SNAP CODE: **090202**

SOURCE ACTIVITY TITLE: **WASTE INCINERATION**
Incineration of Industrial Wastes

NOSE CODE: **109.03.02**

NFR CODE: **6 C**

1 ACTIVITIES INCLUDED

This chapter includes the volume reduction, by combustion, of industrial wastes. The definition of industrial waste varies, but in this case has been assumed to include all non-domestic chemical, hazardous and difficult wastes, and other industrial wastes. In addition the methodology in this chapter includes clinical waste incineration because this source is not covered by any other chapters. Principally this section includes the emissions from chimneys and duct work because of the availability of measurement data, but excludes fugitive emissions from waste handling.

The incineration of domestic/municipal waste is covered under SNAP code 090201 and the incineration of sludges from wastewater treatment is covered under SNAP code 090205. This chapter also does not cover crematoria.

2 CONTRIBUTION TO TOTAL EMISSIONS

The number of large merchant incinerators of hazardous waste, operated by waste disposal contractors to receive a wide variety of wastes from different sources, is relatively small. Many industries have smaller hazardous/chemical waste incinerators constructed within their own site and intended for their use only. A large proportion of these handle only single streams of waste. There is little information on emissions from these smaller plant.

In general, industrial waste incinerators are unlikely to be a significant source of emissions because the waste treated often has a high toxicity and efficient abatement is required to meet the stringent emission standards.

In the UK the large number of small clinical waste incinerators located at hospitals are being replaced by a smaller number of larger-scale centralised incinerators.

The relative proportion of emissions contributed by industrial waste incineration is likely to vary between pollutants. Emissions of carbon dioxide, volatile organic compounds (VOCs) and hydrogen chloride from industrial waste incinerators are likely to be less significant than from other sources. However, industrial waste incinerators are likely to be more significant emitters of dioxins, cadmium and mercury than many other sources, depending on the type of waste, the combustion efficiency and the degree of abatement.

Table 1: Contribution to total emissions of the CORINAIR90 inventory (*28 countries*)

Source-activity	SNAP-code	Contribution to total emissions [%]							
		SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Incineration of Industrial Wastes	090202	0.1	0	0	0	0	0	-	-

0 = emissions are reported, but the exact value is below the rounding limit (0.1 per cent)
- = no emissions are reported

3 GENERAL

3.1 Description

The composition of industrial waste varies considerably. Industrial waste includes any unwanted hazardous/chemical waste such as: acids and alkalis; halogenated and other potentially-toxic compounds; fuels, oils and greases; used filter materials, animal and food wastes. Industrial waste sources include chemical plant, refineries, light and heavy manufacturing etc.

Clinical waste includes human anatomic remains, waste that might be contaminated with bacteria, viruses etc, and general hospital wastes including plastics, textiles etc.

Industrial and clinical waste is incinerated to reduce its volume and to save landfill costs, and to prevent the release of chemical and toxic substances to the environment. In some cases energy is recovered from the waste combustion either for heating or electricity generation.

3.2 Definitions

3.3 Techniques

There are many different furnace designs in use at industrial waste incinerators in Europe. A range of grate designs and fluidised beds are used, but the exact furnace design depends on the type of wastes burned, their composition and the throughput of waste. The principal influences of the incinerator type on the level of atmospheric emissions are the waste burning capacity of the incinerator, the operational techniques and the degree of abatement included in the process design.

Small industrial waste incinerators with a restricted waste supply are often operated as batch processes. This increases the frequency of start up and burn-out emissions, which are often significant.

3.4 Controls

Emissions can be considerably reduced by ensuring efficient combustion, including the control of the temperature, residence time and turbulence in the incinerator furnace. Auxiliary burners and a secondary combustion zone are often included in incinerator designs to ensure effective combustion and burn-out. In addition a range of end-of-process abatement techniques can be applied to reduce emissions. Control of particulates, including heavy

metals, can be achieved by fabric filters, electrostatic precipitators or high energy venturi scrubbers. Acid gas emissions can be controlled by wet and dry scrubbing techniques.

