**SNAP CODE:** **030308**

**SOURCE ACTIVITY TITLE:** **PROCESSES WITH CONTACT**
***Secondary Zinc Production***

**NOSE CODE:** **104.12.09**

**NFR CODE:** **1 A 2 b**

## 1 ACTIVITIES INCLUDED

Zinc is produced from various primary and secondary raw materials. The primary processes use sulphidic and oxidic concentrates, while in secondary processes recycled oxidised and metallic products mostly from other metallurgical operations are employed. This chapter includes information on atmospheric emissions during the production of secondary zinc. In practice, a clear distinction of primary and secondary zinc production is often difficult, because many smelters use both primary and secondary raw materials.

Zinc production in the western world stood at about 5.2 million tonnes in 1990. Of this, 4.73 million tonnes originate from primary resources (ores), while the balance of 0.47 million tonnes is produced at the smelters from secondary raw materials (Metallgesellschaft 1994). The production of zinc in secondary smelters is increasing in various regions of the world. This increase can be as high as 5% per year in Eastern Europe. This chapter describes the methods to estimate both combustion and process emissions of atmospheric pollutants during the secondary zinc recovery from various types of zinc scrap (e.g. Barbour et al, 1978).

## 2 CONTRIBUTIONS TO TOTAL EMISSIONS

There are several trace metals as well as dioxins and furans which can be emitted during the secondary zinc production process. However, heavy metal emissions from this source category are not very significant on a global scale. Nriagu and Pacyna (1988) concluded that the secondary zinc production contributes well below 1 % of the total atmospheric emissions of lead, cadmium, antimony, selenium, and zinc. A similar contribution to European atmospheric emissions from secondary zinc production was estimated at the beginning of the 1980’s (Pacyna, 1983). The estimated contribution of both primary and secondary zinc production to European emissions is given in Table 2.1 (Berdowski 1997). However, a secondary zinc smelter can be an important emission source on a local scale.

The contribution of emissions released from secondary zinc production to total emissions of those pollutants covered by the CORINAIR90 inventory is negligible (see Table 2.2).

**Table 2.1: Contribution to total heavy metal emissions of the OSPARCOM-HELCOM- UNECE inventory for 1990** (up to 38 countries)

| **Source-activity** | **SNAP-code** | **Contribution to total emissions [%]** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | As | Cd | Cr | Cu | Hg | Ni | Pb | Zn |
| Total Zinc Production | 0403zn | 0 | 9.1 | 0 | 0 | 7.1 | 0 | 0.5 | 9.8 |

**Table 2.2: Contribution to total emissions of the CORINAIR90 inventory** (up to 28 countries)

| **Source-activity** | **SNAP-code** | **Contribution to total emissions [%]** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $SO_2$ | $NO_x$ | NMVOC | $CH_4$ | CO | $CO_2$ | $N_2O$ | $NH_3$ |
| Secondary Zinc Production | 030308 | - | - | - | - | 0 | - | - | - |

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

Secondary zinc production is unlikely to be a significant source of sulphurhexafluoride ($SF_6$), hydrofluorocarbons (HFCs) or perfluorocarbons (PFCs), (ETC/AEM-CITEPA-RISOE 1997).

## 3 GENERAL

### 3.1 Description

A secondary zinc smelter is defined as any plant or factory in which zinc-bearing scrap or zinc-bearing materials, other than zinc-bearing concentrates (ores) derived from a mining operation, are processed (e.g. Barbour et al., 1978). In practice, primary smelters often also use zinc scrap or recycled dust as input material.

Zinc recovery involves three general operations performed on scrap, namely pre-treatment, melting, and refining. Scrap metal is delivered to the secondary zinc processor as ingots, rejected castings, flashing, and other mixed metal scrap containing zinc (US EPA, 1995).

Scrap *pre-treatment* includes sorting, cleaning, crushing and screening, sweating, and leaching. In the sorting operation, zinc scrap is manually separated according to zinc content and any subsequent processing requirements. Cleaning removes foreign materials to improve product quality and recovery efficiency. Crushing facilitates the ability to separate the zinc from the contaminants. Screening and pneumatic classification concentrates the zinc metal for further processing. Leaching with sodium carbonate solution converts dross and skimmings to zinc oxide, which can be reduced to zinc metal (US EPA, 1995).

