030309
Secondary copper production

Process description

Secondary raw materials such as oxide materials for example can also be processed in shaft kilns to copper matte or coarse copper. Blister copper is produced from copper matte in the matte converter and anode copper is produced from this in the anode kiln or, from coarse copper in the anode shaft kiln, as well as in the foundry kiln.

Scrap alloys are preferentially used in used metal converters and the copper thus recovered is transferred to the anode kiln. Scrap copper can also be processed directly in the anode kiln.

Copper is recovered from many secondary materials, including copper and copper-alloy scrap, as well as substances that contain oxidized copper, such as slag, flue dust, dross, ash, residue, and sludge.

New scrap (fabricating waste) can be recycled to the appropriate melting and casting plant. Old scrap (used copper), however, must be sorted and sampled to select the most suitable sequence of recovery operations in a smelter or refinery. The recovery of metals from copper alloys is complicated because of separation problems. In practice, pyrometallurgical treatments employing a blast furnace and converter are prefferred.

Converter-Blast Furnace Method

The original so-called Knudsen process was patented in 1915 and its variants became the conventional method. Copper-alloy scrap, such as brass, bronze, gunmetal, and nickel alloys, is melted in small converters with coke and iron scrap (but no silica) during air blowing. Crude copper in the converter contains some impurities and must be refined. The copper-rich slag must be processed by reducing blast furnace smelting to yield black copper.

Blast Furnace-Converter Method

The reversed process is well-suited for smelting oxidized secondary materials [124]. this method of processing brass scrap produces zinc oxide, which is utilized as a raw material for zinc white or zinc metal. Bronze and gunmetal scrap yield mixtures of oxides from which tin-lead solder is made.

Plant data/European situation

The following information has been adopted from Panorama of EU Industry ‹1:›

There are ten major refineries in the EU and it is estimated that the copper refining industry employed more than 5 000 people in 1993. Two companies have facilities of over 250 000 tonnes of refined copper per year capacity, Union Minière (B) and Norddeutsche Affinerie (D). Two others, Hüttenwerke Kayser (D) and Rio Tinto Minera (E), produce more than 100 000 tonnes per year each. Production capacity at the other facilities in Spain, Italy, the United Kingdom, France and Belgium, ranges between 35 000 and 100 000 tonnes of copper per year.

Upstream integration into smelting operations, processing concentrates or low grade scrap varies from one refinery to another. Some are fully or partially integrated whilst others have no smelting facility at all. One company only has a smelting capacity which significantly exceeds its refining capacity (Metallo Chimique in Belgium). At EU level, there is a deficit in copper smelting capacity.

Country	Company	Location	Theoretical annual capacity [kt/a]
	Union Minière	Olen	330
	Metallo-Chimique	Beerse	38
D	Norddeutsche Affinerie	Hamburg	350
	Hüttenwerke Kayser	Lünen	122
	MKM Mansfelder Küpfer und Messing	Hettstedt	55
E	ELMET	Bilbao-Berango	38
	Rio Tinto Minera	Huelva	150
F	Cie Générale du Palais	Le Palais	45
I	ENIRISORSE	Porto Marghera	60
UK	IMI Refiners	James Bridge	46
TOTAL			1234

030309—Table 1: Main copper producers in Europe (EU 15)

Source: International Wrought Copper Council, London, and industry statistics

Activity data

The activity data were taken from annual production statistics (shown in 030309—Table 5) because only three countries presented activity in their national inventories. Note for Austria and particularly for Belgium the differences between the applied values in the national inventories and the values from the annual production statistics. It is interesting to note that the production rates of secondary copper given in metal statistics excced the production capacities shown in 030309—Table 1; this indicates a high contribution of small comparatively producers to the overall production.

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Emission factors

Emission factors for secondary copper production as reported by the national dioxin inventories are shown in 030309—Table 5. Most of them are adopted literature values; flue gas concentrations are reported from Germany only.

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

typical	minimum	maximum
50.0	5.0	500.0

030309—Table 2 Default emission factor for secondary copper production [µg I-TEQ/t]

Emission estimation

On the basis of the selected emission factors and the activity rates the standardised annual PCDD/F emissions were calculated. The values obtained were compared with those reported in the national inventories (see 030309—Table 6). For all 17 countries considered the following results were obtained (030309—Table 3):

	TOTAL
national inventories	103.0
Re-evaluation, min	7.7
Re-evaluation, max	769.2
Re-evaluation, typical	76.9

030309—Table 3 Summary of re-evaluated typical PCDD/F air emissions [g I-TEQ/a] for secondary copper production

Concerning secondary copper production the total typical value for all 17 countries is even below the total of all values from the national inventories; however, the uncertainty range is considerably due to a very small data base.

Conclusions/recommendations

It is quite obvious that secondary copper production is of significant relevance for the total emission of PCDD/F in Europe. However, as for secondary zinc production all calculations in this chapter are associated with considerable uncertainties; since the emission factors are largely based on assumptions a broad uncertainty range is obtained.

Additional emission measurements are recommended to get a more reliable data base for the estimation of annual dioxin emissions from this type of plant.

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	Flue gas conc. [ng I-TEQ/m³]			Emission factors [µg/t]			Remarks
	typ	min	max	typ	min	max	
A				4			
B				200	22	2340	typ. EF is logarith. mean of literature data (US, S, D) covering given range
D		0.032	30		0	110	
F				650			EF taken from German publ. (Lahl)
NL					5	35	no measurements; EFs taken from sec. aluminium prod.;additional invest. necessary
UK					5	35	Composite EFs for whole non ferrous metal industry; estimated total emission is 5 to 35 g I-TEQ/a
				50	**5**	**500**	Selected values

030309—Table 4 PCDD/F air emission factors for secondary copper production from the national dioxin inventories

	Activity rates [kt/a] from inv.	annual production ‹2›
A	70	48.3
B	465	102.8
CH		30.0
D		621.7
DK		
E		64.1
F		129.0
GR		0.0
I		330.0
IRL		0.0
L		
N		
NL	49	52.0
P		0.0
S		20.6
SF		25.0
UK		114.9
Total		1490.1

030309—Table 5 Activity rates releated to secondary copper production

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	from inv. g I-TEQ/a	new typ	min	max
A	0	2.4	0.2	24.2
B	82	5.1	0.5	51.4
CH		1.5	0.2	15.0
D	10	31.1	3.1	310.9
DK		0.0	0.0	0.0
E		3.2	0.3	32.1
F	10	6.5	0.6	64.5
GR		0.0	0.0	0.0
I		16.5	1.7	165.0
IRL		0.0	0.0	0.0
L		0.0	0.0	0.0
N		0.0	0.0	0.0
NL	0.3	2.6	0.3	26.0
P		0.0	0.0	0.0
S	0.1	1.0	0.1	10.3
SF		1.3	0.1	12.5
UK		5.7	0.6	57.5
Total	**103.0**	**76.9**	**7.7**	**769.2**

030309—Table 6 Comparison of PCDD/F air emission estimates [g I-TEQ/a] for secondary copper production

References to 030309

1 Panorama of EU Industry 95-96. Eurostat, Brussels

2 Metal Statistics 1982-1992. Editor: Metallgesellschaft Frankfurt/M, Germany, 1993.