European policy on dioxins: past, present and future.

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Abstract.

This article describes the role played by waste incineration plants in the political decision to introduce the emission standard of 0,1 ng TEQ/m^3 for dioxins and furans. It outlines European legislation on this subject and indicates the principal sources of dioxins. It also forecasts future developments up to the year 2000.

After the disaster at Seveso in 1976, Dutch scientists began to suspect that waste incineration plants might emit dioxins into the atmosphere. In the summer of that year Hutzinger, Olie en Vermeulen from the University of Amsterdam began a study of three municipal waste incinerators (MWI). The publication of their findings on 26 July 1977 caused a great stir in the press,[1)] and from then on the subject became a political issue. The initial political reaction was muted however. The University of Amsterdam was asked to conduct further studies of dioxin emissions from all waste incinerators in the Netherlands. This follow-up study was published in 1980.[2)] Some of the findings are summarised in table 1.

Table 1

PCDD/F from MWI's in 1979.
Average concentration and output

PCDD and PCDF	Fly ash		Flue gas	
	ng/g	kg/a	ng/m^3	kg/a
PCDD sum	2056	123.3	1540	21.6
PCDF sum	1309	78.5	1322	18.6
PCDD/F-TEQ 1979		10.0		1.9

Again, Dutch politicians were restrained in their response on the publication of these results. The significance of the figures was difficult to assess. The Dutch National Institute of Public Health and Environmental Protection (RIVM) and the Netherlands Organization for Applied Scientific Research (TNO) were commissioned to conduct further research. More measurements were requicre d and the significance of the figures needed clarifying. No research carried out anywhere in Europe at this time (Buser, Bosschardt & Rappe) resulted in political measures being taken. Clearly, it was still early days.

By the early eighties, it was well known that waste incinerators emitted dioxins. The question was what levels of emissions were acceptable. The RIVM proposed a tolerable daily intake (TDI) of 4 pg TEQ/kg body weight at a meeting of the World Health Organization (WHO) in 1982, and this limit was actually introduced in the Netherlands. The figure was based on tests on laboratory animals and embodied a saftey factor of 250 instead of the usual figure of 100 for extrapolation from rat to man. In 1991 the WHO set a standard of 10 pg I-TEQ/kg body weight.

In 1982, however, there was still no clear understanding of what TEQ was *supposed to mean. The TEF values for the I-TEQ were fixed by* NATO-CCMS only in 1989. Even today we cannot reach agreement on these values internationally, with the result that there are numerous other TEQs in addition to the I-TEQ. Another question is whether, in additon to the current 17 PCDDs and PCDFs, other substances should be added to the list. Research has clearly shown that this is desirable.

The dioxin problem takes different forms in different European countries. Either no information on this subject is available, or there is a reluctance to provide it. Consequently , it is difficult to produce an overview of total dioxin emissions in each country. An attempt is made in table 2.

Table 2

PCDD/F emissions from some European states (estm.g TEQ/a)

States	Year	MWI	Total	States	Year	MWI	Total
Holland	1991	382	484	UK	1989	1150	3870
Germany W	1991	432	926	Sweden	1993	5	85
Belgum	1990	550	680	France	1985	1300	2100
Denmark	1987	34	120	Austria	1989	3	110

The eighties saw major advances in our understanding of the mechanisms involved in the formation and breakdown of dioxins. The work of Vogg and Stieglitz is particularly important in this regard.[4)] They established that the optimum temperature for the formation of dioxins in incineraton processes was 300°C(de-novo synthesis). This clearly brought out the importance of what happens after the incineration stage as most E-precipitators work best at a temperature of 300°C and therefore produce a lot of dioxins. Boscak has ascertained in practice that there is a connection between dioxin emissions and chimney temperature at MWIs.[5)] Brem shows for two types of waste incineration plants in the Netherlands that dust, CO peaks and carbon concentrations in the E-precipitator ash are parameters for the formation of dioxins.[6)] The lastest discovery in this field is that precursors, together with Cl adsorbed onto carbon, are blame for the formation of dioxins. At Dioxin 92 Hagenmaier presented an overview of the mechanisms whereby dioxins can be broken down at the process stage.

The cleaning techniques used after the process stage were mainly developed in Sweden. Measurements made in 1985 at the Malmö plant, built in 1981 and modified in 1983, showed that a dioxin concentration in the exhaust gases of 0,1 ng TEQ/m^3 can be achieved.(Carlsson).[7)] This value was later to take on a special significance in Europe and beyond. On 7 May 1987 the Swedish government issued guidelines for waste incineration plants. They contained the following values for dioxin emissions: 0,1 ng TEQ/m^3 for new plants and 0.5-2.0 ng TEQ/m^3 for existing plants (Eadon). This was the first move by a European state to introduce standards for dioxin emissions from waste incineration plants. The development of end-off-pipe techniques could only gather pace once other countries had introduced the standard of 0.1 ng TEQ/m^3, which started to happen in 1989. The discovery of an excessive concentration of dioxin in cow's milk in the Lickebaert area of the Netherlands accelerated the formulation of emission standards. In 1989 a statutory measure was introduced in Austria and absolutely binding incinerator guidelines in the Netherlands. The following year saw the introduction of similar measure (17.BImSchV) in Germany. All these measures set the permissible limit for dioxin emissions from MWIs at 0,1 ng TEQ/m^3.(table 3).

