030308
Secondary zinc production

Process description

Lead blast-furnace slag often contains sufficient zinc to make recovery profitable by rotary kiln or submerged combustion slag fuming. In both cases zinc oxide in the slag is reduced to metallic zinc (vapor) by carbon, oxidized by secondary air, and carried out in the furnace gases for recovery of zinc oxide dust.

Zinc recovery rotary kilns (Waelz kilns) are up to 95 m long with an internal diameter of up to 4.5 m and they are lined with refractory material. The granulated blast-furnace slag is mixed with other zinc intermediates (steel dusts, etc.) and solid fuel reductant; it travels down the kiln and is heated to reaction temperature by combustion gases from a burner at the discharge end. In the *slag-fuming process* a mixture of coal dust and air is injected through tuyeres into a liquid blast-furnace slag at 1150 - 1250 °C in a water-jacketed furnace. The slag is delivered in liquid form directly from the lead blast furnace and may have up to 30 % of solid granulated slag or slag skulls added to it. The process is typically operated in batch mode in furnaces of 50 - 100 t capacity.

Abatement technologies:

Ususally secondary zinc smelters are equipped with dust removing installatios like baghouses. These facilities may have very high efficiencies (up to 99.9 %) ‹1›. No special abatement measures exist with respect to PCDD/F emissions.

Plant data/European situation

A list of the main zinc producers in Europe could be obtained from Eurostat „Panorama of EU Industry 1995/96“ and is reprinted in 030308—Table 1.

Country	Company	Location	Process (1)	Theoretical annual capacity (tonnes)
Belgique/ België	Union Minière	Balen-Wezel	E	200,000
BR Deutschland	Ruhr-Zink GmbH	Datteln	E	200,000
	M.I.M. Hüttenwerke Duisburg GmbH	Duisburg-Wanheim	ISF-RT	100,000
	Metaleurop Weser Zink GmbH	Nordenham	E	130,000
	Harz Zink GmbH	Harlingerode	CV	30,000
España	Asturiana de Zinc S.A.	San Juan de Nieva	E	320,000
	Española del Zinc S.A.	Cartagena	E	60,000
France	Union Minière France	Auby	E	220,000
	Metaleurop S.A.	Noyelles Godault	ISF-RT	100,000
Italia	ENIRISORSE	Porto Vesme (Sardegna)	ISF-RT	75,000
		Porto Vesme (Sardegna)	E	80,000
	Pertusola Sud S.p.A.	Crotone (Calabria)	E	100,000
Nederland	Budelco B.V. (Pasminco + Billiton)	Budel-Dorplein	E	215,000
United Kingdom	Britannia Zinc (MIM Holdings)	Avonmouthl	SF-RT	114,000
TOTAL				**1,944,000**

030308—Table 1: Zinc producers in Europe

(1) E = Electrolytic plant ISF = Imperial smelting furnace; CV = Vertical retorts; RT = Fire refining

Source: Industry statistics

It may be assumed that all large zinc manufacturers are engaged in secondary zinc production (however, no specific information on this question is available).

Activity data

Activity data (shown in 030308—Table 5) were taken from the national inventories and from statistics. However, as in some cases the activity rates for zinc were related to

different kinds of applications an overall total had to be calculated for two countries (Germany, United Kingdom). With about 400 kt/a the secondary zinc production constitutes approximately 20% of the total capacity for zinc production in Europe.

Emission factors

Emission factors for secondary zinc production as reported by the national dioxin inventories are shown in 030308—Table 4. Only 4 of the 17 countries considered report any emission factors (Belgium, Germany, France and United Kingdom); the German value appears to be the only one relying on emission measurements.The other values had been gained either by adoption of literature data or by rough estimations (no reference is given for the Belgian emission factor).

From these few emission factors the following emission factors were selected to be used for the emission estimation:

typical	minimum	maximum
50.0	5.0	500.0

030308—Table 2 Chosen emission factor for secondary zinc production [µg I-TEQ/t]

Emission estimation

The standardised annual PCDD/F emissions were derived on the basis of the selected emission factors and the activity rates shown before. The values obtained were compared to those reported in the national inventories (030308—Table 6). For all 17 countries considered the following total results were obtained (030308—Table 3):

	TOTAL
national inventories	32.62
Re-evaluation, min	1.99
Re-evaluation, max	198.60
Re-evaluation, typical	19.86

030308—Table 3 Summary of re-evaluated typical PCDD/F air emissions [g I-TEQ/a] for secondary zinc production

If those countries are included into the total estimation which did not provide any data or emission inventories for secondary zinc production, the European total emission increases by a factor of more than 6 in the worst case.

Conclusions/recommendations

Secondary zinc production is of significant relevance for the total emission of PCDD/F in Europe. However, all calculations in this chapter are associated with considerable uncertainties as some emission factors are largely based on assumptions and most countries did not provide any data at all concerning secondary zinc production. This induces a broad uncertainty range for the annual PCDD/F emissions from this type of industrial installation; additional dioxin measurements are recommended get more reliable statements.

	Flue gas conc. [ng I-TEQ/m³]			Emission factors [µg/t]			Remark
	typ	min	max	typ	min	max	
B				5.00			no reference given for used EF
D		1.8E-3	120			379	conc. measured at various stacks of an imperial smelter plant;max EF calculated with nominal capacity of this plant
F					400	700	EFs taken from German publication [Lahl]
UK					5	35	Composite EFs for whole non ferrous metal industry; estimated total emission is 5 to 35 g I-TEQ/a
				50.00	**5.00**	**500.00**	Chosen values

030308—Table 4 PCDD/F air emission factors for secondary zinc production from the national dioxin inventories

	Activity rates [kt/a] typ	Recovery from sec. materials in primary zinc smelters	annual production [kt/a] Remelted zinc and remelted zinc alloys	Zinc in copper and other alloys	Direct use of scrap in chemicals, paints, pigments etc.	TOTAL
A			1.60			1.6
B	167.00		20.00			20.0
CH						nd
D		54.50	64.00	104.10	47.80	270.4
DK						nd
E			15.00			15.0
F			19.70			19.7
GR						nd
I			7 *)			7.0
IRL						0.3
L						nd
N					15.90	15.9
NL						0.0
P						0.0
S			0.50			0.5
SF						0.0
UK			6.30	20.80	19.70	46.8
TOTAL						395.6

*) alloys only

030308—Table 5 Activity rates releated to secondary zinc production

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		typ	min	max
	g ITEQ/a			
A		0.08	0.008	0.8
B	0.82	1	0.1	10
CH				
D	23.51	13.52	1.352	135.2
DK				
E		0.75	0.075	7.5
F	7.00	0.985	0.0985	9.85
GR				
I		0.35	0.035	3.5
IRL		0.0153	0.00153	0.153
L				
N		0.795	0.0795	7.95
NL		0	0	0
P		0	0	0
S	1.29	0.025	0.0025	0.25
SF		0	0	0
UK		2.34	0.234	23.4
Total	32.62	19.86	1.99	198.60

030308—Table 6 Comparison of PCDD/F air emission estimates [g I-TEQ/a] for secondary zinc production

References to 030308

1 Gordon McInnes (Ed.) (1996) : EMEP/CORINAIR Atmospheric Emission Inventory Guidebook. European Environment Agency, Copenhagen (Ed.)