Pure zinc scrap is *melted* in kettle, crucible, reverberatory, and electric induction furnaces. Flux is used in these furnaces to trap impurities from the molten zinc. Facilitated by agitation, flux and impurities float to the surface of the melt as dross, and are skimmed from the surface. The remaining molten zinc may be poured into moulds or transferred to the refining operation in a molten state (US EPA, 1995).

*Refining* processes remove further impurities from clean zinc alloy scrap and from zinc vaporised during the melt phase in retort furnaces. Molten zinc is heated until it vaporises. Zinc vapour is condensed and recovered in several forms, depending upon temperature, recovery time, absence or presence of oxygen, and equipment used during zinc vapour condensation. Final products from refining processes include zinc ingots, zinc dust, zinc oxide, and zinc alloys (US EPA, 1995).

Generally the processes used for the recycling of secondary zinc can be distinguished by the kind of raw materials employed (Rentz et al., 1996):

Very poor oxidic residues and oxidic dusts, e.g. from the steel industry, are treated in *rotary furnaces* (Waelz furnaces), producing metal oxides in a more concentrated form. These concentrated oxides (Waelz oxides) are processed together with oxidic ores in primary thermal zinc smelters, in particular Imperial Smelting furnaces which are in use for combined lead and zinc production. In this case, a clear discrimination between primary and secondary zinc production as well as between zinc and lead production is difficult.

Metallic products prior to smelting are comminuted and sieved to separate metal grains from the oxides. Afterwards the metallic products are melted in *melting furnaces*, mainly of the induction type or muffle furnaces. Finally the molten zinc is cast and in part refined to high-purity zinc in distillation columns.

In *New Jersey retorts* it is possible to process a large variety of oxidic secondary materials together with metallic materials simultaneously. For charge preparation the oxides are mixed with bituminous or gas coal, briquetted, and coked. The briquettes together with the metallic materials are charged into the retorts. The zinc vapours from the retorts are condensed by splash-condensing.

## 3.2 Definitions

Secondary zinc production: - production of zinc from materials other than ores.

Other definitions are covered in sections 3.1 and 3.3.

## 3.3 Techniques

A *sweating furnace* (rotary, reverberatory, or muffle furnace) slowly heats the scrap containing zinc and other metals to approximately 364°C. This temperature is sufficient to melt zinc but is still below the melting point of the remaining metals. Molten zinc collects at the bottom of the sweat furnace and is subsequently recovered. The remaining scrap metal is cooled and removed to be sold to other secondary processors (US EPA, 1995).

A more sophisticated type of sweating operation involves holding scrap in a basket and heating it in a molten salt bath to a closely controlled temperature. This yields a liquid metal, which separates downwards out of the salt, and a remaining solid of the other metals still free from oxidation. By arranging for heating to a sequence of temperatures, related to the melting point of the metals or alloys involved, a set of molten metal fractions with minimum intermixture can be obtained (e.g. Barbour et al., 1978).

For zinc production in *New Jersey retorts* the zinc containing raw materials are picked up from the stockpiling area. For some raw materials a *charge preparation* is carried out, including comminution, sieving, and magnetic separation, so that a metallic and a oxidic fraction is obtained. Furthermore, for some raw materials dechlorination is necessary. The oxidic raw materials, like dusts and zinc drosses are mixed with bituminous coal. Subsequently, the mixture which contains about 40 % zinc is briquetted together with a binding agent, coked at temperatures around 800°C in an autogenous coking furnace and then charged to the New Jersey retorts together with small amounts of pure metallic materials. By heating with natural gas and CO containing waste gases, in the retorts temperatures of around 1,100°C are achieved, so that the zinc is reduced and vaporised. Subsequently, the vaporised zinc is precipitated in splash-condensers and transferred to the foundry via a holding furnace. Here the so-called selected zinc is cast into ingots. The residues from the retorts are treated in a melting cyclone to produce lead-zinc-mix oxides and slag. Figure 3.1 shows a schematic diagram for secondary zinc production using New Jersey retorts. Potential sources of particulate and heavy metal emissions are indicated. The metallic fraction from charge preparation together with other metallic materials like galvanic drosses, scrap zinc, and scrap alloys are melted. The raw zinc is then sent to a *liquation furnace* where, in a first refining step, zinc contents from 97.5 to 98 % are achieved. The melted and refined zinc is also cast into ingots (Rentz et al., 1996).

