Supplementary materials

Reduction of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans by Chemical Inhibition and Physisorption from a Municipal Solid Waste Incineration System

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Table S1. The Emission Concentration of Conventional Pollutants at Stack (mg/Nm^3).

parameters	normal condition	inhibition condition	national emission standard
Hourly emission of CO	47 ± 3	35 ± 3	< 100
Hourly emission of SO_2	3.5 ± 1.5	20.5 ± 5	< 100
Hourly emission of NO_x	189 ± 8	188 ± 11	< 300
Hourly emission of particulate matter	2.6 ± 0.4	2.3 ± 0.6	< 30

Table S2. The I-TEQ Concentrations (ng I-TEQ/Nm^3 for Inlet and Outlet; ng I-TEQ/g for Ash) of PCDD/F in Different Sites and Conditions.

	normal condition			**inhibition condition**		
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**
2378-TCDD	0.22	0.01	0.26	0.11	0.002	0.20
12378-PeCDD	0.42	0.004	0.47	0.19	0.003	0.34
123478-HxCDD	0.05	0.0004	0.07	0.02	0.0003	0.05
123678-HxCDD	0.06	0.001	0.11	0.02	0.0005	0.07
123789-HxCDD	0.06	0.0005	0.10	0.02	0.0004	0.06
1234678-HpCDD	0.01	0.0002	0.04	0.004	0.0002	0.02
OCDD	0.0004	0.00003	0.01	0.0002	0.00003	0.002
2378-TCDF	0.22	0.01	0.30	0.12	0.002	0.21
12378-PeCDF	0.18	0.002	0.21	0.10	0.001	0.17
23478-PeCDF	1.53	0.02	2.49	0.90	0.01	1.67
123478-HxCDF	**0.51**	**0.005**	**0.68**	**0.23**	**0.003**	**0.45**
123678-HxCDF	**0.43**	**0.004**	**0.68**	**0.22**	**0.003**	**0.49**
123789-HxCDF	**0.05**	**0.0004**	**0.11**	**0.02**	**0.000**	**0.07**
234678-HxCDF	**0.45**	**0.003**	**0.90**	**0.21**	**0.002**	**0.52**
1234678-HpCDF	0.06	0.001	0.13	0.03	0.0003	0.09
1234789-HpCDF	0.02	0.0001	0.02	0.01	0.0001	0.01
OCDF	0.001	0.00002	0.003	0.00	0.00001	0.002
PCDD	**0.82**	**0.01**	**1.06**	**0.37**	**0.01**	**0.74**
PCDF	**3.45**	**0.05**	**5.52**	**1.82**	**0.02**	**3.69**
PCDD/F	**4.27**	**0.06**	**6.58**	**2.19**	**0.03**	**4.43**
PCDF/(PCDD/F)	0.81	0.81	0.84	0.83	0.79	0.83

