Supporting information for "*Updated atmospheric mercury emissions from iron and steel production in China during 2000-2015*"

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Table S1. Hg release rate during different processes

Processes	Hg release rate (%)					
	Wang F. Y. et al., 2016		Zhang et al., 2015	Fukuda et al., 2011	Ma, 2008	This study
Roasting	98					98
Coke oven	71	90	87	94	60	80
Sinter/pellet	61	91	92	96		85
Blast furnace	99	98	94	100		98
Oxygen steel making	73	87				80
Arc steel making	95					95

Table S2. Provincial crude steel productions and raw materials consumptions in 2015

Province	Crude steel (Mt)	Limestone (Mt)	Dolomite (Mt)	Coking coal (Mt)	PCI coal (Mt)	Iron Concentrates (Mt)	Scrap steel (Mt)	Alloy (Mt)
Beijing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tianjin	20.7	5.6	1.0	2.6	2.8	23.9	2.1	0.7
Hebei	188.3	45.0	8.2	74.1	25.0	217.1	19.5	6.0
Shanxi	38.5	11.3	2.0	108.6	5.1	44.4	4.0	1.2
Inner Mongolia	17.4	4.8	0.9	41.1	2.1	20.0	1.8	0.6
Liaoning	60.7	14.9	2.7	28.3	8.7	70.0	6.3	1.9
Jilin	10.7	3.1	0.6	5.0	1.4	12.3	1.1	0.3
Heilongjiang	4.2	1.9	0.3	9.3	0.6	4.8	0.4	0.1
Shanghai	17.8	4.4	0.8	7.2	2.4	20.6	1.8	0.6
Jiangsu	110.0	22.6	4.1	32.9	10.1	126.8	11.4	3.5
Zhejiang	15.9	4.1	0.8	4.0	1.5	18.4	1.7	0.5
Anhui	25.1	6.5	1.2	13.0	3.0	28.9	2.6	0.8
Fujian	15.9	4.1	0.7	2.1	1.4	18.3	1.6	0.5
Jiangxi	22.1	5.6	1.0	11.0	3.0	25.5	2.3	0.7
Shandong	66.2	16.3	3.0	59.0	9.7	76.3	6.9	2.1
Henan	29.0	5.9	1.1	39.8	4.2	33.4	3.0	0.9
Hubei	29.2	7.8	1.4	12.4	3.3	33.7	3.0	0.9
Hunan	18.5	4.4	0.8	8.9	2.5	21.4	1.9	0.6
Guangdong	17.6	4.1	0.8	3.3	1.6	20.3	1.8	0.6
Guangxi	21.5	4.2	0.8	7.9	1.8	24.7	2.2	0.7
Hainan	0.2	0.1	0.0	0.0	0.0	0.3	0.0	0.0
Chongqing	6.9	2.1	0.4	2.9	0.5	8.0	0.7	0.2
Sichuan	19.5	5.3	1.0	17.6	2.5	22.5	2.0	0.6
Guizhou	4.7	1.2	0.2	9.9	0.6	5.4	0.5	0.1
Yunnan	14.2	4.6	0.8	15.5	1.8	16.4	1.5	0.5
Tibet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shaanxi	10.3	2.4	0.4	49.2	1.2	11.8	1.1	0.3
Gansu	8.5	2.5	0.4	7.1	1.0	9.8	0.9	0.3
Qinghai	1.2	0.4	0.1	0.0	0.2	1.4	0.1	0.0
Ningxia	1.8	0.3	0.1	10.2	0.3	2.1	0.2	0.1
Xinjiang	7.4	3.0	0.5	22.2	1.1	8.5	0.8	0.2

Note: PCI: Pulverized coal injection.