4 SIMPLER METHODOLOGY

The simpler methodology relies on the use of a single emission factor for each pollutant combined with a national industrial or clinical waste incineration statistic.

5 DETAILED METHODOLOGY

The detailed methodology involves the use of plant-specific emission factors derived from emission measurement programmes, and plant-specific throughput, normally obtained from each plant.

6 RELEVANT ACTIVITY STATISTICS

For the simpler methodology the national annual quantity of industrial waste incinerated is required.

The more detailed method requires plant specific waste throughput obtained from the operators. A record of quantity burned is normally kept by incinerator operators as waste generators are normally charged on the basis of weight of waste to be burned. If neither of these values are available the mass burn rate of each incinerator should be multiplied by the estimated operating time.

7 POINT SOURCE CRITERIA

There is a range of sizes of industrial waste incinerators within Europe. The larger incinerators may be treated as point sources if plant-specific data are available.

8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

Emission factors for dioxins have been divided into incinerators meeting modern emission standards and older plant with only particle emission abatement equipment. Separate emission factors have been given for industrial and clinical waste incineration because the type and size of incinerator, and the waste composition, vary greatly for these two types of incinerators. Much of the information on pollutant emissions has been reported as emission concentrations rather than emission factors. These have been converted using a specific flue gas volume of 5000 m^3 at 11% O_2 per tonne of waste.

There is significant uncertainty associated with the aggregation of the reported emissions from different measurement programmes to give a general emission factor. For compounds other than dioxins, the emission factors are given for older plant assuming only particle abatement equipment.

Table 8.1.2: Dioxin Emission Factors for Industrial Waste Incineration Plant

Plant type	Emission Factor µg I-TEQ/tonne	Quality Code	Reference
Particle abatement only	30	C	HMIP (1995) Thomas & Spiro 1994 Fiedler & Hutzinger 1992 Bremmer et al. 1994 Fiedler 1994
Modern advanced	0.5	E	Assumed to be the same as for advanced MSW plant

Table 8.2.2: Typical Emission Factors for Industrial Waste Incineration Plant with only Particle Emission Abatement Equipment

Pollutant	Emission Factor g/tonne waste burned	Quality Code	Reference
SO_2	70	E	1
NOx	2500	E	1
NMVOC	7400	E	Passant 1983
PAH	0.02	D	Wild & Jones 1995 Ramdahl 1982 Mitchell 1992
CO	125	E	1
CO_2	-		
CH_4	-		
HCl	105	E	1
Pb	35	E	1
Cu	3	E	1
Cd	3	E	1
Mn	0.4	E	1
Zn	21	E	1
Co	0.3	E	1
As	0.05	E	1
Cr	0.3	E	1
Ni	0.1	E	1
Hg	3	E	1

[1]Assumed to be the same as for clinical waste incineration (see table 8.4)

Table 8.3: Dioxin Emission Factors for Clinical Waste Incineration Plant

Plant type	Emission Factor µg I-TEQ/tonne	Quality Code	Reference
Particle abatement only	150	C	Mitchell et al. 1992 Mitchell & Scott 1992 Loader & Scott 1992 Cains & Dyke 1993 Thomas & Spiro 1994 Fiedler & Hutzinger 1992
Modern advanced	0.5	E	Assumed to be the same as for advanced MSW plant

Table 8.4: Typical Emission Factors for Clinical Waste Incineration Plant with only Particle Emission Abatement Equipment

Pollutant	Emission Factor g/tonne waste burned	Quality Code	Reference
SO_2	70	D	1,2,3
NOx	2500	D	5
NMVOC	7400	E	9
PAH	0.02	D	6,7,8
CO	125	D	2,3
CO_2	-		
CH_4	-		
HCl	105	C	1,2,3
Pb	35	C	1,2,3,4,5
Cu	3	C	1,2,3,4,5
Cd	3	C	1,2,3,4,5
Mn	0.4	C	1,2,3,5
Zn	21	D	2,3,4
Co	0.3	D	2,3
As	0.05	D	1,2,3,4,5
Cr	0.3	C	1,2,3,4,5
Ni	0.1	C	1,2,3,4,5
Hg	3	C	1,2,3,4