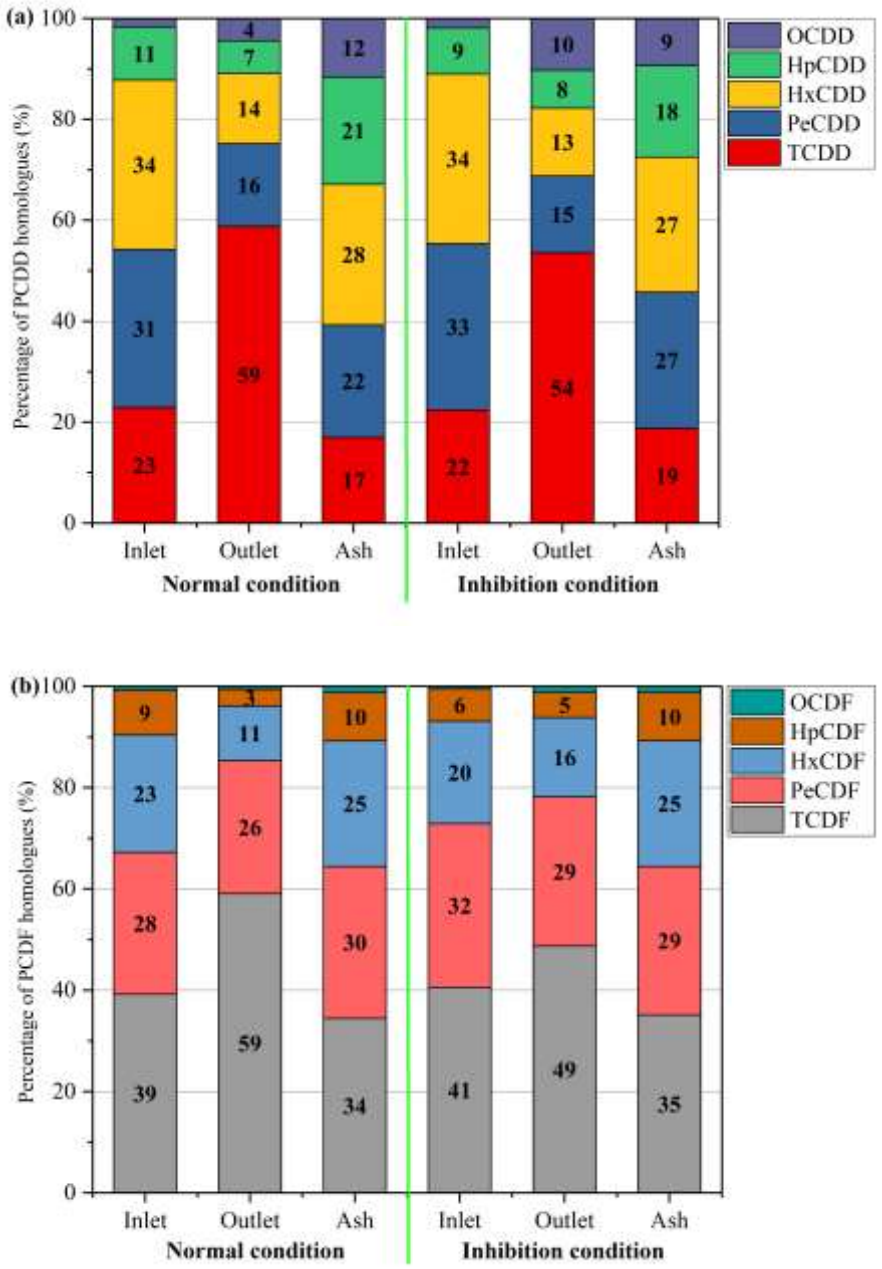

Figure S1. Distribution of the PCDD/F homologues (%): (a) PCDD homologues; (b) PCDF homologues.