Table 3

Some European emission standards for MWI's (mg/m³)

	S '87	A '89	NL '89	D '90	EG '89	EG/HWI
Dust	20	15	5	10	50	10
CO (CO/CO_2)		(0,002)	50	50	100	-
C		-	10	10	20	10
HCl	100	10	10	10	50	10
HF	5	0,7	1	1	2	1
SO_x		50	40	50	300	50
NOx		100	70	100	-	-
Σ H-metals		0,5	1	1	5	0,5
Hg	0,08	0,05	0,05	0,05	0,1	0,05
Cd		0,05	0,05	0,05	0,1	0,05
PCDD/F ng TEQ/m³	0,1 0,5-2,0	0,1	0,1 (0,4)	0,1	-	0,1

These standards created a large market in Europe for the necessary equipment and its technical development progressed in leaps and bounds. AVICON, wich includes the Hamburg-based GRP cosultancy and the Dutch DHV consultancy, reported in late 1989 that a value of 1 ng TEQ/m^3 was possible for new plants but that this value was still not feasible for existing plants.[8] However values of less than 0,05 ng I-TEQ/m^3 are already being attained with existing plants, thanks to the carbon box, dry scrubbers and fabric filters with lime and carbon, special catalysts in SCR equipment for DeNOx, and H_2O_2 equipment.

Measuring methods and techniques are also undergoing important changes. Not until 1985 did it become posseble to measure dioxin at all reliably in the chimneys of waste incinerators. A large number of sampling and analytical methods are now used. The desire to standardise these methods is clearly having an effect. In the Netherlands a survey was recently conducted in which the results of analyses carried out by 6 institutes were compared (RIVM).[9] A regulation concerning sampling methods and guidlines for carrying out analyses have since been published (VROM).[10] In a European context, the European Commitee for Standardisation (CEN) is currently making a comparison of various sampling methods. Initial findings show that the results are resonably comparable. The tests will be continued. There are now sufficient suitable measuring and analytical methods and specialised institutes to make the enforcement of the 0,1 ng TEQ/m^3 a practical proposition.

In addition to waste incinerators there are several other important sources of dioxins. Originally the main ones were the paper and pulp industries, but these sources are now of little significance. In the Netherlands a survey of the other sources has recently been carried out, the results of which will be presented by de Koning at this symposium. Table 4 shows the most important results of similar research carried out in Germany, the UK and the Netherlands. Clearly the figures do not compare very well. The figures given for Germany relate solely to fomer West-Germany. Most of the figures for both the UK and Germany concern incineration processes only. A futher international study maybe worth while.

Table 4

PCDD/F emission sources in some European States (g TEQ/a)

Source	UK'89	D'91	NL'91	NL2000
Municipal waste incin.	1150	432	382	2–4
Hazardous waste incin.	11	72	16	1,7
Hospital waste incin	32	5,4	2,1	0
Sludge, biogas incin.	?	1,1	0,3	1,5
Cable burning	?	?	1,5	1,5
Oil combustion	?	1,2	1,0	1,0
Coal combustion	1489	2,9	3,7	3,7
Vehicle exhaust	613	12,6	7,0	0,5–5
Non ferro metal indust.	?	380	4,0	4,0
Sintering/steel mills	?	19	26	3
Wood conservation PCP	?	?	25	20
Other sources	559	?	15,7	12,7
Total	3870	926	484	58

Table 4 contains a forecast of emission levels in the Netherlands in the year 2000. A sharp drop in emissions is expected. The figure fell from 960 g I- TEQ in 1989 to 484 g I-TEQ in 1991 and is expected to be no more than 58 g I-TEQ in 2000.[11] In 1989 waste incinarators were by far the largest source of dioxins in the Netherlands, accounting for over 80% of total emissions.[12] After anti-emission measures have been taken at the last few waste incinerator plants in 1994, the only remaining sources of any significance will be timber treated with PCPs and the burning of wood in open hearths. In other countries industrial sources are often the most important. As with waste incineration plants. emissions policy should concentrate on a process-oriented approach. The use of the dioxin decomposition mechanisms mentioned by Hagenmaier, such as biodegradation, chemical destruction, ozonisatiön, thermal destruction and catalytic destruction, often bring rapid success. It should be borne in mind that converting dioxin pollution into other forms of pollution cannot be continued indefinitely. Many waste incineration plants still produce too much unusable waste. This is regrettable because there are already many plants where this waste can be transformed into raw materials. When considering designs for new plants, this should be taken into account.[13)]

The measures taken in different countries reflect their political system. Some implement statutory measures, while others issue guidelines. The Dutch approach is to give industry the freedom to find and implement solutions for itself, but only if it has clearly expressed a willingness to take responsibility for this. Targets are laid down in contracts which each sector of industry. This is known as target group policy. The targets are derived from the objectives contained in the National Environmental Policy Plan.[14)] In addition to these sectoral agreements, there is also a decentralised licensing system. Statutory measures are taken at the central government level and guidelines are issued where necessary. Future developments in the EC are important as far as Europe is concerned. The agreement that hazardous waste may be incinerated only if the resulting dioxin emissions are less than 0,1 ng I-TEQ/m^3 gives hope for the future.

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