

SNAP CODE: 030304

SOURCE ACTIVITY TITLE: PROCESSES WITH CONTACT  
Primary Lead Production

NOSE CODE: 104.12.05

NFR CODE: 1 A 2 b

## 1 ACTIVITIES INCLUDED

The primary lead production process is defined as the production of lead from lead concentrates. A detailed description of other process steps e.g. sintering can be found in chapter B331. However, in the following if useful for description sintering processes are included.

## 2 CONTRIBUTION TO TOTAL EMISSIONS

The contribution of gaseous emissions released from primary lead production to total emissions in countries of the CORINAIR90 inventory is given as follows:

**Table 2.1: Contribution to total emissions of the CORINAIR90 inventory (28 countries)**

Source-activity	SNAP-code	Contribution to total emissions [%]							
		SO <sub>2</sub>	NO <sub>x</sub>	NMVOC	CH <sub>4</sub>	CO	CO <sub>2</sub>	N <sub>2</sub> O	NH <sub>3</sub>
Primary Lead Production	030304	0.2	0	-	-	0	0	-	-

0 = emissions are reported, but the exact value is below the rounding limit (0.1 per cent)

- = no emissions are reported

The contribution of heavy metal emissions from primary lead production to the total heavy metal emissions, according to IWAD [7], is given in Table 2.2.

**Table 2.2. The contribution of heavy metal emissions from primary lead production to the total emissions of the IWAD study [7]**

Contribution to total emissions (%)					
Cd	Cr	Cu	Ni	Pb	Zn
1.1	0	0.2	0	1.5	0.3

0 = emissions are reported, but the exact value is below the rounding limit

### 3 GENERAL

#### 3.1 Description of activities

This process contains the classical steps of ore pretreatment and concentration, sintering, smelting, and product refining. Most primary lead smelters also produce other metals to a certain extent. The process route is based on sintering, reduction of sinter in a shaft furnace, and refining of bullion, either pyrometallurgically or hydrometallurgically.

In the sintering process fine particles of metal ores are agglomerated into nodules, briquettes, sinter, or pellets. Also a roasting process is involved in which lead sulphide is converted into lead oxide. Dust emissions result from handling and stockpiling of raw materials or intermediate products. Abatement methods are the use of bag filters, wet scrubbers or electrofilters.

In the smelting process ore, coke, and flux compounds are heated either in a shaft furnace or an electric furnace. Dust abatement can be provided by bag filters or electrofilters. Improved abatement is encapsulation or evacuation of the process.

The refining process is mainly directed at the removal of copper, silver, zinc, and bismuth. Dust emissions mainly occur at the treatment of the different by-product streams.

Several improved processes are either in the pilot stage, or being used at a single plant. However, no general applicable information is available yet.

#### 3.2 Definitions

Sintering process	Agglomeration of ore particles, flux compounds and other material by the combustion of coke.
Roasting process	Oxidation of lead concentrate converting the lead sulphide to lead oxide.

#### 3.3 Techniques

The main techniques for the smelting process are the shaft furnace and the electric furnace process. For refining the main techniques are pyrometallurgical refining and hydrometallurgical refining. Several direct smelting technologies have been under development or are being developed yet. Information about the emissions of these techniques is not yet available.

#### 3.4 Emissions

The main emissions during the primary lead production are dust emissions.

Pollutants released are sulphur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), volatile organic compounds (non-methane VOC and methane (CH<sub>4</sub>)), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), and nitrous oxide (N<sub>2</sub>O). According to CORINAIR90 the main relevant pollutants is SO<sub>2</sub> (see also table 2.1).

The most relevant step with regard to SO<sub>2</sub> emissions is the sintering process (for details see B331). However, only about 7 % of the total sulphur in the ore is emitted as SO<sub>2</sub>. The

remainder is captured by the slag. The concentration of this SO<sub>2</sub> stream can vary from 1.4 to 7.2 g/m<sup>3</sup>, depending on the amount of dilution air injected to oxidise the carbon monoxide and to cool the stream before baghouse particulate removal [1].

Nearly 85 % of the sulphur present in the lead ore concentrate is eliminated in the sintering operation (see chapter B331). In handling process offgases, either a single weak stream is taken from the machine hood at less than 2 % SO<sub>2</sub>, or two streams are taken, a strong stream (5 to 7 % SO<sub>2</sub>) from the feed end of the machine and a weak stream (less than 0.5 % SO<sub>2</sub>) from the discharge end. Single stream operation has been used if there is little or no market for recovered sulphur, so that the uncontrolled, weak SO<sub>2</sub> stream is emitted to the atmosphere.

When sulphur removal is required, however, dual stream operation is preferred. The strong stream is sent to a sulphuric acid plant, and the weak stream is vented to the atmosphere after removal of particulate [1].

Sulphur oxides are also generated in blast furnaces during the smelting process from small quantities of residual lead sulphide and lead sulphates in the sinter feed. The quantity of these emissions is a function not only of the sinter's residual sulphur content, but also of the sulphur captured by copper and other impurities in the slag [1].