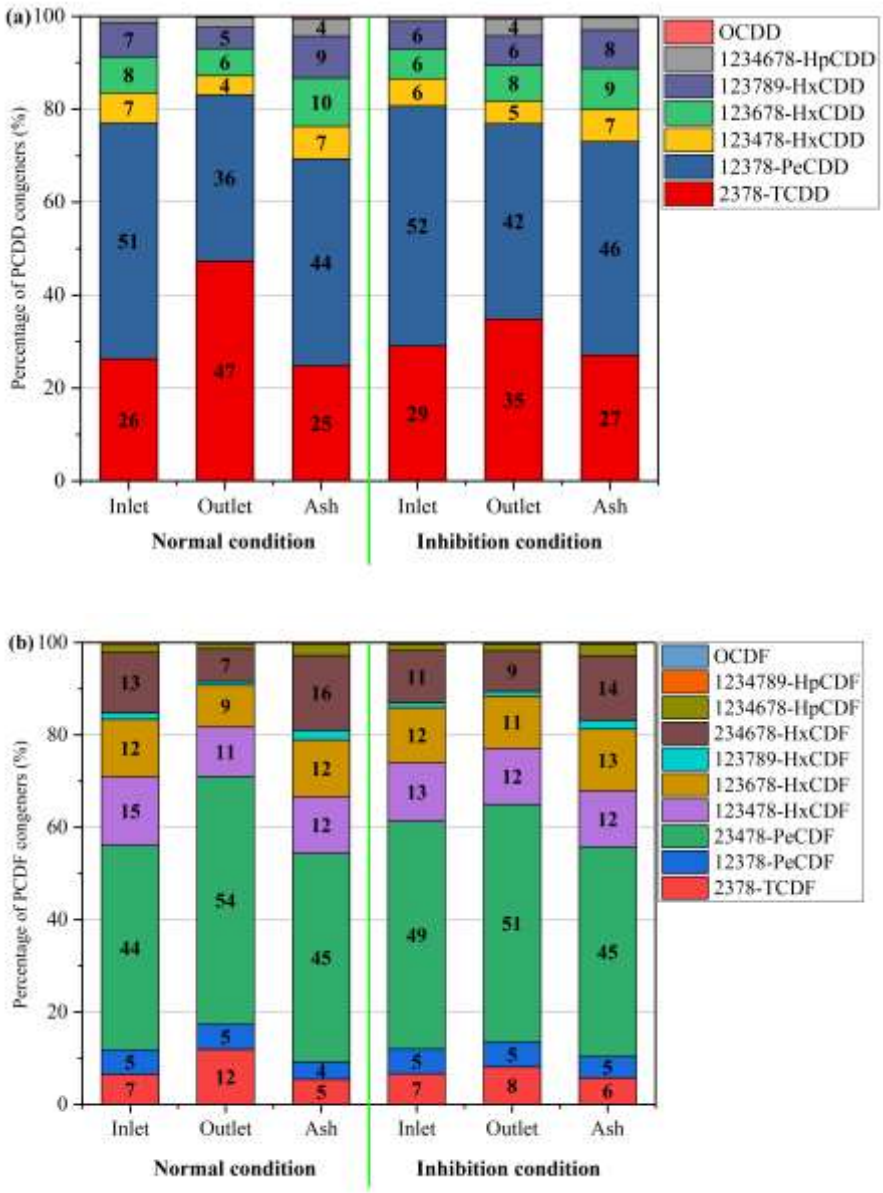

Figure S2. Distribution of the 2378-substituted PCDD/F congeners (%): (a) PCDD congeners; (b) PCDF congeners.

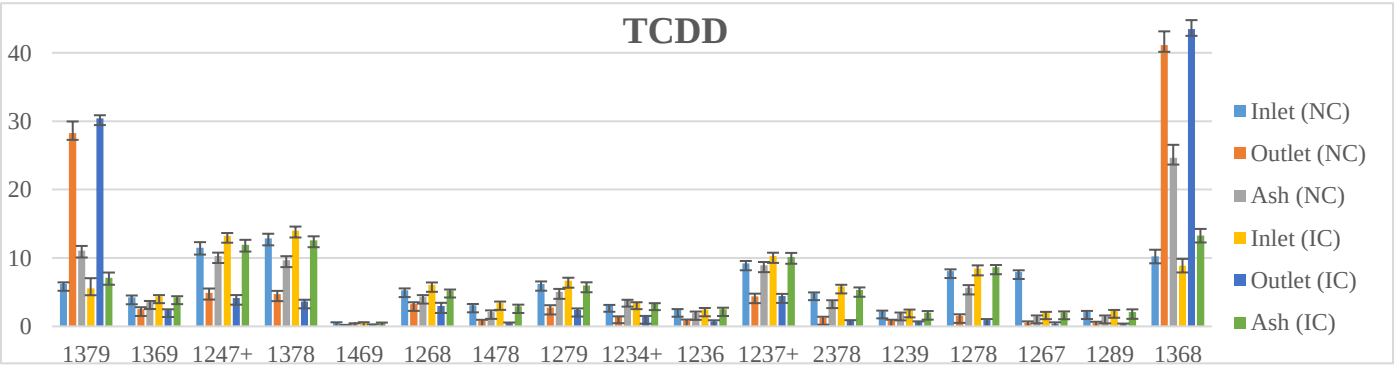

Figure S3. Distribution of PCDD/F-isomers in different sampling sites and conditions (%) (NC represents normal condition, and IC represents inhibition condition).