The raw materials for *Waelz furnaces* are mainly dusts and slurry from electric arc furnaces used in the steel industry, together with other zinc and lead containing secondary materials. For transferring and charging, the dustlike secondary materials are generally pelletised at the steel plant.

After mixing, the zinc and lead containing pellets, coke as reducing agent, and fluxes are charged via a charging sluice at the upper end of the slightly sloped rotary kiln. The rotation and the slope lead to an overlaid translational and rotational movement of the charge. In a counter-current direction to the charge air as combustion gas is injected at the exit opening of the furnace. At temperatures of around 1,200°C and with residence times of around 4 hours zinc and lead are reduced and vaporised. The metal vapours are reoxidised in the gas filled space of the furnace and evacuated through the charge opening together with the waste gas. In a cleaning device, the metal oxides are collected again and as filter dust the so-called Waelz oxide with a zinc content of around 55 % and a lead content of around 10 % is generated. The Waelz oxide is subsequently charged into an Imperial Smelting furnace which is used for combined primary zinc/lead smelting. The slag from the Waelz furnace is cooled down and granulated in a water bath. Additional oil as fuel is only needed at the start-up of the furnace, while in stationary operation the combustion of the metal vapours and carbon monoxide covers the energy demand of the process (Rentz et al., 1996). A schematic representation of the Waelz process is depicted in Figure 3.2.

Secondary zinc is sometimes combined with primary material for refining. Various pyrometallurgical refining technologies can be applied, depending on the feed material and product specification. Thermal zinc refining by fractional distillation is possible in rectifying columns at temperatures around 950°C (Rentz et al., 1996).