### **3.5 Controls**

The dust emissions can be abated by using fabric filters, wet scrubbers or electrofilters. Improvement can be achieved by using encapsulation or evacuation. New approaches are under development.

The SO<sub>2</sub> containing emissions are often used as input for sulphuric acid plants. Here, emissions from combustion and from other process steps are reconciled. Single stage sulphuric acid plants can attain sulphur oxide levels of 5.7 g/m<sup>3</sup>, and dual stage plants can attain levels of 1.6 g/m<sup>3</sup>. Typical efficiencies of dual stage plants in removing sulphur oxides can exceed 99 %. Other technically feasible SO<sub>2</sub> control methods are elemental sulphur recovery plants and dimethylamine and ammonia absorption processes [1].

## **4 SIMPLER METHODOLOGY**

An approach calculating the emissions from economic or production statistics is feasible. Emission factors are presented in section 8.

## **5 DETAILED METHODOLOGY**

Information about the newer processes mentioned above is not yet available to allow a more detailed methodology to be followed.

## 6 RELEVANT ACTIVITY STATISTICS

Lead Production Statistics should be available nationally or from international statistics.

## 7 POINT SOURCE CRITERIA

The primary lead production should be treated as a point source if plant specific data are available.

## 8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

The emissions can vary widely depending on the ore used and the abatement measures applied, see Table 8.1 for reported emission factors. The emission factors given in Table 8.2 were prepared for the PARCOM-ATMOS Emission Factors Manual 1992. The factors for the emissions are based on the information from Table 8.1.

**Table 8.1. Emission factors for primary lead production (g/Mg product) as reported by several countries/authors**

Compound	Sweden [2]		Poland [3]			Germany [4]	Pacyna [5,6]
	limited	improved	limited	improved	unabated	unknown	unknown
Arsenic	3	0.2	16-43	-	-	3	300
Cadmium	3	0.6	10-22	-	-	6	10
Copper	10	4	10	7	-	-	-
Lead	400	200	560-1200	-	-	400	3000
Mercury	-	-	-	-	-	-	3
Zinc	50	20	110	-	680	-	110

**Table 8.2.: Proposed emission factors for primary lead production (g/Mg product)**

Substance	Emission factor		
	limited abatement	improved abatement	unknown level of abatement
Arsenic	3	0.5	10
Cadmium	10	1	15
Copper	10	5	10
Lead	800	200	2000
Mercury	3	3	3
Zinc	80	20	100

The following Table 8.3 contains fuel related emission factors for primary lead production based on CORINAIR90 data in [g/GJ]. Technique related emission factors, mostly given in other units (e.g. g/m<sup>3</sup>) are listed in footnotes. In 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. At this stage no data for the definition of appropriate conversion factors are available.

**Table 8.3: Emission factors for primary lead production<sup>6)</sup>**

Type of fuel			NAPFUE code	Emission factors						
				SO <sub>2</sub> <sup>3)</sup> [g/GJ]	NO <sub>x</sub> <sup>4)</sup> [g/GJ]	NMVOC <sup>5)</sup> [g/GJ]	CH <sub>4</sub> [g/GJ]	CO [g/GJ]	CO <sub>2</sub> [kg/GJ]	N <sub>2</sub> O [g/GJ]
s	coal	hc steam	102	149-520 <sup>1)</sup>	160 <sup>1)</sup>	15 <sup>1)</sup>	15 <sup>1)</sup>	100 <sup>1)</sup>	94 <sup>1)</sup> , 99 <sup>2)</sup>	4 <sup>1)</sup>
s	coal	hc sub-bituminous	103	838 <sup>2)</sup>	39 <sup>2)</sup>					
s	coal	bc briquettes	106	149-176 <sup>1)</sup>	140 <sup>1)</sup>	15 <sup>1)</sup>	15 <sup>1)</sup>	100 <sup>1)</sup>	97 <sup>1)</sup>	3.5 <sup>1)</sup>
s	coke	hc coke oven	107	149-520 <sup>1)</sup> , 462-501 <sup>2)</sup>	140 <sup>1)</sup> , 35 <sup>2)</sup>	0.5 <sup>1)</sup>	0.5 <sup>1)</sup>	100 <sup>1)</sup>	100-105 <sup>1)</sup> , 105 <sup>2)</sup>	4 <sup>1)</sup>
s	coke	bc coke oven	108	660 <sup>1)</sup>	200 <sup>1)</sup>	05 <sup>1)</sup>	0.5 <sup>1)</sup>	100 <sup>1)</sup>	100 <sup>1)</sup>	4 <sup>1)</sup>
l	oil	residual	203	149- 1,470 <sup>1)</sup>	150-175 <sup>1)</sup>	4 <sup>1)</sup>	4 <sup>1)</sup>	10-15 <sup>1)</sup>	76-78 <sup>1)</sup>	2 <sup>1)</sup>
l	oil	gas	204	68-1,410 <sup>1)</sup>	70-100 <sup>1)</sup>	2.5 <sup>1)</sup>	2.5 <sup>1)</sup>	10-12 <sup>1)</sup>	73-74 <sup>1)</sup>	2 <sup>1)</sup>
g	gas	natural	301	0.4-149 <sup>1)</sup> , 371 <sup>2)</sup>	50 <sup>1)</sup> , 45 <sup>2)</sup>	2.5 <sup>1)</sup>	2.5 <sup>1)</sup>	10 <sup>1)</sup>	55-56 <sup>1)</sup> , 55 <sup>2)</sup>	1.5 <sup>1)</sup>

