Emission Inventry of HCB and PCB in Japan

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Introduction

Under Article 5 of the Stockholm Convention on Persistent Organic Pollutants (POPs), Parties are required to develop emission inventories and an action plan to reduce or eliminate releases from unintentional production of POPs (UPOPs); polychlorinated dibenzo-p-dioxins (PCDD), polychlorinated dibenzofurans (PCDF), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCB).

Since the POPs Convention entered into force in 2004, each Party shall take measures to reduce the UPOPs releases under Article 5 of the Convention. Therefore, it's urgent for Parties to develop inventories by identifying source categories and estimating emissions from them as the basis of the measures. Since there are few data and information on source categories and emission factors of unintentionally produced HCB and PCB in the world, it would be in great need for collecting such data and information, and sharing them among countries to the extent possible.

This paper reports the outlines of the investigation on emission sources, calculation of emission factors and estimated amount of emission of unintentionally produced HCB and PCB.

Methods and discussion

As a first step of inventory development, identification of emission sources categories is essential. The potential source categories releasing HCB and/or PCB in Japan have been identified on the analogy of emission inventories and information on emission sources of HCB and PCB in other countries (Table 1).

Next we need an investigation on emission sources and calculation of emission factors of HCB and PCB. We examined facility capacities, operating time, HCB and PCB concentration in the emission gas of the facilities of potential interest in the first step investigation.

Three hundred and eleven facilities were investigated in 2001-2004. Based on the above data, emission factors of HCB or PCB for each type of facilities were calculated by the following calculation.

Emission factor for HCB or PCB of a facility type =

Σ HCB or PCB concentration in the flue gas × annual amount of emission gas

÷Σ annual amount of activity of the facility type

Table 2 shows the result of the investigation on the emissions of HCB and PCB. Finally, using the emission factors estimated, annual emissions of HCB or PCB were calculated as follows

Annual emissions of HCB or PCB

= emission factor of HCB or PCB of a type of facility × nationwide activity index

Table 3 shows estimation of annual emissions of HCB and PCB. The total emissions of HCB and PCB in Japan in 2002 were estimated 190kg and 560kg, respectively. Estimations of HCB emissions of the whole world or some countries were reported; 1.8-11.8 ton/y in US[1)], 1.27 ton/y (1990) and 0.89 ton/y (1997) in UK[2)], 10-100ton/y in the world[1),3)]. Recent estimations of HCB and PCB emission were 307 and 1452 kg/y (2002) in UK[4)]. Toxic Release Inventory (TRI) in US showed 549 and 198 kg/y (2003) respectively[5)].

Conclusion

Most of the mechanisms of unintentionally emissions of HCB and PCB are considered to be basically similar to those of dioxins. For this reason, the emission of HCB and PCB would be reduced according to the progress of the measures against dioxins. Emission factors reported here are calculated using data of investigations in 2001-2004, and they should be revised periodically according to the progress of the measures.

References

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4)http://www.naei.org.uk/emissions/emissions_2002/summary_tables.php?action=unece&page_name=HCB02.html, http://www.naei.org.uk/emissions/emissions_2002/summary_tables.php?action=unece&page_name=PCB02.html

5) http://www.epa.gov/tri/tridata/tri03/index.htm

Table 1 Sources verified emissions of HCB and PCB in the inventory of each country

Source categories				HCB		PCB	
				Air	Water	Air	Water
Sources listed in Part of Annex C of the Stockholm Convention							
	Waste incineration	Waste incineration or power generation using waste in urban areas		◎	◎	◎	
		Hazardous or chemical waste incineration				◎	
		Medical or biotic waste incineration				◎	
		Sewage sludge incineration				◎	
		Firing waste oil				◎	
		Waste tyres incineration				◎	
		Production or incineration of RDF				◎	
	Production of cement			◎	△		
	Production of paper pulp			◎	◎		
	Metallurgical industry	Iron and steel	Sinter plants	◎		◎	
		Secondary aluminium production		◎	○		
Sources listed in Part of Annex C of the Stockholm Convention							
	Metallurgical industry	Iron and steel	Electric ark furnace			◎	
			Pure oxygen converters ?			◎	
		Primary nonferrous metal production		◎			
	Residential combustion sources	Firing wood in residences				◎	
	Firing fossil fuels	Power generation		◎	◎		
		Firing coal				◎	
		Firing petroleum				◎	
		Residue oil boilers				◎	
		Combustion in manufacturing industry		◎		◎	
	Firing wood and other biomass fuels	Firing wood in industry				◎	
		Firing straw in agriculture				◎	
	Chemical industry	Chlorinated organic solvents	Production of tetrachlorinated carbon	◎	○		
			Production of tetrachloroethylene	◎	○		
			Production of trichloroethylene	◎	○		
		Production of agricultural chemicals		◎	○		
		Production of chlorine, alkali or hydrochloric acid		◎	◎		
		Processes of diisocyanate			◎		
Other sources							
	Processing surfaces of metallic cans			◎			
	Refining petroleum			◎			
	Production of tyers			◎			
	Production of smokeless solid fuel					◎	
	Use of chlorinated organic solvents			◎			
	Scattering agricultural chemicals			◎			
	Telegraph pole			◎			
	Substances containing PCB	Leakage from equipments containing PCB				◎	
		Storage or disposal facilities of substances containing PCB				◎	◎
	Disposal or storage of waste			◎	◎		
	Sewage disposal			◎	◎		
	Use of sewage sludge to soil					◎	
	Agriculture and forestry, or change of land usage or amount of forest storage			◎			