Table S3. The Removal and Inhibition Efficiency (%) of PCDD/F Congeners and Isomers in Different Sites and Conditions (NC Represents Normal Condition, IC Represents Inhibition Condition, FG Represents Flue Gas).

isomer	normal condition			inhibition condition			RE-NC	RE-IC	IE-FG	IE-Ash	RE+IE
	inlet	outlet	ash	inlet	outlet	ash					
TCDD											
1379	0.3298	0.1260	0.9913	0.1231	0.1053	0.3346	**61.79**	**14.49**	**62.66**	**66.24**	68.07
1369	0.2253	0.0119	0.3170	0.0975	0.0082	0.2008	94.72	91.57	56.73	36.66	96.35
1247/1248/1246/1249	0.6114	0.0233	0.9194	0.2933	0.0145	0.5636	96.19	95.06	52.03	38.70	97.63
1378	0.6831	0.0221	0.8658	0.3103	0.0128	0.5937	96.77	95.86	54.57	31.43	98.12
1469	0.0315	0.0010	0.0403	0.0134	0.0007	0.0259	96.83	94.83	57.35	35.78	97.79
1268	0.2811	0.0152	0.3882	0.1342	0.0098	0.2466	94.58	92.67	52.25	36.47	96.50
1478	0.1624	0.0042	0.1878	0.0757	0.0019	0.1397	97.43	97.51	53.39	25.63	98.84
1279	0.3306	0.0130	0.4502	0.1476	0.0083	0.2828	96.07	94.41	55.35	37.17	97.50
1234/1269	0.1669	0.0067	0.3484	0.0780	0.0047	0.1595	96.00	94.02	53.25	54.22	97.20
1236	0.1281	0.0042	0.1749	0.0548	0.0027	0.1188	96.72	95.07	57.21	32.10	97.89
1237/1238	0.4893	0.0206	0.7995	0.2279	0.0151	0.4794	95.80	93.38	53.42	40.04	96.92
2378	0.2571	0.0059	0.3293	0.1290	0.0030	0.2518	97.70	97.68	49.82	23.53	98.84
1239	0.1154	0.0039	0.1682	0.0513	0.0022	0.0938	96.59	95.79	55.53	44.22	98.13
1278	0.4291	0.0073	0.5080	0.1876	0.0033	0.4070	98.31	98.23	56.28	19.87	99.23
1267	0.4217	0.0028	0.1298	0.0456	0.0014	0.0965	99.33	96.87	**89.19**	**25.69**	99.66
1289	0.1103	0.0025	0.1288	0.0500	0.0011	0.0992	97.75	97.80	54.62	22.96	99.00
1368	0.5433	0.1841	2.2083	0.1969	0.1514	0.6264	**66.11**	**23.11**	**63.75**	**71.63**	72.13
PeCDD	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	ash	inlet	outlet	ash	outlet	ash					
12479/12468	1.3746	0.0332	2.6107	0.6048	0.0257	1.2876	**97.58**	**95.75**	56.00	50.68	98.13
12469	0.2861	0.0035	0.3727	0.1239	0.0025	0.2361	98.76	97.97	56.71	36.63	99.12
12368	0.8579	0.0241	1.7444	0.3609	0.0206	0.8010	**97.19**	**94.31**	57.93	54.08	97.60
12478	0.8417	0.0098	1.0670	0.4019	0.0061	0.7641	98.84	98.48	52.26	28.38	99.27
12379	0.7741	0.0169	1.3942	0.3211	0.0136	0.6965	**97.82**	**95.76**	58.52	50.04	98.24
12369/12467/12489	1.0028	0.0102	1.4856	0.5140	0.0085	1.0085	98.98	98.35	48.75	32.12	99.16