[1]Mitchell et al. 1992 [2]Mitchell & Scott 1992 [3]Loader & Scott 1992
[4]Parcom 1992 [5]US EPA 1985 [6]Wild & Jones 1995
[7]Ramdahl et al. 1982 [8]Mitchell 1992 [9]Passant 1993

9 SPECIES PROFILES

Little data are available on the species profile of dioxin emission from industrial waste incinerators. Emission measurements carried out on clinical waste incinerators have shown that the profile is slightly dominated by the tetra and penta dioxins and furans in terms of toxic equivalence (Mitchell et al. 1992, Mitchell & Scott 1992, Loader & Scott 1992, US EPA 1985)

10 UNCERTAINTY ESTIMATES

The emission factors given are taken from measurements at a wide range of older industrial and clinical waste incineration plant. Little information is available on measurements of emissions from advanced plant. There are wide differences in measured emissions of dioxins and heavy metals depending on both the type of plant and on which of the many combinations of gas-cleaning equipment was in use on the plant. Therefore each emission factor is currently subject to an uncertainty considerably greater than a factor of 2.

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

The simpler methodology relies on the use of a single emission factor for each pollutant for all plant. However, emission factors for different plant are likely to vary significantly, and the plant-specific detailed methodology is likely to produce a significantly more reliable estimate of total emission. However, plant-specific data are difficult to obtain.

Much of the information on pollutant emissions has been reported as emission concentrations rather than emission factors, and these have been converted using a specific flue gas volume of 5000 m^3 at 11% O_2 per tonne of waste. However, the gas volume per tonne of waste will depend on a number of factors, including the type and throughput of waste, and will therefore vary considerably in reality.

12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

Spatial disaggregation requires the knowledge of the location of industrial waste incinerators. In the absence of such data, disaggregation of national totals should be done on the basis of population.

13 TEMPORAL DISAGGREGATION CRITERIA

Some of the larger industrial and clinical waste incinerators operate as continuously as possible and should be treated as emitters for 24 hour days, 7 days a week. However, the smaller plant with a throughput of less than 5 tonnes per hour should be treated as workday emitters for 8 hour days, 5 days a week, unless any information is available to suggest otherwise.

14 ADDITIONAL COMMENTS

There are many potential problems in estimating emissions, in particular the fact that some countries have more advanced emission abatement programmes for incinerators than other countries.

15 SUPPLEMENTARY DOCUMENTS

16 VERIFICATION PROCEDURES

Verification should include comparison with emission estimates from incinerators in other countries together with ambient air measurement programmes near selected sites (except for the trace organics as residual historical soil levels may greatly influence present day air concentrations).

17 REFERENCES

Bremmer H J, Troost L M, Kuipers G, de Koning J and Sein A A (1994). Emissions of dioxins in the Netherlands. Report No. 770501003, RIVM (Research for Man and the Environment), Bilthoven, Netherlands.

Cains P W and Dyke P (1993). Chlorinated Dibenzodioxins and Dibenzofurans in Waste Combustion. Formation Mechanisms and Analysis of UK Plant Measurements. ETSU.

Fiedler H (1994) Sources of PCDD/PCDF and Impact on the Environment. Organohalogen Compounds Vol. 20, pp.229-236.

Fiedler H and Hutzinger O (1992) Sources and Sinks of Dioxins : Germany. Chemosphere Vol.25 Nos.7-10, pp.1487-1491.

HMIP (1995) A review of Dioxin Emissions in the UK. DoE, London.

Loader A and Scott D (1992) Emission Investigation at an Advanced Starved Air Clinical Waste Incinerator. Report No. LR890 (PA), Warren Spring Laboratory, Stevenage, UK.

