SOURCES OF DIOXIN EMISSIONS IN THE NETHERLANDS

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Introduction
In 1989, high dioxin concentrations were found in cow's milk in the Netherlands originating from areas near Municipal Solid Waste (MSW) incinerators. Knowledge on the distribution of emitted dioxins into the environment and especially the exposure of cows to dioxins was restricted. This induced the Dutch government to set up an extensive programme for measuring dioxins emitted from all possible sources in the Netherlands, and for determining routes of exposure and possible risks for the Dutch population. This research programme was carried out jointly by the Netherlands Organization for Applied Scientific Research (TNO) and the National Institute of Public Health and Environmental Protection (RIVM).

In 1990, the dioxin emissions from all Dutch MSW incineration plants were measured. On the basis of distribution research programmes a relation between dioxin emissions and concentrations in cow's milk could be formulated[1]. Sources other than MSW incinerators, the subject of this paper, were investigated in 1991[2].

Selection of processes
Measurements at sources other than MSW incinerators had previously been carried out on a limited scale. In cooperation with the regional Inspectorates of Public Health for Environmental Protection, an inventory of possible dioxin sources was made for setting up a complete measuring programme[3]. On the basis of the results of this inventory, a number of additional measurements were carried out at industrial sources not previously measured. The results of emission measurements at about 60 industrial installations are now available. These results were evaluated to estimate the dioxin emissions for the different process categories, and the total dioxin emission in the Netherlands. In some cases, additional information from the literature was used to estimate totals.

Accuracy
As far as possible, one or more measurements were carried out at installations considered to be representative of the respective process category. Measurements were carried out at more installations belonging to process categories where higher contributions were expected. By doing so, the emission estimates from the most significant sources (thus the greater part of the total emission) will be the most accurate.

Results

Present situation (1991)
All processes measured appeared to have measurable dioxin emissions. The dioxin flue-gas concentrations measured at MSW incinerators varied from 1 to 92 ng TEQ/m^3 (at 11% O_2 , TEQ according to NATO/CCMS)[1]; for the other process categories concentrations varied from 0.001 to 19.5 ng TEQ/m^3. The quantities emitted per installation varied from 0.8 to 234 g TEQ per year for MSW incineration plants, and from 0.02 mg to 24 g TEQ per year for the other process categories.

In 1991, a total of 484 g TEQ was emitted into the air in the Netherlands (for 1989 this amount was estimated at 960 g TEQ per year[3,4]; the difference between 1989 and 1991 is mainly caused by the shut-down and improvement of several MSW incineration plants). This figure does not include emissions from accidental fires. The table below presents the estimated annual emissions per process category in 1991. In addition, an estimate has been made for the year 2000.

Process category	1991 Annual emission [g TEQ]	2000 Annual emission [g TEQ]
- Municipal solid waste incineration	382	max. 4
- Incineration of hazardous waste	16	1.7
- Incineration of landfill, biogas and sludge	0.3	1.5
- Burning of cables and electromotors	1.5	1.5
- Waste incineration at hospitals	2.1	0
- Asphalt-mixing plants	0.3	0.3
- Combustion of oil	1.0	1.0
- Combustion of coal and lignite	3.7	3.7
- Combustion of wood	12	9
- Crematoria	0.2	0.2
- Traffic	7.0	max. 5
- Sintering processes	26	3
- Metal industry	4.0	4.0
- Chemical production processes	0.5	0.5
- Use of wood preservatives	25	20
- Various high-temperature processes[1)]	2.7	2.7
- Accidental fires	?	?
Total (exclusive of accidental fires)	484	max. 58

[1)] Soil cleaning, fly-ash drying, cement production, production of glass/mineral wool, etc.

From this table it can be seen that in 1991 79% of the total dioxin emissions into the air were caused by MSW incinerators. The remaining 21% were spread over 16 process categories. Precise emission figures are known (from the various measurements carried out) for sintering processes (5.4% of the total) and for hazardous waste incineration (3.3%). The emissions due to cable burning (0.3%), wood combustion (max. 2.5%) and the former use of wood preservatives (5.2%) are the least precise. Due to the lack of data, the emissions by accidental fires cannot be reliably indicated.