<sup>1)</sup> CORINAIR90 data, area sources (preliminary data)

<sup>2)</sup> CORINAIR90 data, point sources (preliminary data)

<sup>3)</sup> SO<sub>x</sub>: /1/ 17,209 · S g/m<sup>3</sup> fuel: primary metal production, process heaters, NAPFUE 204, S = sulphur content of fuel  
19,006 · S g/m<sup>3</sup> fuel: primary metal production, process heaters, NAPFUE 203, S = sulphur content of fuel  
Emission factors of SO<sub>2</sub> given here may contain emissions from combustion of fuel as far as emissions from sintering of ore.

<sup>4)</sup> NO<sub>x</sub>: /1/ 2,397 g/m<sup>3</sup> fuel: primary metal production, process heaters, NAPFUE 204  
6,591 g/m<sup>3</sup> fuel: primary metal production, process heaters, NAPFUE 203

<sup>5)</sup> VOC: /1/ 24 g/m<sup>3</sup> fuel: primary metal production, process heaters, NAPFUE 204  
34 g/m<sup>3</sup> fuel: primary metal production, process heaters, NAPFUE 203

<sup>6)</sup> It is assumed, that emission factors cited within the table are only related to combustion sources in primary lead production (except of SO<sub>2</sub>); other process emissions are not covered.

## **9 SPECIES PROFILES**

## **10 UNCERTAINTY ESTIMATES**

The quality class of the emission factors is estimated to be about B.

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

The weakest aspects in the current methodology are the emission factors.

The fuel specific emission factors provided in Table 8.3 are related to point sources and area sources without specification. CORINAIR90 data can only be used in order to give a range of emission factors with respect to point and area sources. Further work should be invested to develop emission factors, which include technical or fuel dependent explanations concerning emission factor ranges.

## **12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES**

Not applicable if actively treated on a point source basis.

## **13 TEMPORAL DISAGGREGATION CRITERIA**

The primary lead production as such is a continuous process.

## **14 ADDITIONAL COMMENTS**

## **15 SUPPLEMENTARY DOCUMENTS**

- Richtlinien zur emissionsminderung in nicht-eisen-metall-industrien. Umweltbundesamt 1980.
- US-EPA (ed.): AP 42 CD-Rom; 1994

## **16 VERIFICATION PROCEDURES**

A comparison between the profile of the calculated emissions and the composition of the ore could be used as a verification method.

## 17 REFERENCES

- 1 EPA (ed.): AIR Facility Subsystem, EPA-Doc. 450/4-90-003, Research Triangle Park, 1990.
- 2 Preliminary note on guidelines on measures and methods for heavy metals emissions control for the primary non-ferrous metal industry in the framework of the ECE task force "Heavy metal emissions" Presented by Sweden on meeting Berlin 21-24 January 1992.
- 3 Heavy metals emission to air in Poland for years 1980-1992, Hlawiczka, S., Zeglin, M., Koterska, A., Inst. Ecol. Ind. Areas, Report 0-2.081, Katowice, 1995 (in Polish).
- 4 Datenerhebung über die Emissionen Umweltgefährdenden Schwermetalle; Jockel, W., Hartje, J.; Forschungsbericht 91-104 02 588, TÜV Rheinland e.V. Köln; 1991.
- 5 Emission factors of atmospheric Cd, Pb and Zn for major source categories in Europe in 1950-1985; Pacyna, J.M.; NILU Report OR 30/91 (ATMOS 9/Info 7); 1990.
- 6 Survey on heavy metal sources and their emission factors for the ECE countries; Pacyna, J.M.; Proc. 2<sup>nd</sup> Mtg Task Force Heavy Metals Emissions, ECE Convention on Long-range Transboundary Air Pollution Working Group on Technology, Prague, 15-17 October 1991; page 27-55; 1990.
- 7 Calculation of atmospheric deposition of contaminants on the North Sea, Baart, A.C., Berdowski, J.J.M., Jaarsveld, J.A. van, Wulffraat, K.J., TNO-report TNO-MW-R 95/138, 1995.

## 18 BIBLIOGRAPHY

## 19 RELEASE VERSION, DATE, AND SOURCE

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## 20 POINT OF ENQUIRY

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