12347/12346	0.3670	0.0109	0.8157	0.1614	0.0104	0.4091	97.02	93.59	56.01	49.85	97.18
12378	0.8860	0.0087	1.1002	0.4105	0.0055	0.7929	99.02	98.66	53.67	27.93	99.38
12367	0.4277	0.0056	0.5808	0.1893	0.0032	0.3926	98.69	98.29	55.74	32.41	99.24
12389	0.4506	0.0042	0.5620	0.1929	0.0024	0.3881	99.07	98.77	57.20	30.94	99.47
HxCDD	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
124679/124689	1.1153	0.0106	1.3959	0.5125	0.0069	0.8618	99.05	98.65	54.05	38.26	99.38
123468	1.2413	0.0485	6.0469	0.5112	0.0468	1.5483	**96.09**	**90.84**	58.81	74.40	96.23
123679/123689	2.6199	0.0237	3.5243	1.1380	0.0154	1.9675	99.09	98.65	56.56	44.17	99.41
123469	0.2625	0.0028	0.3210	0.1082	0.0022	0.2059	98.93	97.96	58.79	35.86	99.16
123478	0.5789	0.0048	0.8233	0.2358	0.0035	0.5632	99.18	98.51	59.28	31.59	99.40
123678	0.6658	0.0067	1.1381	0.2502	0.0053	0.6807	98.99	97.88	62.42	40.19	99.20
123467	0.5786	0.0042	0.6899	0.2471	0.0031	0.4574	99.27	98.76	57.29	33.70	99.47
123789	0.7163	0.0058	0.7311	0.3307	0.0037	0.4373	99.20	98.87	53.83	40.19	99.48
HpCDD	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
1234679	1.1773	0.0245	6.3392	0.4439	0.0224	2.2299	97.92	94.96	62.29	64.82	98.10
1234678	1.2695	0.0261	4.8729	0.4618	0.0263	2.3290	97.94	94.31	63.62	52.20	97.93
OCDD	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
12346789	0.3937	0.0341	6.1142	0.1893	0.0325	2.3431	91.33	82.85	51.92	61.68	91.75
TCDF	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
1368	3.1509	0.1303	3.2853	1.7390	0.0415	2.9223	**95.86**	**97.61**	44.81	11.05	98.68
1468	2.2829	0.0760	2.3699	1.1739	0.0223	1.8128	96.67	98.10	48.58	23.51	99.02
2468	2.4536	0.0813	3.5865	1.1935	0.0356	1.9962	96.69	97.02	51.36	44.34	98.55
1247/1347/1378/1346/1246	7.7170	0.3873	13.3102	5.4725	0.1084	10.4354	**94.98**	**98.02**	29.08	21.60	98.60
1367/1348/1379/1248	6.6447	0.2268	7.5489	3.9112	0.0680	6.1687	96.59	98.26	41.14	18.28	98.98
1268	2.3383	0.0695	2.6340	1.1168	0.0276	2.1210	97.03	97.53	52.24	19.47	98.82
1467	1.9758	0.0541	2.3321	0.9581	0.0159	1.5732	97.26	98.34	51.51	32.54	99.19

