SNAP CODE: **040203**

SOURCE ACTIVITY TITLE: **PROCESSES IN IRON & STEEL INDUSTRIES & COLLIERIES**
Pig Iron Tapping

NOSE CODE: **105.12.03**

NFR CODE: **2 C 1**

ISIC: **2410**

1 ACTIVITIES INCLUDED

Pig iron tapping is a part of the production process for primary iron and steel.

2 CONTRIBUTION TO TOTAL EMISSIONS

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

Source-activity	**SNAP-code**	**Contribution to total emissions [%]**										
Pig Iron Tapping	040203	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	TSP*	PM_{10}*	$PM_{2.5}$*
Typical contribution		0	0	-	0	0	-	-	-	0.092	0.171	0.201
Highest value										0.235	0.413	0.444
Lowest value										0.005	0.012	0.020

* for total blast furnace process (cowpers, charging and tapping), EU $PM_{2.5}$ Inventory project for EU25 for the year 2000 (TNO, 2006), contribution to total national emissions, excluding agricultural soils,
0 = emissions are reported, but the exact value is below the rounding limit (0.1 per cent)
- = no emissions are reported

Emissions of heavy metals from primary iron and steel industry, including pig iron tapping give a relevant contribution to the emissions on a national level. For heavy metal emissions, no specific figures for this source activity are available. The average relative contribution from the total iron and steel production industry and the production of pig iron, to the total emission of heavy metals has been presented for European countries in Table 2.2. Pig iron tapping is part of the production of pig iron. The data in Table 2.2 is according to Baart *et al.* (1995). /1/

Table 2.2: Average relative contribution of the production of iron and steel and the production of pig iron to the total emission of heavy metals in European countries

Compound	**Total iron & steel production (%)**	**Pig iron production (%)**
Cadmium	22	-
Chromium	36	3.7
Copper	16	-
Nickel	14	3.0
Lead	12	-
Zinc	33	-

- = not available

3 GENERAL

3.1 Description

The liquid molten iron and the sludge gathering in the bottom of the smelter are tapped on a regular basis. A smelter has usually three holes that are plugged with refractory material. After the process holes are bored by remote boring, and the mixture of pig iron and slag is guided by the trough to the skimmer where iron and slag are separated. The liquid pig iron is guided by the iron runner and the tilting runner to the mixer; the sludge is removed for granulation or dumping. After emptying the smelter the bore holes are closed again with refractory material. The fire resistant coating of the guides has a limited lifetime, and has to be exchanged regularly.

3.2 Definitions

Trough — Covered guide between the oven and the skimmer.

Skimmer — Tunnel shaped construction where the heavier pig iron is seperated from the lighter slag floating on the iron.

Iron run — Connection between the skimmer and the tilting runner.

Tilting runner — A bridge on the end of the iron runner where the mixers can be filled and exchanged. The mixer is a container placed on a railroad carriage used for transport to for instance the steel factory.(Basic Oxygen Furnace).

Refractory material — Material used for closing a tap hole. The refractory material contains in general coal and tar.

Runner coating — Fire resistant material used for coating the runners. This product also contains coal and tar.

3.3 Techniques

3.4 Emissions

The boring of the tap and the filling of the trough gives rise to dust emissions. These emissions mainly arise from contact between the hot metal and slag and ambient oxygen.Also dust emissions occur after the skimmer, but to a lesser extent than in the first part of the route. The dust contains some heavy metals. The particle size of the dust during the boring is mainly below ten micron. The size of the particles from the emissions from the roof is usually about 50 % bigger than ten micron.

After coating, the transport trough has to be heated. This gives volatile decomposition products. These decomposition products are also emitted by the heating of the plugging material.

Decomposition products from tar are polycyclic aromatic hydrocarbons (PAH) and benzene containing aromatics. The exact benzene content is not available. In principle the same products are produced by the heating of coal. The amount of coal used is however so small that these emissions can be neglected.

3.5 Controls

The trough, the skimmer, and the transport runners are usually covered. Dust and decomposition products are removed, and are passing fabric filters before emission into air. The part not captured passes through the roof. This emission is not abated. The total amount escaping through the roof is about 40 % of the total emission.

From the decomposition products of tar and coal only the condensable part of the PAH emissions is captured by the fabric filters.

4 SIMPLER METHODOLOGY

Emissions can be estimated at different levels of complexity; it is useful to think in terms of three tiers[1]:

- Tier 1: a method using readily available statistical data on the intensity of processes ("activity rates") and default emission factors. These emission factors assume a linear relation between the intensity of the process and the resulting emissions. The Tier 1 default emission factors also assume an average or typical process description.
- Tier 2: is similar to Tier 1 but uses more specific emission factors developed on the basis of knowledge of the types of processes and specific process conditions that apply in the country for which the inventory is being developed.
- Tier 3: is any method that goes beyond the above methods. These might include the use of more detailed activity information, specific abatement strategies or other relevant technical information.

[1] The term "Tier" is used in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and adopted here for easy reference and to promote methodological harmonization.

By moving from a lower to a higher Tier it is expected that the resulting emission estimate will be more precise and will have a lower uncertainty. Higher Tier methods will need more input data and therefore will require more effort to implement.

For the simpler methodology (equivalent to Tiers 1 and 2), where limited information is available, a default emission factor can be used together with production capacity information for the country or region of interest without further specification on the type of industrial technology or the type and efficiency of control equipment.

Consequently the simplified methodology is to combine an activity rate (AR) with a comparable, representative, value of the emissions per unit activity, the emission factors (EF). The basic equation is:

$$\text{Emission} = \text{AR} \times \text{EF}$$

In the energy sector, for example, fuel consumption would be activity data and mass of material emitted per unit of fuel consumed would be a compatible emission factor.