◎ sources verified emissions in inventory of each country

○ sources verified emissions in other references

△ sources indicated high possibility of emissions to concerning media in present references

Table 2 Result of the investigation on the emissions of HCB and PCB

Source Categories			number of facilities	Year of investigation (FY)	Activities of the investigated facilities			Emission per ton of each activity index	
					Index	Activities	Unit	HCB ng/t	PCB ng/t
Sources listed in Part of Annex C of the Stockholm Convention									
Waste incinerators	Municipal waste incinerators		16	2001-2002, 2004	annual incinerated amount	434,998	t/year	551,927	117,735
	Industrial waste incinerators		13	2001-2003	annual incinerated amount	81,435	t/year	1,036,814	411,801
	Small scale waste incinerators		4	2001	annual incinerated amount	1,154	t/year	814,847	566,246
	Sewage sludge incinerators of human waste treatment center, etc.		8	2002-2003	annual incinerated amount	241,175	t/year	20,874	356,399
Cement kilns			54	2001-2004	annual production of clinkers	64,391,904	t/year	161,293	5,103,203
Pulp manufacturing facilities			5	2003	annual production of bleached kraft pulp	1,897,635	t/year	9,670	683,000
Thermal processes in the metallurgical industry	Sinter plants in the iron and steel industry		20	2001-2002	annual production of sintering steel	92,197,050	t/year	148,775	425,659
	Secondary aluminium production	Drying furnaces	7	2001	annual treated amount of cutoffs	47,793	t/year	1,739,807	3,387,499
		Roasting furnaces	2	2001	annual treated amount of can scrap	27,400	t/year	46,283	127,115
		Melting furnaces	17	2001	annual melted amount of scrap	380,586	t/year	1,722,292	6,931,702
		Chlorination	3	2001	annual chlorinated amount	91,311	t/year	1,114,542	23,030
		Rolling, scrap melting	8	2001	annual production	514,620	t/year	38,758	129,400
	Secondary zinc production		16	2001	annual treated amount of electric furnace dust	302,076	t/year	36,216,034	85,033,657
Sources listed in Part of Annex C of the Stockholm Convention									
Thermal processes in the metallurgical industry not mentioned in Part	Lead recovery facilities		3	2002	annual charged amount of the material	84,069	t/year	993,167	92,074,637
	Electric furnaces used for steel making		19	2002, 2004	annual production of steel by electric furnaces	7,825,626	t/year	2,297,382	2,916,436
	Primary copper smelting		11	2002	annual charged amount of the material	1,609,371	t/year	10,846,575	95,742
	Primary lead smelting		2	2002	annual charged amount of the material	115,221	t/year	368,131	10,453,433
	Primary zinc smelting		10	2002	annual charged amount of the material	849,757	t/year	1,456,440	927,506
	Wrought copper product manufacturing facilities		10	2003-2004	annual production	140,228	t/year	17,523,450	4,427,131
Fossil fuel-fired facilities		Thermal power stations	5	2002	annual amount of power generation	21,172,110	MWh	778	1,703
Firing installations for wood and other biomass fuels		Kraft pulp boilers used for pulp production	8	2002	annual treated amount of black liquor	3,666,793	t/year	2,400	19,402

Specific chemical production processes	Vinyl chloride monomer manufacturing facilities	14	2002	annual production of the products	2,994,150	t/year	71,551	8,905
	Caprolactam manufacturing facilities	2	2002	annual production	157,728	t/year	3,231	8,141
	Chlorobenzene manufacturing facilities	1	2002	annual production	36,000	t/year	115	293
	Tetrachlorinated carbon manufacturing facilities	1	2001	annual production of the products	3,000	t/year	457	402,655
	PCE manufacturing facilities	1	2002	annual production of the products	10,000	t/year	1,819,231	5,712
Crematoria		10	2002	actual number of cremation	14	body	151,549	413,591
Smouldering of copper cables		6	2002	annual production	484,480	t/year	576,031	114,851
Other sources								
Roof tile manufacturing facilities		2	2003	annual production of the products	12,714,286	t/year	38	65
Lime manufacturing facilities		5	2003	annual production of the products	524,180	t/year	8,048	146,774
Cast and forged steel manufacturing facilities		11	2003-2004	annual charged amount of steel scrap	371,468	t/year	211,515	2,028,101
Noble metal recovery facilities		3	2002	annual charged amount of the material	4,269	t/year	204,036,810	159,795,413
Alumina fiber manufacturing facilities		4	2002	annual production of the products	106	t/year	37,293,011	107,147,094
Aluminium casting facilities		10	2003	annual production	54,100	t/year	295,420	135,325
Total		311						