Table S3. Productions and consumptions during 2000-2015

Year	Production (Mt)				Consumption (Mt)							
	Crude steel	Pig iron	Sinter	Pellet	Coke	Limestone	Dolomite	Iron concentrates	Coking coal	PCI coal	Scrap steel	Alloy
2000	127	131	179	19	122	30	6	198	175	19	29	9
2001	152	156	193	21	131	36	7	214	188	22	34	11
2002	182	171	248	28	116	43	8	276	163	25	39	12
2003	222	214	254	35	178	52	10	289	251	31	48	15
2004	273	252	304	44	210	64	12	349	292	36	54	17
2005	356	345	369	59	254	84	16	428	349	50	63	20
2006	421	413	430	76	298	99	19	506	409	59	67	21
2007	490	477	524	99	336	115	22	623	459	69	69	21
2008	512	483	560	100	324	120	23	660	453	70	72	22
2009	577	569	622	106	353	135	26	728	476	82	83	26
2010	639	596	688	124	392	157	29	812	529	86	87	27
2011	702	645	769	156	432	173	31	925	583	93	91	28
2012	731	670	810	136	442	180	33	946	597	96	84	26
2013	813	748	887	158	482	203	37	1044	651	108	86	27
2014	822	714	901	139	480	203	37	1041	648	103	88	27
2015	804	691	887	118	448	199	36	1005	605	100	83	26

Note: PCI-pulverized coal injection.

Table S4. Application rate, Hg removal efficiency, and Hg speciation profile of APCDs

Processes	APCDs[2]	Application rate					Hg removal		Hg speciation profile			
		2000 (%)	2005 (%)	2010 (%)	2015 (%)	Reference[3]	Efficiency (%)	Reference[2]	Hg^0 (%)	Hg^{2+} (%)	Hg_p (%)	Reference[2]
Roasting plant	CYC/NOC	97	92	32	0	(1)-(4)	1	(5)-(6)	38	38	24	(5)-(6)
	WS	3	8	18	0		23	(5)-(6)	65	34	1	(5)-(6)
	ESP	0	0	25	50		29	(7)	14	85	1	(7)
	FF	0	0	25	50		67	(6)	48	52	0	(10)
Coke oven	NOC[1]	100	100	100	100	(1)-(4)	0	(6)	60	35	5	(9)
	Cooler	100	100	75	50		70	(5)- (6)	46	53	1	(5)-(6)
	Cooler+WS	0	0	25	50		93	(6)	65	34	1	(6)
Sinter/Pellet plant	CYC	20	5	0	0	(1)-(4)	1	(5)-(6)	38	38	24	(5)-(6)
	WS	40	20	5	0		23	(5)-(6)	65	34	1	(5)-(6)
	ESP	40	65	50	25		29	(7)	18	82	0	(7)
	FF	0	10	13	15		67	(6)	18	82	0	(7)
	ESP+WFGD	0	0	25	50		57	(7)	41	59	0	(7)
	ESP+DFGD+FF	0	0	7	10		72	(7)	0.5	99	0.5	(7)
Blast furnace	WS+Venturi	100	100	90	80	(1)-(4)	45	(7)-(8)	65	30	5	(7)
	FF	0	0	10	20		67	(7)	38	61	1	(6)
Oxygen steel making	WS	50	40	88	78	(1)-(4)	38	(7)	65	34	1	(5)-(6)
	ESP	50	60	12	22		68	(7)	57	43	0	(7)
Arc steel making	WS	85	60	30	0	(1)-(4)	23	(5)- (6)	65	34	1	(5)-(6)
	ESP	10	30	47	37		29	(7)	58	41	1	(6)
	FF	5	10	23	63		35	(7)	92	8	0	(7)

Note: 1. Specifc for indigeous coke making process;

2. NOC-None of control;CYC-Cyclone; WS-Wet scrubber; ESP-Electrostatic precipitator; FF- Fabric filter; WFGD: Wet flue gas desulfurization towers;

3. (1)Wang et al., 2014; (2)Zhao et al., 2013; (3)CISIA, 2001-2016; (4)NBS, 2001-2016; (5)Zhang et al., 2015; (6)Wu et al., 2016; (7)Wang F.Y. et al., 2016; (8)Zhang, 2012; (9)Li, 2011; (10)Yang, 2014.