Estimates for the different process categories were also made with respect to the quantities of dioxins in residues from combustion processes. Specifically at MSW incinerators, these quantities are considerable, i.e. 1030 g TEQ per year. For all process categories combined, the emissions via residues were estimated at 1050 g TEQ per year. The emissions to surface water were approximately 3 g TEQ per year.

Future developments
An emission standard of 0.1 ng TEQ/m^3 for new MSW incineration plants has been included in the Dutch Incineration Decree. This decree is based on the principle of best technical means. In 1995, the decree will also become operational for existing installations. Extensive measures are currently being prepared for sintering processes, hazardous waste incineration and hospital waste incineration in order to reach an emission reduction below 0.1 ng TEQ/m^3. Attempts are being made to stop the domestic combustion of polluted wood through good advice, which should result in decreased dioxin emissions for wood combustion. For traffic, an emission reduction is expected as a result of the increasing use of unleaded petrol. As a result of the ban imposed on the use of pentachlorophenol in wood preservatives in 1989, the emission of dioxins caused by the use of preservatives will decrease independently. Since there will be a sharp increase in the quantity of sludge to be incinerated in the future, the dioxin emission in this process category will rise.

As a result of the developments mentioned above, dioxin emissions will change in the coming years, as shown in the table. A total annual emission of about 58 grams TEQ (max.) is expected for the year 2000.

The table also shows that in the future the former use of wood preservatives will probably be the largest source of dioxin emissions in the Netherlands, although the absolute value is much lower than the present total of dioxin emissions. These emissions are diffuse and cannot be affected (see above). Research in this field is therefore not recommended.

The estimate of the dioxin emissions from wood combustion is not very accurate. Because wood combustion could probably be the second largest source of dioxin emissions in the future, additional research is recommended to establish a more precise level of such emissions from wood combustion.

Although the emissions from accidental fires cannot be quantified, there are indications that this source can certainly not be neglected. Emission measurements on open fires with different materials are desirable in order to establish the importance of the source.

Dispersion of dioxins through air and the risks for public health
The major route of human exposure to dioxins is through food consumption, especially of milk and dairy products. On the basis of distribution research programmes, a chain model has been developed. With this model, a quantitative relation between dioxin emissions and dioxin concentrations in cow's milk can be given. In 1991, the calculated background deposition in the Netherlands was 8 ng TEQ/m^2.year, 50%

of which was contributed by foreign sources. A reduction in the dioxin emissions to about 58 g TEQ per year will decrease the background deposition from 8 ng TEQ/ m^2.year to about 4 ng TEQ/m^2.year, assuming that the contribution of foreign sources remains the same.

Further calculations using the model show that in the surroundings of none of the industrial installations the Dutch standard for milk (6 pg TEQ/g milk fat) was exceeded in 1991. A decreasing background deposition will also result in lower background concentrations in cow's milk. In the year 2000 the background concentration in cow's milk will depend for more than 90% on emissions from foreign countries (assuming unchanged emissions in these countries).

Cow's milk originating from an area near one of the Dutch MSW incinerators still has a dioxin level which is too high. It is expected, however, that in the course of 1993 this concentration level will decrease to below the standard.

Conclusions

As a result of measures already taken, the total dioxin emission in the Netherlands decreased from approximately 960 g TEQ per year in 1989 to 484 g TEQ per year as established in 1991. When all measures now anticipated for emission reduction have been taken, the emission will not exceed 58 g TEQ per year in 2000. In that case, the background deposition in the Netherlands will drop from 8 ng TEQ/m^2.year in 1991 to 4 ng TEQ/m^2.year in 2000, and will then for more than 90% be dependent on emissions in foreign countries.

The standard for dioxin in milk was not exceeded in 1991, with the exception of one area. In the years to come this situation will improve and the standard will be met everywhere.

In 2000, wood combustion will possibly be the largest dioxin source in the Netherlands that can be influenced. However, as little precise information about the magnitude of this source is available, research in this field is recommended. This recommendation also holds for emissions from accidental fires. At the moment an estimate of the magnitude of this source cannot be given at all.

References

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