NOTE: The basic equation may be modified, in some circumstances, to include emission reduction efficiency (abatement factors).

Default emission factors for this purpose are provided in Section 8.1.

5 DETAILED METHODOLOGY

The detailed methodology (equivalent to Tier 3), to estimate emissions of gaseous pollutants from the pig iron production is based on measurements or estimations using plant specific emission factors. Guidance on determining plant specific emission factors is given in Measurement Protocol Annex.

6 RELEVANT ACTIVITY STATISTICS

Information on the production of pig iron production, suitable for estimating emissions using of the simpler estimation methodology (Tier 1 and 2), is widely available from UN statistical yearbooks or national statistics.

The detailed methodology (Tier 3) requires more detailed information. For example, the quantities of pig iron produced by various types of industrial technologies employed in the iron and steel industry at plant level. This data is however not always easily available.

Further guidance is provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 3 on Industrial Processes and Product Use (IPPU), chapter 2.2.1.3 " Choice of activity statistics".

7 POINT SOURCE CRITERIA

The emissions of the complete plant should be considered as a point source.

8 EMISSION FACTORS

The total air flowing from a representative smelter is between 540,000 and 660,000 m^3/hour. The dust content is measured from time to time. The emissions from the roof are based on information from a measurement campaign in a plant in the Netherlands. The emissions of hydrocarbons by decomposition of tar and coal from plugging mass and coating materials are based on expert estimations.

The emission factors presented in Table 8.1a are calculated by relating a measured dust production with the known production of the smelter in the same period (30.2 g dust per Mg pig iron produced).

Table 8.1a: Emission factors for the emission of heavy metals related to dust emissions from pig iron tapping

	Emission factor (in g Mg^{-1} pig iron produced)		
	total	unabated	fabric filters
Arsenic	0.0009	0.0003	0.0006
Cadmium	0.0003	0.0001	0.0002
Chromium	0.015	0.006	0.009
Copper	0.015	0.006	0.009
Lead	0.015	0.006	0.009
Mercury	0.0003	0.0001	0.0002
Nickel	-	-	-
Zinc	0.021	0.009	0.012

Table 8.1b shows emission factors for particulate matter derived from CEPMEIP.

Table 8.1b: Heavy metal emission factors for particulate matter in kg ton^{-1} pig iron (furnace charging and tapping, CEPMEIP*)

Technology	Abatement	TSP	PM_{10}	$PM_{2.5}$	Uncertainty-factor
Modern plant (BAT)	High efficiency ESP or equivalent to control primary sources; fabric filters for fugitive emission;	0.04	0.038	0.036	3
Conventional plant	Installation with average age; conventional dedusting: ESP, wet scrubber; some capturing of fugitives	0.24	0.192	0.12	2
Older technology	multi-cyclones only	2	1	0.5	2

NOTE: The uncertainty range (95% confidence) in the emission factor is expressed as a factor. The lower limit of the uncertainty range can be found by dividing the emission factor by the uncertainty factor, whereas the upper limit of the uncertainty range can be found by multiplying the range with the uncertainty factor. Example (first row in Table 8.2): The uncertainty in the emission factor for $PM_{2.5}$ emissions from a modern plant is 3. The emission factor

with uncertainty range will therefore be 0.036 kg per tonne pig iron with an uncertainty range of 0.012 (0.036 / 3) to 0.11 (0.036 x 3).
* Includes PM emission factors for the combination of both charging and tapping – see chapter B422 for Pig Iron Charging.

Although the amount of decomposition products is determined by the amount of tar and coal used, a relation can be established with the total amount of pig iron transported through the transport runners. This calculation results in the emission factors for organic compounds as presented in Table 8.2.

Table 8.2: Emission factors for the emission of organic compounds related to pig iron tapping.

	Emission factor (in g.Mg^{-1} pig iron)		
Substance	total	unabated	fabric filter
PAH	3.45	2.5	0.95
Aromatic hydrocarbons, including benzene	0.3	14.3	66
Benzene	2.5	0.45	2.05

9 SPECIES PROFILES

The dust emissions could be related to the profile of the ore. No general applicable information about ore compositions is available.

10 UNCERTAINTY ESTIMATES

The quality code of the emission factors is estimated to be C.

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

The only improvement measure for this part of the process is the exchange of tar with tar-free products in the plugging material and the coatings.

12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

Not applicable.

13 TEMPORAL DISAGGREGATION CRITERIA.

The tapping is a discontinuous process; the use of the smelter as such is a continuous process.

14 ADDITIONAL COMMENTS

No additional comments.

15 SUPPLEMENTARY DOCUMENTS.

Environmental Protection Agency, Compilation of air pollutants emission factors AP-42
PARCOM-ATMOS Emission factors Manual
W. Mulder, personnal communication, Delft, 1995.

16 VERIFICATION PROCEDURES.

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

17 REFERENCES

/1/ A.C. Baart, J.J.M. Berdowski, J.A. van Jaarsveld; Calculation of atmospheric deposition of contaminants on the North Sea; IWAD; ref. TNO-MW-R 95/138; TNO MEP; Delft; The Netherlands; 1995

/2/ Visschedijk, A.J.H., J. Pacyna, T. Pulles, P. Zandveld and H. Denier van der Gon, 2004, Cooordinated European Particulate Matter Emission Inventory Program (CEPMEIP), In: P. Dilara et. Al (eds), Proceedings of the PM emission inventories scientific workshop, Lago Maggiore, Italy, 18 October 2004, EUR 21302 EN, JRC, pp 163 - 174

18 BIBLIOGRAPHY

General literature references about the primary steel industry.

19 RELEASE VERSION, DATE AND SOURCE

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20 POINT OF ENQUIRY

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