Table S5. Comparison of emission factors from different studies

Region	APCDs[1]	Emission factor	Note	References[2]
Whole process (unit: g/t crude steel)				
Global	-	0.0400	Sinter/Pellet plant + Blast furnace	(1)-(6)
Global		0.0413	Coke oven + Sinter/Pellet plant + Blast furnace + Oxygen steel making	(7)
Europe	-	0.1000	Coke oven + Sinter/Pellet plant + Blast furnace	(8)
Japan		0.0488	Coke oven + Sinter/Pellet plant + Blast furnace	(9)
China (2000)		0.0527	Sinter/Pellet plant + Blast furnace	This study
China (2015)		0.0296	Sinter/Pellet plant + Blast furnace	This study
China (2000)	-	0.0590	Sinter/Pellet plant + Blast furnace + Steel making	This study
China (2015)		0.0320	Sinter/Pellet plant + Blast furnace + Steel making	This study
China (2000)	-	0.0818	Coke oven + Sinter/Pellet plant + Blast furnace + Steel making	This study
China (2015)		0.0363	Coke oven + Sinter/Pellet plant + Blast furnace + Steel making	This study
China (2000)	-	0.0902	Roasting plant + Coke oven + Sinter/Pellet plant + Blast furnace + Steel making	This study
China (2015)	-	0.0407	Roasting plant + Coke oven + Sinter/Pellet plant + Blast furnace + Steel making	This study
Roasting plant (unit: g/t lime)				
Global	-	0.0074	Roasting plant	(10)
China (2000)	-	0.0663	Roasting plant	This study
China (2015)	-	0.0439	Roasting plant	This study
Coke oven (unit: g/t coke)				
Europe	-	0.2185	Coke oven	(8)
Germany	-	0.01-0.03	Coke oven	(10)
China (2000)	-	0.0238	Coke oven	This study

China (2015)	-	0.0077	Coke oven	This study
Sinter plant (unit: g/t sinter)				
Europe	-	0.0490	Sinter plant	(8), (11)
Europe	ESP+WS	0.1040	Sinter plant	(8), (11)
Europe	WFGD	0.0180	Sinter plant	(8), (11)
Europe	dry ESP	0.0090	Sinter plant	(8), (11)
Europe	ACI+FF	0.0060	Sinter plant	(8), (11)
Japan	ESP	0.1251	Sinter plant	(8), (11)
Japan	ESP+FGD	0.0718	Sinter plant	(8), (11)
Japan	ESP+AC	0.2962	Sinter plant	(8), (11)
Korea	dry ESP	0.0427	Sinter plant	(12)
China (2000)	-	0.0243	Sinter plant	This study
China (2015)	-	0.0158	Sinter plant	This study
Pellet plant (unit: g/t pellet)				
Europe	-	0.2000	Pellet plant	(8), (11)
China (2000)	-	0.0255	Pellet plant	This study
China (2015)	-	0.0165	Pellet plant	This study
Blast furnace (unit: g/t pig iron)				
Russia	-	0.0395	Blast furnace	(12)
Europe	-	0.0001	Blast furnace	(8), (11)
Europe	FF/Heat recovery	0.0002	Blast furnace	(8), (11), (13)
Europe	dry ESP	0.0001	Blast furnace	(8), (11)
Japan	-	0.0014	Blast furnace	(9)
China (2000)	-	0.0142	Blast furnace	This study
China (2015)	-	0.0114	Blast furnace	This study
Oxygen steel making (g/t crude steel)				
Europe	dry ESP	0.0006	Oxygen steel making	(8), (11)
China	FF	0.0019	Oxygen steel making	(13)
China (2000)	-	0.0023	Oxygen steel making	This study
China (2015)	-	0.0018	Oxygen steel making	This study

Arc steel making (g/t crude steel)				
Europe	-	0.0500	Arc steel making	(8), (11)
Europe	FF	0.0761	Arc steel making	(8), (11), (13)
Europe	dry ESP	0.0240	Arc steel making	(8), (11)
Korea	FF	0.0190	Arc steel making	(12)
China (2000)	-	0.0272	Arc steel making	This study
China (2015)	-	0.0162	Arc steel making	This study

Note: 1. ESP-Electrostatic precipitator; FF-Fabric filter; (W)FGD-(Wet) flue gas desulfurization towers; ACI-Activated carbon injection; AC-Activated coke adsorption tower

2. (1)Pacyna and Pacyna, 2002; (2)Pacyna et al., 2006; (3)Pacyna et al., 2010; (4)AMAP/UNEP, 2008; (5)Zhang et al., 2015; (6)Wu et al., 2016; (7)AMAP/UNEP, 2013; (8)EMEP/EEA, 2013; (9)Fukuda et al., 2011; (10)UNEP, 2005; (11)EMEP/CORINAIR, 2001; (12)Kim et al., 2010; (13)ACAP, 2005; (13)Wang K. et al., 2016

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