1478	3.0022	0.0832	2.6804	1.6037	0.0242	2.3856	97.23	98.49	46.58	11.00	99.19
1369/1237	6.1983	0.2483	14.0183	4.5474	0.0914	8.3671	95.99	97.99	26.64	40.31	98.53
2467	3.9351	0.0979	5.0819	2.0484	0.0391	3.7657	97.51	98.09	47.95	25.90	99.01
1238/1236/1469/1678/1234/2368	4.4845	0.1902	8.6691	2.6781	0.0853	5.3166	**95.76**	**96.81**	40.28	38.67	98.10
1278/1349	3.7224	0.0881	3.7316	1.8741	0.0315	2.8860	97.63	98.32	49.65	22.66	99.15
1267	2.0335	0.0474	2.0060	1.0508	0.0174	1.6874	97.67	98.34	48.32	15.89	99.14
2348	3.0889	0.1100	6.9784	2.3658	0.0338	3.7950	96.44	98.57	23.41	45.62	98.91
2378	2.7677	0.0632	3.2420	1.4834	0.0256	2.2885	97.72	98.28	46.40	29.41	99.08
2347/1279	2.9252	0.0683	3.9317	1.4627	0.0321	3.1069	97.66	97.81	50.00	20.98	98.90
2346/1249	4.2613	0.1165	8.1523	2.2482	0.0476	4.3853	97.27	97.88	47.24	46.21	98.88
2367/3467	6.3123	0.2927	19.6966	5.1402	0.1052	13.5332	**95.36**	**97.95**	18.57	31.29	98.33
1269	0.7874	0.0185	0.7471	0.3680	0.0072	0.5512	97.65	98.06	53.26	26.22	99.09
1239	0.6062	0.0121	0.6189	0.2614	0.0059	0.3209	98.01	97.76	56.88	48.16	99.03
1289	0.3883	0.0077	0.5692	0.1674	0.0046	0.3111	98.02	97.27	56.90	45.35	98.82
PeCDF	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
13678/13467/12467	7.3727	0.2077	15.1943	5.9829	0.0896	10.9659	97.18	98.50	18.85	27.83	98.79
12368/13478/12478	6.6367	0.2220	16.3042	5.6466	0.1014	11.6435	**96.66**	**98.20**	14.92	28.59	98.47
13479	1.4043	0.0281	1.6103	0.7720	0.0117	1.4171	98.00	98.48	45.03	12.00	99.17
14678	2.3712	0.0447	3.0394	1.2418	0.0201	2.3335	98.11	98.38	47.63	23.22	99.15
12479/13469	2.1130	0.0352	2.6440	1.0724	0.0159	1.8850	98.33	98.52	49.25	28.71	99.25
23468/12469/12347	2.0454	0.0335	3.0105	0.9278	0.0172	1.7249	98.36	98.14	54.64	42.70	99.16
12346	5.1016	0.1085	12.5243	3.4352	0.0573	6.7814	97.87	98.33	32.66	45.85	98.88
12348	1.1954	0.0230	2.0105	0.6035	0.0122	1.2262	98.08	97.97	49.51	39.01	98.98
12378	3.7459	0.0517	4.5331	2.0118	0.0255	3.7102	98.62	98.73	46.29	18.15	99.32
12367/12678	5.2292	0.0927	8.1830	3.0989	0.0452	5.5609	98.23	98.54	40.74	32.04	99.14
12379	0.8933	0.0128	1.1576	0.4810	0.0061	0.8722	98.56	98.74	46.16	24.66	99.32
23478/12489	5.5732	0.1051	10.9359	3.7952	0.0507	7.3473	98.11	98.66	31.90	32.82	99.09
12679	0.8186	0.0118	1.0500	0.4302	0.0062	0.7910	98.56	98.56	47.45	24.66	99.25
12369/23467	5.3714	0.1023	16.2880	4.1590	0.0566	9.1653	98.10	98.64	22.57	43.73	98.95