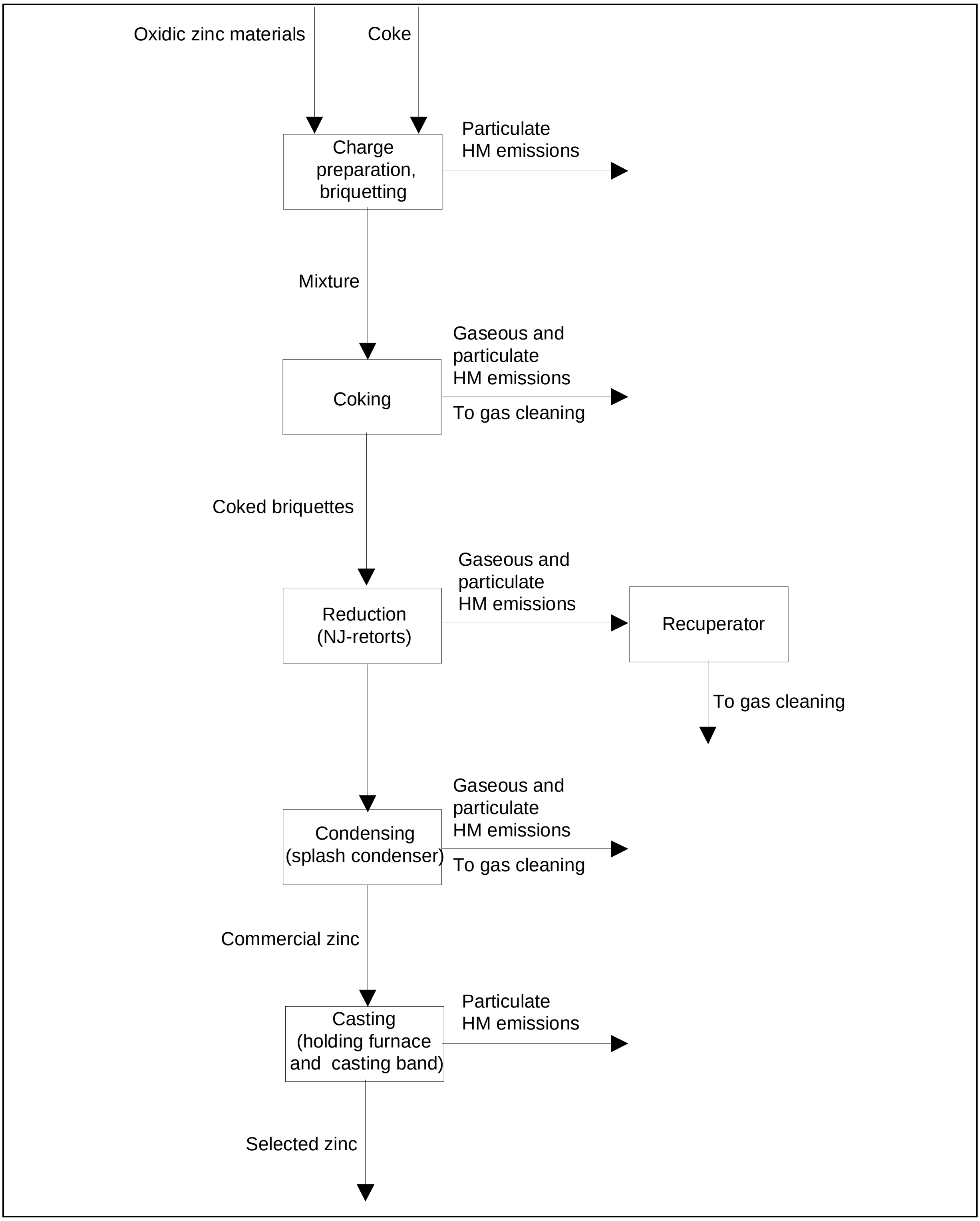

**Figure 3.1:** Secondary zinc production using New Jersey retorts with potential heavy metal emission sources (Rentz et al., 1996)

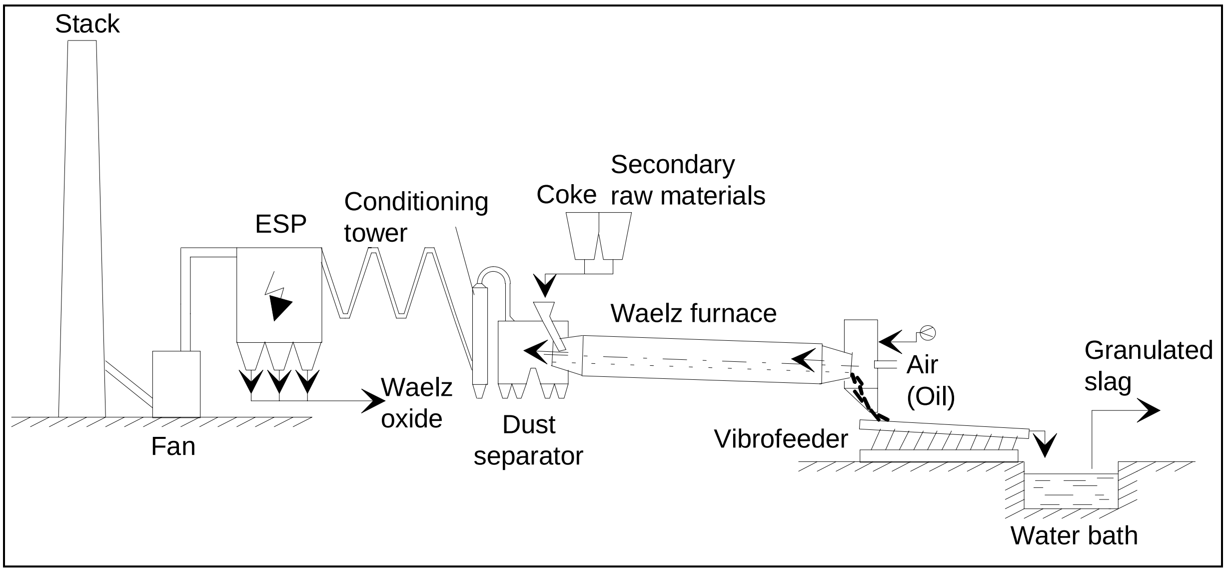

**Figure 3.2:** Waelz furnace with emission reduction installations (Rentz et al. 1995)

## 3.4 Emissions

Among the various process steps the melting furnace operation represents the most important source of atmospheric emissions. In general, continuous and periodical emissions can be distinguished. Continuous emissions are connected with the process as such, whereas periodical emissions occur e.g. during charging, heating, skimming, or cleaning operations. The most important factors influencing emissions from scrap pre-treatment and melting are:

- The composition of the raw material, in particular the content of organic and chlorinated compounds which affects the formation of dioxins and furans,
- the utilisation of flux powder ,
- the furnace type - direct heating with a mixture of process and combustion waste gases reduces the content of organic compounds released from the bath,
- the bath temperature - a temperature above 600°C creates significant emissions of zinc oxide,
- the fuel type - in general, natural gas or light fuel oil are used.

Continuous emissions from the melting furnace consist of combustion waste gases and gaseous effluents from the bath. The specific gas flow amounts to about 1,000 $m^3$ (STP)/Mg zinc produced.

Important periodical emissions often occur with charging and melting of the raw material. Emissions of organic compounds are mainly connected with charging operations. Furnace clearing, fluxing, ash drawing, and also cleaning operations are of minor relevance. Tapping is carried out at low temperature and therefore, no metal vapours are released.

In zinc distillation a high quality input material is used and therefore, emissions of carbon or chlorine containing compounds are low. Emissions mainly consist of zinc and zinc oxide containing particles and combustion waste gases (R. Bouscaren et. al., 1988).

### 3.5 Controls

Most of the secondary zinc smelters are equipped with dust removing installations, such as baghouses. In general, emission control systems vary depending on the type of scrap being processed and the products being obtained. A distinction can be made between purely oxidised, mixed oxidised/metallic and purely metallic products.

The control efficiency of dust removing installations is often very high reaching 99.9 %. Both, primary gases and fugitive dust emissions are reduced in baghouses to concentrations below 10 mg/m$^3$.

Afterburners are reported for non-ferrous-metal industry in the USA. Also wet scrubbers may be used.

## 4 SIMPLER METHODOLOGY

Application of general emission factors with appropriate activity statistics can be regarded as a simple methodology for estimation of emissions from secondary zinc production. However, it should be noted that the chemical composition of input scrap is one of the most important factors affecting the amount of emissions. The chemical composition of input scrap varies considerably from one plant to another and so do emission factors. Default emission factors in accordance with the simpler methodology are proposed in section 8.

## 5 DETAILED METHODOLOGY

In this case, specific emission factors for the different process steps of the various production technologies should be used. An account of the effect of emission controls should be considered. The different emission factors will have to be evaluated through measurements at representative sites. Currently, appropriate default emission factors are not available.

## 6 RELEVANT ACTIVITY STATISTICS

In many metal statistics secondary zinc production is not reported separately. The World Metal Statistics Year Book published by the World Bureau of Metal Statistics in Massachusetts, USA, reports total production of zinc without disaggregating it into primary and secondary production. The World Metal Statistics published monthly by the same organisation reports more detailed data which includes primary and secondary production for some countries and total production for others.

Information is also available from the UN statistical yearbooks (e.g. United Nations 1993). These data are satisfactory to estimate emissions using the simpler methodology. However, in most cases, no information is available from the statistical yearbooks on the quantities of the metal produced by various types of industrial technologies employed in the secondary zinc industry. Therefore, the application of a detailed estimation methodology may be complicated unless the statistical data are available directly from a given smelter. Some information in this respect is available from the International Lead and Zinc Study Group (ILZSG) (e.g. ILZSG, 1985).

## 7 POINT SOURCE CRITERIA

Secondary zinc smelters should be regarded as point sources if plant specific data are available.

## 8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

In the literature only emission factors for the simpler methodology are currently available. The CORINAIR methodology requires the separate reporting of combustion related emissions (SNAP 030308) and process related emissions (SNAP 040300). Table 8.1 also gives emission factors related to the energy input in [g/GJ] based on CORINAIR90 data. In the case of using production statistics the specific energy consumption (e.g. GJ/Mg product) has to be taken into account, which is process and country specific. Within CORINAIR 90 a value for the specific energy consumption of 38.5 GJ/Mg product was reported.

