Estimated evolution of dioxin emissions in Belgium from 1985 to 1995.

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1. Introduction

Belgium is one of the nations that subscribed the Oslo and Paris Conventions for the Protection of the North Sea. During the Third Ministerial Conference at the Hague in 1990, a committment was made to reduce discharges of dioxins via all pathways into the North Sea by 70 % from 1985 to 1995.
The environmental policy in Belgium largely falls under the authority of the 3 Regions of the federation : Flanders, Wallonia and Brussels. In order to achieve the target reduction an emission inventory was made based on measurements available for Belgium and on emission factors obtained in other countries.

2. Sources of dioxin emission

The main sources of environmental dioxin release in Belgium are identified as waste incineration, industry and energy use and production.
Few measured data of dioxin emissions before 1990 are available. More recently the three Belgian Regions organized several measuring campaigns on incineration facilities for municipal, industrial and medical waste.

2.1. Waste incineration

At present waste combustion especially of municipal waste is the major source of dioxin emissions in Belgium. Most MSWI facilities are small scale and older than 20 years. Since 1993 the emissions of all 23 municipal waste incinerators in Flanders and some in Wallonia and Brussels were analyzed for dioxins. The results indicate the emission depends among other things on the flue gas cleaning system. Consequently incinerators were classified according to their pollution control equipment with emission factors to air from 2.5 (with dioxin removal) to 240 µg TEQ/ton (ESP). Dioxin emissions to water were calculated with an emission factor of 0.09 µg TEQ/ton.
Hospital waste usually has higher chlorine concentrations than MSW and the hospital incinerators are smaller and less efficient than MSWIs. Emission measurements on 4 installations showed a very high average emission factor of 2 250 µg TEQ/ton.
The emission factors for the incineration of industrial waste depend on the type of waste, the combustion facility and the gas cleaning system. Emission factors between 2 and 163 µg TEQ/ton are found in the literature[1-4]. In this study 48 µg TEQ/ton to air was used, corresponding to the average measured at 20 Flemish installations in 1994. For emissions to water from these measurements an emission factor of 0.15 µg TEQ/ton is assumed.

2.2. Industry

In order of importance the industrial sources of dioxin emissions in Belgium are non-ferrous and steel industry, cement and lime kilns, chemical industry including chloralkali, vinyl chloride and PVC plants, and paper and pulp bleaching.
Emission measurements are only scarcely available. A few sectors have data on emissions which are kept confidential. In recent years the environmental authorities of the three Regions have organized emission measurements in order to improve knowledge of the sources. Calculation of the unmeasured PCDD and PCDF emission was based on production quantities and emission factors obtained from Swedish, Dutch and German studies[1-5] or data from comparable technological equipment (table 1).

Table 1 : Emission factors of PCDD and PCDF from industrial processes to air and to water

Industrial sector	µg TEQ/ton to air			µg TEQ/ton to water		
	1985	1990	1995	1985	1990	1995
Non-ferrous						
Aluminium	10	10	5	-	-	-
Aluminium Secundary	130	130	60	-	-	-
Copper Primary	10	10	10	-	-	-
Copper Secundary	200	200	200	-	-	-
Zinc-lead-other...Primary	3	3	1	-	-	-
Zinc-lead-other...Secundary	5	5	5	-	-	-
Steel						
Cokes production	0.3	0.3	0.3	0.063	0.063	0.063
Sintering and agglomeration	5	5	5	0.3	0.3	0.3
Electric steel furnaces	5	5	5	-	-	-
Cement kilns	1	1	1	-	-	-
Lime kilns	18	18	18	-	-	-
Paper and pulp bleaching	0.17	0.17	0.17	10	10	10

2.3. Energy

The energy sector includes space heating, industrial combustion facilities, production of electricity and road traffic. The emission factors given in table 2 were estimated from data from measuring campaigns and literature. For road traffic these data were calibrated with the results of tunnel measurements [6].