Table 3 Estimation of the emission of HCB and PCB

Source categories			Activities index	Nationwide activities /year			Annual emissions			
							HCB		PCB	
				Year		Unit	g	kg	g	kg
Sources listed in Part of Annex C of the Stockholm Convention										
Waste incinerators	Municipal waste incinerators		annual incinerated amount	2002	42,016,190	t	23,190	44	4,947	15
	Industrial waste incinerators		annual incinerated amount	2002	19,900,000	t	20,633		8,195	
	Small scale waste incinerators		annual incinerated amount	2002	340,000	t	277		193	
	Sewage sludge incinerators of human waste treatment center, etc.		annual incinerated amount	2002	5,323,200	t	111		1,897	
Cement kilns			annual production of clinkers	2002	68,948,508	t	11,121	11	351,858	350
Pulp manufacturing facilities			annual production of bleached kraft pulp	2002	8,306,974	t	80	0.080	5,674	5.7
Thermal processes in the metallurgical industry	Sinter plants in the iron and steel industry		annual production of sintering steel	2002	106,274,536	t	15,811	16	45,237	45
	Secondary aluminium production	Drying furnaces	annual treated amount of cutoffs	2002	129,694	t	226	3.0	439	10
		Roasting furnaces	annual treated amount of can scrap	2002	94,186	t	4		12	
		Melting furnaces	annual melted amount of scrap	2002	1,376,307	t	2,370		9,540	
		Chlorination	annual chlorinated amount	2002	325,163	t	362		7	
		Rolling, scrap melting	annual production	2002	2,247,318	t	87		291	
	Secondary zinc production		annual treated amount of electric furnace dust	2002	305,530	t	11,065	11	25,980	26
Sources listed in Part of Annex C of the Stockholm Convention										
Thermal processes in the metallurgical	Lead recovery facilities		annual charged amount of the material	2002	90,145	t	90	100	8,300	100
	Electric furnaces used for steel making		annual production of steel by electric furnaces	2002	29,580,889	t	67,959		86,271	

industry not mentioned in Part	Primary copper smelting		annual charged amount of the material	2002	1,306,610	t	14,172		125	
	Primary lead smelting		annual charged amount of the material	2002	122,502	t	45		1,281	
	Primary zinc smelting		annual charged amount of the material	2002	702,157	t	1,023		651	
	Wrought copper product manufacturing facilities		annual production	2002	964,429	t	16,900		4,270	
Fossil fuel-fired facilities		Thermal power stations	annual amount of power generation	2002	492,031,000	MWh	383	0.38	838	0.84
Firing installations for wood and other biomass fuels		Kraft pulp boilers used for pulp production	annual treated amount of black liquor	2002	14,281,733	t	34	0.034	277	0.28
Specific chemical production processes	Vinyl chloride monomer manufacturing facilities		annual production of the products	2002	2,743,331	t	196	0.27	24	0.12
	Caprolactam manufacturing facilities		annual production	2002	113,157	t	0		1	
	Chlorobenzene manufacturing facilities		annual production	2002	54,081	t	0		0	
	Alumina fiber manufacturing facilities		annual production of the products	2002	816	t	30		87	
	Tetrachlorinated carbon manufacturing facilities		annual production of the products	2001	12,439	t	0		5	
	PCE manufacturing facilities		annual production of the products	2001	25,408	t	46		0	
Crematoria			actual number of cremation	2002	1,068,809	body	162	0.16	442	0.44
Smouldering of copper cables			annual production	2002	731,668	t	421	0.42	84	0.084
Other sources										
Roof tile manufacturing facilities			annual production of the products	2002	864,740,000	piece	33	1.9	56	5.0
Lime manufacturing facilities			annual production of the products	2002	7,419,935	t	60		1,089	
Cast and forged steel manufacturing facilities			annual charged amount of steel scrap	2002	1,376,684	t	291		2,792	
Noble metal recovery facilities			annual charged amount of the material	2002	5,622	t	1,147		898	
Aluminium casting facilities			annual production	2002	1,165,833	t	344		158	
Total							188,675	190	561,920	560