Currently, a uniform emission factor for dioxin emissions from secondary zinc production cannot be given due to the enormous range of concentrations measured in the waste gases of 6 orders of magnitude. This is illustrated by results from measurements at German plants given in Tables 8.1 and 8.3 (Quaß 1997).

## Table 8.1: Emission Factor Table

| **Compound** | **Plant type** | **Emission factor** | **Data Quality** | **Abatement type** | **Abatement efficiency** | **Fuel type** | **Country or region** | **Ref.** |
|---|---|---|---|---|---|---|---|---|
| $SO_2$ | *unknown* | 0.85 g/GJ | *E* | *n. a.* | *n. a.* | *natural gas* | *Europe* | *CORINAIR90* |
| $SO_2$ | Calcining kiln | 9,150g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| $SO_2$ | Retort distillation/ oxidation | 10,000g/Mg zinc oxide produced | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| $SO_2$ | Muffle distillation/ oxidation | 20,000g/Mg zinc oxide produced | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| $SO_2$ | Secondary metal production, process heaters | $17,209 \cdot S$ g/m$^3$ fuel | *E* | *n. a.* | *n. a.* | NAPFUE 204, S = sulphur content of fuel | *USA* | *US EPA (1990)* |
| $SO_2$ | Secondary metal production, process heaters | $19,006 \cdot S$ g/m$^3$ fuel | *E* | *n. a.* | *n. a.* | NAPFUE 203, S = sulphur content of fuel | *USA* | *US EPA (1990)* |
| $NO_x$ | *unknown* | 27 g/GJ | *E* | *n. a.* | *n. a.* | *coke oven coke* | *Europe* | *CORINAIR90* |
| $NO_x$ | *unknown* | 60 g/GJ | *E* | *n. a.* | *n. a.* | *natural gas* | *Europe* | *CORINAIR90* |
| $NO_x$ | Pot furnace | 950 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| $NO_x$ | Galvanising kettle | 200 g/Mg zinc used | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| $NO_x$ | Rotary sweat furnace | 100 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| $NO_x$ | Retort distillation / oxidation | 3,950 g/Mg zinc oxide produced | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| $NO_x$ | Muffle distillation/ oxidation | 55,000 g/Mg zinc oxide produced | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| $NO_x$ | Process heaters in secondary metal production | 2,397 g/m$^3$ fuel | *E* | *n. a.* | *n. a.* | NAPFUE 204 | *USA* | *US EPA (1990)* |
| $NO_x$ | Process heaters in secondary metal production | 6,591 g/m$^3$ fuel | *E* | *n. a.* | *n. a.* | NAPFUE 203 | *USA* | *US EPA (1990)* |
| VOC | Calcining kiln | 30 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| VOC | Concentrate dryer | 2 g/Mg processed | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| VOC | Sweating furnaces (general) Kettle (pot) melting furnace | 1,200 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| VOC | Crucible melting furnace, scrap smelting | 1,250 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| VOC | Reverberatory melting furnace, scrap smelting | 2,600 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| VOC | Electric induction melting furnace, scrap melting | 90 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *USA* | *US EPA (1990)* |
| VOC | Process heaters in primary metal production | 24 g/m$^3$ fuel | *E* | *n. a.* | *n. a.* | NAPFUE 204 | *USA* | *US EPA (1990)* |

