

030101-03/06**Combustion in boilers and other stationary equipments***Process description*

Covered here are furnace installations for wood in the industrial sector. Combustion takes place in vertical cyclone furnaces, cyclone injection firings, sloping grate firings, combined grate/coal dust firings or fluidised bed firing installations.

Vertical cyclone furnaces

The vertical cyclone furnaces are modern low-emission installations for the combustion of wood with a furnace thermal output of approx. 800 kW. The air for combustion is blown tangentially into the combustion compartment in order that a thorough admixture and a high dwell time of the firing gases in the combustion compartment is achieved.

Cyclone injection firing

The cyclone injection firing with downstream large-scale post combustion compartment enables a low-emission operation with good burn-out conditions. A thorough admixture and a high dwell time of the firing gases in the combustion compartment are achieved by the tangential admission of air into the burner muffle. The combustion compartment temperatures lie in the range of around 600 to 900°C.

Sloping grate firing

The installation can be operated with heating oil EL as an alternative. For the use of wood shavings, the combustion compartment is preheated by an ignition burner up to the operating temperature before being switched over to firing the wood shavings. The boiler temperatures are between 700 and 1,000°C.

Combined grate/coal dust firing

The installation is a combination of furnaces for coal dust and feed grate firing (combustion thermal output for grate firing: 25 MW; for coal dust burner: 14 MW).

Fuel

The fuel wood can differ very much in terms of forms and properties. Bulky wood, shavings, remainders from chipboard and other types of wooden materials, untreated wood, coated with substances either containing or not containing chlorinated organics, or treated with wood-protection agents, are several classification criteria.

The chlorine content of untreated wood is usually about between 0.001 and 0.01 % by weight. The chlorine content of bark lies significantly higher in the range of 0.01 to 0.02 % by weight. Depending on the location, even higher chlorine contents can be found in untreated wood and barks in certain cases. Chipboard can have chlorine contents of up approx. 0.2 % by weight depending on the constitution of the binding agents. Significantly higher values are to be found in wood materials which contain PVC constituents.

Abatement technologies:

On furnace installations for wood in the industrial sector measures can be implemented on the furnace as well as on the waste gas side to reduce the emissions (amongst others combustion compartment design, graduated air intake for combustion, waste gas return, E-filters, fabric filters).

Plant data/European situation

Data on the number and capacities of industrial wood combustion facilities are provided by some of the national dioxin inventories (see 030101-03/06—Table 1). On basis of

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this information several thousands of large wood burning installations can be assumed to be operated in the European countries.

country	number	capacity (range) [kW]
B	200-300	no data given
D	1000	> 100
	24,000	< 100
NL	1000	100-1000

030101-03/06—Table 1 data on wood combustion facilities provided by the national dioxin inventories

Activity data

Activity data (shown in 030101-03/06—Table 5) were taken from the national inventories; because apparently no data are supplied by national or European statistics.

Information about the relative consumption of different types of wood is given only in the British dioxin inventory. According to this inventory about 75% of the total burned wood is assumed to be treated wood, and about 25% being clean or untreated wood.

Emission factors

Emission factors for wood combustion are reported in the national dioxin inventories or other publications from Belgium, Switzerland, Germany, The Netherlands and the United Kingdom (shown in 030101-03/06—Table 4). They had been gained either by special measurement programs or by adoption of literature data. Several scientific studies were performed in the recent past to assess the formation of PCDD/F during wood combustion at industrial installations (see corresponding chapters in Volume 2). Flue gas concentrations depending on the operation conditions and the contamination of

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wood used as fuel are reported from Germany, France, Luxembourg and the Netherlands.