12349	0.4660	0.0095	1.0565	0.2100	0.0056	0.5418	97.95	97.35	54.93	48.72	98.81
12389	0.5407	0.0072	0.8682	0.2635	0.0037	0.5620	98.66	98.59	51.26	35.27	99.32
HxCDF	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
123468	3.9250	0.0423	6.9825	1.7850	0.0274	4.5259	98.92	98.47	54.52	35.18	99.30
134678/124678	7.3435	0.1376	23.3125	5.5408	0.0840	16.4319	98.13	98.48	24.55	29.51	98.86
134679	1.6606	0.0155	2.6338	0.8018	0.0100	2.3287	99.06	98.75	51.72	11.58	99.40
124679	2.2133	0.0205	3.6190	1.0102	0.0124	2.4593	99.07	98.77	54.36	32.04	99.44
124689	0.8021	0.0077	1.4407	0.3552	0.0051	0.9532	99.04	98.57	55.71	33.84	99.37
123467	4.6220	0.0392	7.9949	2.0782	0.0251	5.5259	99.15	98.79	55.04	30.88	99.46
123478	6.1513	0.0591	8.4905	2.7629	0.0339	5.6208	99.04	98.77	55.08	33.80	99.45
123678	5.0964	0.0500	8.3890	2.5811	0.0313	6.0960	99.02	98.79	49.36	27.33	99.39
123479	1.1259	0.0109	1.7652	0.4888	0.0064	1.2571	99.03	98.68	56.59	28.79	99.43
123469	1.0561	0.0088	1.7961	0.4240	0.0054	1.1837	99.17	98.71	59.85	34.09	99.48
123679	1.7002	0.0128	2.5779	0.7381	0.0083	1.8504	99.25	98.88	56.59	28.22	99.51
234678/123689	5.0888	0.0384	11.2018	2.3642	0.0252	6.4508	99.25	98.93	53.54	42.41	99.50
123789/123489	1.1523	0.0086	2.6233	0.4479	0.0058	1.6504	99.25	98.71	61.13	37.09	99.50
HpCDF	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
1234678	8.2595	0.0768	18.8530	3.9206	0.0512	13.2258	99.07	98.69	52.53	29.85	99.38
1234679	3.2436	0.0240	5.6823	1.2431	0.0149	3.6754	99.26	98.80	61.68	35.32	99.54
1234689	2.2383	0.0203	4.3101	0.8409	0.0129	2.7128	99.09	98.46	62.43	37.06	99.42
1234789	2.1875	0.0158	3.1607	0.7180	0.0095	2.0143	99.28	98.68	67.18	36.27	99.57
OCDF	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
12346789	1.5033	0.0252	4.0219	0.5222	0.0213	2.7501	98.32	95.92	65.26	31.62	98.58
Homologues	**normal condition**			**inhibition condition**			**RE-NC**	**RE-IC**	**IE-FG**	**IE-Ash**	**RE+IE**
	inlet	**outlet**	**ash**	**inlet**	**outlet**	**ash**					
TCDD	5.32	0.45	8.96	2.22	0.35	4.72	91.45	84.37	58.31	47.29	93.48
PeCDD	7.27	0.13	11.73	3.28	0.10	6.78	98.25	97.00	54.87	42.24	98.65

HxCDD	7.78	0.11	14.67	3.33	0.09	6.72		98.62	97.39	57.14	54.18	98.88
HpCDD	2.45	0.05	11.21	0.91	0.05	4.56		97.93	94.63	62.98	59.34	98.01
OCDD	0.39	0.03	6.11	0.19	0.03	2.34		91.33	82.85	51.92	61.68	91.75
TCDF	71.08	2.47	115.19	42.86	0.87	79.73		96.53	97.97	39.69	30.78	98.78
PeCDF	50.88	1.10	100.41	34.13	0.53	66.53		97.85	98.46	32.91	33.74	98.97
HxCDF	41.94	0.45	82.83	21.38	0.28	56.33		98.92	98.69	49.02	31.99	99.33
HpCDF	15.93	0.14	32.01	6.72	0.09	21.63		99.14	98.68	57.80	32.42	99.44
OCDF	1.50	0.03	4.02	0.52	0.02	2.75		98.32	95.92	65.26	31.62	98.58
PCDD	23.20	0.77	52.69	9.93	0.61	25.12		**96.67**	**93.83**	**57.22**	**52.32**	**97.36**
PCDF	181.32	4.18	334.46	105.62	1.79	226.97		**97.70**	**98.31**	**41.75**	**32.14**	**99.02**
PCDD/F	204.53	4.95	387.14	115.55	2.40	252.09		**97.58**	**97.92**	**43.51**	**34.88**	**98.83**

Table S3. Distribution of Gas- and Particle-Phase PCDD/F Homologues (%) in Different Sites and Conditions.