## Table 8.1: continued

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| VOC | Process heaters in primary metal production | 34 g/m³ fuel | *E* | *n. a.* | *n. a.* | NAPFUE 203 | *USA* | *US EPA (1990)* |
| VOC | Process heaters in primary metal production | 44,851 g/m³ fuel | *E* | *n. a.* | *n. a.* | NAPFUE 301, process gas | *USA* | *US EPA (1990)* |
| CO | *unknown* | 535 g/GJ | *E* | *n. a.* | *n. a.* | *coke oven coke* | *USA* | *US EPA (1990)* |
| CO | *unknown* | 7 g/GJ | *E* | *n. a.* | *n. a.* | *natural gas* | *Europe* | *CORINAIR90* |
| $CO_2$ | *unknown* | 105 kg/GJ | *E* | *n. a.* | *n. a.* | *coke oven coke* | *Europe* | *CORINAIR90* |
| $CO_2$ | *unknown* | 55 kg/GJ | *E* | *n. a.* | *n. a.* | *natural gas* | *Europe* | *CORINAIR90* |
| As | *unknown* | 10 (1-20) g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *Germany (1980s)* | PARCOM/ ATMOS (1992) |
| Cd | *unknown* | 25 (2-50) g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *Germany (1980s)* | PARCOM/ ATMOS (1992) |
| Cd | *unknown* | 14 g/Mg zinc produced | *E* | *n. a.* | *n. a.* | *n. a.* | *Poland* | S. Hlawiczka (1995) |
| Hg | *unknown* | 0.02 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *Germany (1980s)* | PARCOM/ ATMOS (1992) |
| Pb | *unknown* | 85 g/Mg zinc produced | *E* | *n. a.* | *n. a.* | *n. a.* | *Poland* | S. Hlawiczka (1995) |
| Pb | *unknown* | 200 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *Germany (1980s)* | PARCOM/ ATMOS (1992) |
| Zn | *unknown* | 5,000 g/Mg product | *E* | *n. a.* | *n. a.* | *n. a.* | *Germany (1980s)* | PARCOM/ ATMOS (1992) |
| Zn | *unknown* | 9,000 g/Mg zinc produced | *E* | *uncontrolled* | *0 %* | *n. a.* | *Europe* | PARCOM/ ATMOS (1992) |
| Zn | *unknown* | 1,089 g/Mg zinc produced | *E* | *n. a.* | *n. a.* | *n. a.* | *Poland* | S. Hlawiczka (1995) |
| Zn | *unknown* | 10,000 g/Mg zinc produced | *E* | *n. a.* | *n. a.* | *n. a.* | *Europe* | R. Bouscaren (1988) |
| PCDD/F | *Hot briquetting plant capacity 16.7 Mg Zn/h* | 63.1-379 µg I-TEQ/Mg zinc produced | *E* | *controlled* | *n. a.* | *n. a.* | *Germany* | Quaß (1997) |
| PCDD/F | *Rotating cylinder (Waelz furnace), plant capacity 16.7 Mg Zn/h* | 62.3 µg I-TEQ/Mg zinc produced | *E* | *controlled* | *n. a.* | *n. a.* | *Germany* | Quaß (1997) |

*n. a.: not available*

## Table 8.2: Heavy Metal Emission Measurements

| **Process type:** | *New Jersey retorts Process waste gases* | Waelz furnace Process waste gases, metal oxide recovery | Waelz furnace Furnace mouth |
|---|---|---|---|
| **Country or region:** | Germany | Germany | Germany |
| **Abatement:** | *Recuperator, heat exchanger, cooler, flat bag filter (polyacrylonitrile)* | *Dust separator, conditioning tower, 3-field electrostat. precip.* | *Bag filter (Nomex needlefelt)* |
| **Waste gas stream:** [$m^3$(STP)/h] | *124,000* | *62,000* | *9,200* |
| **Compound:** | *Clean gas [mg/$m^3$(STP)]* | *Clean gas [mg/$m^3$(STP)]* | *Clean gas [mg/$m^3$(STP)]* |
| *As* | *0.0009* | n. a. | n. a. |
| *Cd* | 0.02 | 0.014 | < 0.001 |
| *Cr* | n. a. | n. a. | n. a. |
| *Cu* | < 0.0009 | n. a. | n. a. |
| *Hg* | < 0.0009 | n. a. | n. a. |
| *Ni* | n. a. | n. a. | n. a. |
| *Pb* | 0.11 | 0.4 | 1.3 |
| *Zn* | n. a. | 1.6 | 3.4 |
| *Particulates* | 6.3 | 5.7 | 8 |
| **Reference:** | Steinmann (1984) | Kola (1991) | Kola (1991) |

