of a local waste incineration plant is 80ng- TEQ/Nm^3.

It is expected that dioxin emissions will be reduced to the specified control level for specified substances by use of the best available technology so as to achieve cut-down to the maximum extent technically practicable.

It is important to conduct guidance based on guidelines or the like to be prepared from time to time for small incineration furnaces, from the standpoint of proper disposal. To prevent an attempt to evade the application of the regulatory provisions by establishing two or more small-scale plants separately, guidance should be provided so as to impose the pertinent regulation on the combined capacity of such separate plants.

Disposal of municipal solid waste and industrial waste similar to such municipal waste in composition together deserves a study from the standpoint of dioxin control. Due attention must be directed to small incinerators from the standpoint of environment conservation and risk reduction even if their chimneys are short and their disposal capacity is small. It is urgently necessary to foster engineering supervisors capable of maintaining and managing a plant with due consideration given to the development of a new dioxin reduction process for small incinerators in particular and dioxin cut-down at plants in general and upgrade the capabilities of such supervisors.

Recently the experts' committee of WHO (World Health Organization) has decided to lower TDI for dioxins from 10pg- TEQ/kg/day at present to 1 to 4pg- TEQ/kg/day. The Ministry of Health and Welfare and the Environment Agency will discuss the action to be taken in response to this decision.

Table 1 Concentration Standard for Dioxins in Exhaust Gas Contained in Maintenance and Management Standard (Control Standard for Specified Substances Under Air Pollution Prevention Law)

Disposal capacity of combustion chamber	Standard for new plant	Standard for existing plant		
	From Dec. 1, 1997	Until Dec., 1998	1998 to 2002	After 2002
4t/h or more	0.1ng- TEQ/Nm^3	Application of the standard was suspended.	80ng- TEQ/Nm^3	1ng- TEQ/Nm^3
2t/h to 4t/h	1ng- TEQ/Nm^3			5ng- TEQ/Nm^3
Less than 2t/h	5ng- TEQ/Nm^3			10ng- TEQ/Nm^3

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