	normal condition					inhibition condition				
	inlet-g	**inlet-p**	**outlet-g**	**outlet-p**	**ash**	**inlet-g**	**inlet-p**	**outlet-g**	**outlet-p**	**ash**
TCDD	2.56	0.04	8.42	0.28	2.31	1.89	0.03	11.24	0.40	1.87
PeCDD	3.42	0.13	2.29	0.17	3.03	2.75	0.09	3.06	0.30	2.69
HxCDD	3.59	0.22	1.94	0.15	3.79	2.72	0.16	2.87	0.35	2.67
HpCDD	1.02	0.17	0.97	0.08	2.90	0.63	0.16	1.36	0.22	1.81
OCDD	0.13	0.06	0.60	0.08	1.58	0.08	0.08	0.96	0.16	0.93
TCDF	34.05	0.71	50.95	1.40	29.75	36.56	0.54	34.80	2.51	31.63
PeCDF	23.71	1.17	20.09	0.86	25.94	28.68	0.86	21.97	1.82	26.39
HxCDF	18.82	1.69	7.84	0.73	21.39	17.27	1.23	11.29	1.75	22.35
HpCDF	6.81	0.98	2.26	0.39	8.27	5.01	0.81	3.12	0.92	8.58
OCDF	0.57	0.16	0.41	0.10	1.04	0.30	0.15	0.66	0.22	1.09
PCDD	**10.72**	**0.62**	**14.22**	**0.75**	**13.61**	**8.07**	**0.52**	**19.50**	**1.44**	**9.96**
PCDF	**83.96**	**4.70**	**81.55**	**3.48**	**86.39**	**87.82**	**3.59**	**71.84**	**7.22**	**90.04**
PCDD/F	**94.68**	**5.32**	**95.77**	**4.23**	**100**	**95.89**	**4.11**	**91.34**	**8.66**	**100**
$d_{Cl-PCDD}$	5.32	6.12	4.81	5.36	5.88	5.29	6.32	4.86	5.61	5.72
$d_{Cl-PCDF}$	5.00	5.73	4.54	5.11	5.13	4.90	5.77	4.79	5.24	5.12
$d_{Cl-PCDD/F}$	5.04	5.77	4.58	5.16	5.23	4.94	5.84	4.80	5.30	5.18

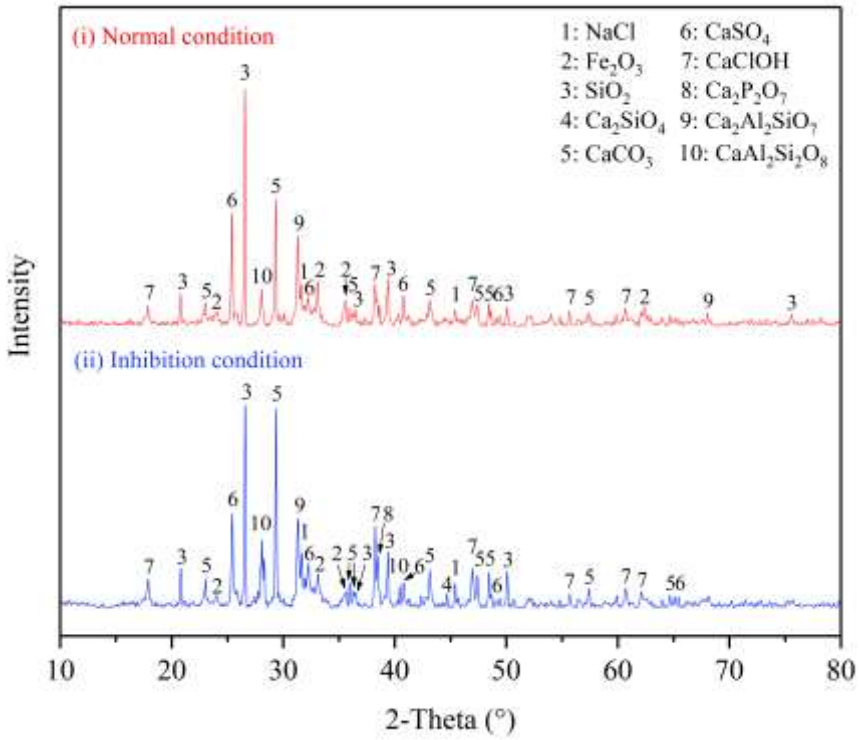

Figure S4. XRD results of ashes collected in (i) normal condition and (ii) inhibition condition.