Mitchell D (1992) Investigation of PAH Releases from two MSW Incinerators. Report No. CR 3740, Warren Spring Laboratory, Stevenage, UK.

Mitchell D and Scott D (1992) Emission Investigation at an Advanced Rotary Kiln Clinical Waste Incinerator. Report No. LR897 (PA), Warren Spring Laboratory, Stevenage, UK.

Mitchell D, Scott D and Briscombe C (1992) Emission Investigation at a Small Starved Air Clinical Waste Incinerator. Report No. LR897 (PA), Warren Spring Laboratory, Stevenage, UK.

Parcom (1992) Emission Factors Manual Parcom-Atmos - Emission Factors for Air Pollutants 1992. TNO, The Netherlands.

Passant (1993) Emissions of Volatile Organic Compounds from Stationary Sources in the UK. Warren Spring Laboratory, Stevenage UK, Report No. LR990.

Ramdahl T, Alfheim I and Bjorseth A (1983). PAH Emission from Various Sources and their Evolution over the Last Decades. In Rondia D et al. (eds.) Mobile Source Emissions Including Polycyclic Organic Species (1983) pp.277-297.

Thomas V M and Spiro T G (1994) An Estimation of Dioxin Emissions in the United States. Centre for Energy and Environmental Studies, Princeton University PU/CEES Report No.285 (revised December 1994)

US EPA (1985) Compilation of Air Pollutant Emission Factors. Volume 1. Stationary Point and Area Sources, 4th Ed., US EPA, AP-42, September 1985.

Wild, S. R. and Jones, K. C. (1995). Polynuclear aromatic hydrocarbons in the United Kingdom environment: a preliminary source inventory and budget. Environ. Poll., 88: 91-108.

18 BIBLIOGRAPHY

DoE (HMIP) (1991) Pollution Control at Chemical Incineration Works. Report No. DoE/HMIP/RR/91/055 (UK).

DoE (1991) Chief Inspector's Guidance to Inspectors, Environmental Protection Act 1990, Industry Sector Guidance Note IPR 5 - Waste Disposal Industry Sector. HMSO, London UK.

DoE (1992) Chief Inspector's Guidance to Inspectors, Environmental Protection Act 1990, Industry Sector Guidance Note IPR 5/1 - Waste Disposal and Recycling, Merchant and In House Chemical Waste Incineration. HMSO, London UK.

DoE (1992) Chief Inspector's Guidance to Inspectors, Environmental Protection Act 1990, Industry Sector Guidance Note IPR 5 - Waste Disposal and Recycling, Clinical Waste Incineration. HMSO, London UK.

DoE (1995) UK Digest of Environmental Statistics. HMSO London.

DoE (1992) Waste Combustion and Emissions Technical Review. Wastes Technical Division, UK Department of the Environment.

Eduljee G H, Dyke P and Cains P W. (1995) PCDD/PCDF Releases from Various Waste Management Strategies. Organohalogen Compounds Vol.24, pp.125-130.

Hutzinger O and Fiedler H (1989) Sources and Emissions of PCDD/F. Chemosphere Vol.18 Nos 1-6 pp.23-32.

Wevers M and De Fre R (1995) Estimated Evolution of Dioxin Emissions in Belgium from 1985 to 1995. Organohalogen Compounds Vol.24, pp.105-108.

19 RELEASE VERSION, DATE AND SOURCE

Version: 1.2

Date: October 1995

Source: Mike Wenborn
AEA Technology Environment
UK

20 POINT OF ENQUIRY

Any comments on this chapter or enquiries should be directed to:

Panagiota Dilara

Emissions and Health Unit
Institute for Environment and Sustainability (IES)
European Commission
Joint Research Centre
I-21020 Ispra (VA)
Italy

Tel: +39 0332 789207
Fax: +39 0332 785869
Email: panagiota.dilara@jrc.it