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. 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, the incineration of sludges from wastewater treatment is covered under SNAP code 090205 and the incineration of hospital wastes is covered under SNAP code 090207. Flaring is covered under SNAP code 090203 for oil refinery, SNAP code 090204 for chemical industries and SNAP code 090206 for gas and oil extraction. 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.

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 and particulate matter from industrial waste incinerators are likely to be less significant than from other sources (see Tables 2.1, 2.2). 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 2.1: 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

Table 2.2: Contribution to total particulate matter emissions from 2004 EMEP database (WEBDAB)†

NFR Sector*	**Data**	**PM_{10}**	**$PM_{2.5}$**	**TSP**
6 C - Waste Incineration	No. of countries reporting	13	11	14
	Lowest Value	0.0%	0.0%	0.0%
	Typical Contribution	1.2%	1.6%	0.8%
	Highest Value	5.8%	7.3%	5.9%

*Includes contribution from Chapters 921 925, 927, 970 and 991

†These activities are not believed to be a significant source of $PM_{2.5}$ for the majority of countries. Data reported for 2004, however, indicates that it may be significant for in some cases.

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.

Industrial 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 species combined with a national waste incineration statistic:

Total emission	=	mass of waste incinerated (tonnes)	x	overall emission factor (emission per tonne of waste incinerated)	(1)

Default emission factors for incinerators to facilitate this approach are provided in section 8.1

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.

Should a key source analysis indicate this to be a major source of particulate matter (TSP, PM_{10} or $PM_{2.5}$) then installation level data should be collected using a protocol such as that illustrated in the Measurement Protocol Annex.

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
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)

The CONCAWE Air Quality Management Group (Concawe, 2006) has identified issues for the oil refining sector with regard to the data submissions for both European Pollutant Emission Register (EPER) mandated by European Directive 96/61/EC on integrated pollution prevention and control (IPPC) and UNECE Kiev Protocol on Pollutant Release and Transfer Registers (PRTR), CONCAWE initiated a review of the published emission factors for those air pollutants which may be emitted in excess of the EPER threshold values from sources found at the majority of European refineries.

The CONCAWE report provides the air pollutant emission estimation algorithms, incorporating those factors, which CONCAWE recommends for EPER and PRTR reporting purposes. The emission factors provided include several relevant for industrial waste incineration but are for uncontrolled releases. Reported emissions must take account of any abatement equipment installed e.g. wet gas scrubbers, electrostatic precipitators, etc. Where emission factors are available, algorithms are provided for sources found in the majority of European refineries.

As incinerator streams are of very variable composition, it is necessary to know the stream make up to determine the net calorific value (and density if the stream volume combusted is known instead of the mass). CONCAWE suggests the emission factors of Table 8.2.3 for the combustion of the incinerator gas stream. The emission factors of the gas stream are assumed equal to that for natural gas in an uncontrolled small furnace. .For the combustion of auxiliary fuel used to support incineration, must be used the usual combustion emission factors.

Table 8.2.3: Emission Factors for Refinery Incinerator gas stream

Pollutant	Emission Factor g/GJ of gas incinerated (°)
SO_2	2000000 S **(°°)**
NOx	33.3
NMVOC	2.58
CO	393
TSP	0.89 (°°°)
PM_{10}	0.89 (°°°)
$PM_{2.5}$	0.89 (°°°)
As	0,000343
Cd	0,000712
Cr	0,00274
Cu	0.00222
Hg	0,000086
Ni	0,0036
Pb	0,00179
Zn	0.0255

(°) for SO_2 expressed as g/ton of gas flared

(°°) S = mass fraction of sulphur in flare gas

(°°°) = CONCAWE provides a PM_{10} factor of 3.56 g/GJ which is from USEPA data for natural gas and represents filterable + condensable PM. The USEPA report that the filterable fraction is 25% of the total and is representative of PM_1 (that is, TSP, PM_{10} and $PM_{2.5}$).

Table 8.2.4: AP 42 Particulate Matter Emission Factors* for clinical waste (US EPA 1996)

	Emission Factor kg/Mg				
Control level	**TSP**	**Rating**	**PM_{10}**	**$PM_{2.5}$**	**Rating**
Uncontrolled	2.33	B	1.51	1.01	E
Low Energy Scrubber/FF	0.455	E	0.34	0.23	E
Medium Energy Scrubber/FF	0.0803	E	0.0803	0.0803	E
FF	0.0876	E	0.0876	0.0876	E
Low Energy Scrubber	1.45	E	1.0	0.039	E
High Energy Scrubber	0.741	E	0.53	0.020	E
DSI/FF	0.169	E	0.169	0.169	E
DSI/Carbon Injection/FF	0.0361	E	0.0361	0.0361	E
DSI/FF/Scrubber	1.34	E	0.96	0.036	E
DSI/ESP	0.367	E	0.275	0.184	E

FF = Fabric Filter
DSI = Dry Sorbent Injection
ESP = Electrostatic Precipitator
* = In the absence of more appropriate data use the AP 42 emission factors

USEPA size data were used to derive uncontrolled and scrubber-controlled emission factors for PM_{10} and $PM_{2.5}$. All other factors are estimates based on 'expert judgement'.

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).

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19 RELEASE VERSION, DATE AND SOURCE

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AEA Technology Environment
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