*n. a.: not available*

## Table 8.3: PCDD/F Emission Measurements

| **Country or region:** | Germany | |
|---|---|---|
| **Process type** | **PCDD/F concentration** waste gas [ng I-TEQ/$m^3$] | **Mass flow** [µg I-TEQ/h] |
| *Hot briquetting* | 20 - 120 | 1054 - 6326 |
| *Rotating cylinder* | 20.8 | 1040 |
| *Ore roasting furnace* | 0.0018 | |
| *Zinc melting furnace* | 0.042 - 0.121 | 0.9 - 2.7 |
| *Zinc melting furnace* | 0.097 | 5.2 |
| *Zinc melting furnace* | 0.028 | 0.3 |
| **Reference:** | Bröker (1995) | |

## 9 SPECIES PROFILES

At present little information exists on physical and chemical species of trace metals and dioxins/furans emitted during the secondary zinc production. Atmospheric emissions of various pollutants depend greatly on the degree of pre-sorting and the type and homogeneity of the scrap charged. Particles emitted during the production process contain predominantly zinc oxide, some metallic zinc, chlorides of various compounds, as well as the impurities derived from other metals in the scrap charge (Rentz et al., 1996). $ZnCl_2$ containing particulates result from the use of fluxes and granulated metal recovered from galvanic processes as a raw material. ZnO is formed from the reaction of zinc vapour with oxides at the surface. (R. Bouscaren et al., 1988).

## 10 UNCERTAINTY ESTIMATES

It is difficult to assess current uncertainties of emission estimates for pollutants emitted during the secondary zinc production. Recently it was concluded that up to 50 % of uncertainties can be assigned for the emission estimates of most of the trace elements emitted from major point sources in Europe (Pacyna, 1994). Much bigger uncertainty can be assigned for emission estimates of these compounds from the secondary zinc production. Information on emission factors and statistics is largely missing for the secondary zinc smelters; thus the accuracy of emission estimates for this category cannot even be compared with the accuracy of emission estimates for major point sources, such as primary smelters and power plants.

A key uncertainty is the type of abatement associated with the emission factors in section 8 which is currently not known.

Uncertainty is also increased by missing information on secondary zinc production in activity statistics. If activity rates related to the energy input are required a conversion of units is often necessary which may cause a further increase of uncertainty.

## 11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

Development of emission factors for trace elements and dioxins/furanes and improvement of zinc emission factors given in section 8 is necessary in order to obtain emission estimates for the secondary zinc production. Further work is required to assess the missing parameters such as abatement type and efficiencies. The improvement should also focus on preparing individual emission factors for major industrial technologies and process units currently employed in the zinc industry. In this way a detailed methodology for emission estimates can be applied. Obviously, it will be necessary to obtain relevant statistical data on the production of zinc in various secondary zinc furnaces.

In many cases, a clear distinction between primary and secondary zinc production is not possible due to the simultaneous use of primary and secondary raw materials. In addition, a combined production of lead and zinc may occur (e. g. in IS-furnaces). Here, a double counting of emissions has to be avoided. Therefore, emissions from smelters should be reported as point sources using plant specific activity data.

The fuel specific emission factors cited from the CORINAIR90 inventory in Table 8.1 are related to both point sources and area sources without specification. It is assumed that according to the CORINAIR methodology they only include emissions from combustion (SNAP 030308). Further investigations should cover the influence of fuel characteristics and process technology on these factors for an improved discrimination between combustion and process related emissions.

## 12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

National emission estimates can be disaggregated on the basis of production, population or employment statistics.

## 13 TEMPORAL DISAGGREGATION CRITERIA

The secondary zinc production is a continuous process. No temporal disaggregation is needed.

## 14 ADDITIONAL COMMENTS

No additional comments.

## 15 SUPPLEMENTARY DOCUMENTS

No supplementary documents are required.

## 16 VERIFICATION PROCEDURES

Estimated emission factors could be best verified by measurements at plants using different industrial technologies.

## 17 REFERENCES

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| With support from: | Otto Rentz, Dagmar Oertel<br>University of Karlsruhe (TH)<br>Germany |

## 20 POINT OF ENQUIRY

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

**Ute Karl**

French-German Institute for Environmental Research
University of Karlsruhe
Hertzstr 16
D-76187 Karlsruhe
Germany

Tel: +49 721 608 4590
Fax: +49 721 75 89 09
Email: ute.karl@wiwi.uni-karlsruhe.de