Emission estimation

The 17 states regarded in this study provided data which varied considerably; several countries supplied either flue gas concentrations, emission factors, activity rates or annual emissions. As the data on annual emissions were most complete (data from 10 states) these values were taken as the basis. From this data emissions per capita were calculated and the geometric mean was used for the re-calculation of the annual emissions of all 17 states. The values obtained are compared to those reported in the national inventories. For all 17 countries considered the following results are obtained (030101-03/06—Table 2):

combustion of wood	total
national inventories	12,10
Re-evaluation	20,89

030101-03/06—Table 2 Summary of re-evaluated typical PCDD/F air emissions [g I-TEQ/a] from industrial wood combustion

Using the mean of the annual emission per capita the values obtained are considerably higher for Germany, France and the United Kingdom than in the national reports. Only in the case of Belgium a considerable decrease was observed; this is because in the Belgian survey the high emission factor of the Parcom-Atmos Manual was used (130 µg I-TEQ/t). If those countries are included into the total estimation which did not provide any data or emission inventories for industrial wood combustion, the European total emission increases by a factor of less than 2.

Combustion in boilers and other stationary equipments*Conclusions/recommendations*

Industrial wood combustion is of some relevance for the total emission of PCDD/F in Europe. However, all calculations in this chapter are associated with considerable uncertainties since the activity rates are largely based on assumptions. A brief inventory of the amounts and different types of annually burnt wood in industrial furnaces is necessary for a better precision of the estimates.

Moreover, considerable uncertainties exist with regard to the applied emission factors.

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	Flue gas conc. [ng I-TEQ/m ³]			Emission factors [µg/t]			Remark
	typ	min	max	typ	min	max	
A							
B				5.00			rough estimation of wood consumption based on data from NL; EF taken from US EPA dioxin reassessment
CH				0.88	0.11	1.47	EF typ.: mean value of 3 results [CH 129, 187, 261], originally given in ng/GJ; conversion factor: 14.654 GJ/t
D		0.00	9.82	30.00	1.00	505.00	highest concentration found with contaminated wood
DK							
E				1			Ef taken from Technical Paper of OSPARCOM-HELCOM-UNECE Emission Inventory < 1 >
F	0.02	0.01	0.02				
GR							
I							
IRL							
L	0.05						
N							
NL	0.63	0.40	1.00		2.20	50.00	
P							
S							
SF							
UK				1.41 13.08	1 9	2 19	clean wood contaminated wood

030101-03/06—Table 3 PCDD/F air emission factors for industrial wood combustion from the national dioxin inventories

Country	Industrial wood combustion [kt/a]	
	from Inventories	from statistics
A	405	nd
B	650	nd
CH		nd
D	2730 *)	nd
DK		nd
E	2211	nd
F		nd
GR		nd
I		nd
IRL		nd
L		nd
N		nd
NL	228	nd
P		nd
S		nd
SF		nd
UK	50 (clean) 150 (contaminated)	nd

030101-03/06—Table 4 Activity rates related to industrial wood combustion (nd: no data available)

*) corresponds to 40 PJ as estimated in < 2>

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	Annual Emissions		re-estimated with number of capita	relation re- estimate/Invent.
	from Inv.	Emission per Capita [$\mu\text{g}/\text{a}$]		
A	0.53	0.07	0.43	0.82
B	3.25	0.32	0.55	0.17
CH			0.39	
D	1.59	0.02	4.45	2.80
DK	0.25	0.05	0.29	1.16
E	2.20	0.06	2.17	0.98
F	1.00	0.02	3.16	3.16
GR			0.56	
I			3.11	
IRL			0.19	
L	0.03	0.08	0.02	0.69
N			0.24	
NL	0.70	0.05	0.84	1.20
P			0.54	
S			0.48	
SF	0.50	0.10	0.28	0.56
UK	2.04	0.04	3.18	
Total:	12.10		20.89	
mean:		0.055		1.28

030101-03/06—Table 5 Comparison of PCDD/F air emission estimates [$\text{g I-TEQ}/\text{a}$] for industrial wood combustion reported by national inventories with those derived in this study

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References to 030101-03/06

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