2.4. Miscellaneous sources and reservoirs.

For crematories an emission factor of 6 µg TEQ/cremation was applied. For accidental fires the mass of burned material was estimated from the fire statistics and emission factors of 170 µg TEQ/ton to air and 1 µg TEQ/ton to water. For the incineration of biogas only landfill gas was taken into account with an emission factor of 1 µg TEQ/Nm^3 gas. Glass and ceramic industry, cable burning, regeneration of active carbon and catalysts, open fires and evaporation from PCP are not included because of the large uncertainty of the estimates.
An estimation of the emissions from reservoir sources, especially untreated household and industrial waste waters, indicates that these sources probably cause higher dioxin discharges into surface waters than primary sources.

Table 2 : Emission factors to air in the energy sector

Sector	Fuel	Emission factor in µg TEQ/ton
Space heating	Oil Coal Wood	2 50 130
Industrial combustion facilities	Oil Coal Wood	0.21 0.69 5
Production of electricity	Oil Coal	0.036 0.31
Road traffic	Leaded gasoline Unleaded gasoline+catalyst Unleaded gasoline Gasoil	2.2 0.10 0.014 0.043

3. Overview and evolution of dioxin emissions

The total emissions of dioxins for the period 1985-1995 are given by Region in table 3 and by sector in table 4.
From 1985 to 1995 the overall emissions, excluding reservoir sources, were reduced by 23 % (reduction to air : 22 %, to water : 39 %). The 70 % reduction target was not met mainly because several new sources were found in the last 5 years, which were unknown in 1985. Furthermore there is a delay in the implementation of emission reduction measures in the sector of waste incineration.
The sectors space heating, non-ferrous metallurgy, steel, cement and lime kilns have relatively important contributions to the overall emission. The emission estimates for these sectors however rely on very few measurements which may cause a bias to the partition of the emissions inventory. These sectors need to be further investigated by individual plant or process before a reasonable emission reduction plan can be imposed.
Only a limited number of sources were identified that have emissions towards water. The emission factors to water generally are considerably lower than these for air.

Table 3 : Dioxin emissions in Belgium and the three Regions in g TEQ

Region		1985	1990	1995	% reduction
Flanders	to air	425	448	291	31.5
	to water	1.58	1.88	1.78	+12.7
	to waste	201	251	243	+21
Wallonia	to air	277	281	208	25
	to water	4.58	4.95	1.99	56.5
	to waste	38.3	68.3	112	+192
Brussels	to air	148	164	163	+10
	to water	0.05	0.045	0.002	96
	to waste	108	128	130	+20
Belgium	to air	850	892	662	22
	to water	6.21	6.87	3.77	39
	to waste	347	447	485	+40

Table 4 : Survey of the dioxin emissions to air and water in Belgium in g TEQ/year

	1985		1990		1995	
	to air	to water	to air	to water	to air	to water
Waste incineration						
Municipal waste	297	0.0305	385	0.0471	184	0.0575
Medical waste	100	-	100	-	95	-
Industrial waste	7.65	0.0024	11.2	0.010	20.9	0.021
Sludge	1.45	-	0.70	-	0.75	-
Industry						
Coke production	1.75	0.37	1.59	0.33	1.07	0.23
Sintering and agglomer.	62.5	3.75	67.5	4.05	53.2	3.19
Electric steel furnaces	2.59	-	4.89	-	6.42	-
Non-ferro	80	-	109	-	107	-
Cement kilns	16.1	-	19.7	-	20.8	-
Lime kilns	30.4	-	34.6	-	33.4	-
Paper & pulp bleaching	0.04	1.81	0.05	2.18	-	-
Chemical industry						
chloralkali plants	-	0.03	-	0.03	-	0.03
prod. of vinyl chloride	0.447	0.201	0.455	0.205	0.05	0.222
Energy						
Space heating	228	-	138	-	122	-
Ind. comb. facilities	10.2	-	8.64	-	7	-
Production of electricity	1.54	-	2.11	-	2.31	-
Road traffic	6.08	-	4.76	-	1.71	-
Miscellaneous						
Crematories	0.08	-	0.13	-	0.19	-
Fires	3.36	0.0198	3.22	0.0196	2.56	0.0151
Biogas burning	0	-	0	-	0.012	-
TOTAL	850	6.21	892	6.87	659	3.77
Reservoirs-Sewage water		18.2		17.1		9.74

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4. References

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