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The distribution of heavy metals in pyrolysis residue from MSW and CSD

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1. BACKGROUND

Because Japan has scarce resource of metal, it is worthwhile considering municipal solid waste as "urban mine". In gasification-melting system, which is an emerging technology combining pyrolysis and melting of solid components, and which is getting popularilty to reduce both the emission of dioxin end the landfill volume, pyrolysis residue contains metals in not-oxidized form. In addition, due to relatively low temperature of pyrolysis (600℃), metals would not be melted, so it is expected to be easily separated. Particles of high metal content, if exists, can be recovered by a simple operation.

In this study, in order to investigate the possibility of recovering metals from pyrolysis residue, pyrolysis residue was classified by particle size and by specific gravity, then the metal contents were determined.

2. SAMPLE

A typical process flow of a gasification melting facilities are shown in Figure 1. The samples were obtained from two facilities (A and B). In the both facilities, kiln-type waste thermolysis system is installed as the gasification furnace. The outlines of the facilities and samples are shown in Table 1. Facility A processes only combustible MSW, such as waste paper and food waste. Facility B processes car shredder dust (CSD), which is residue from waste automobile treatment facilities.

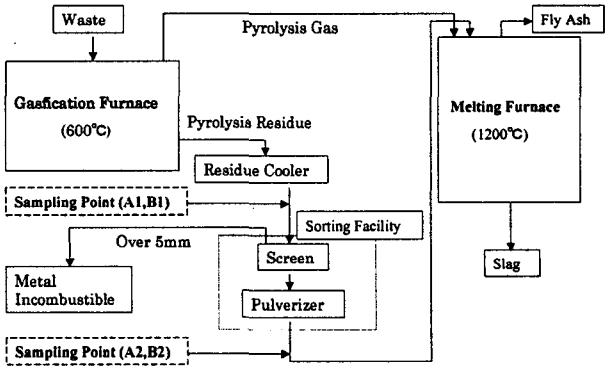

Figure 1 Schematic diagram of typical gasification melting system

Table 1 The outlines of the facilities and the samples

Facility	Capacity	Supply waste	Sample	Sampling date
A	20t/d	Combustible Municipal Solid Waste	Obtained before pulverizing (A1)	7/Sep/00 pm12:30-
			Obtained after pulverizing (A2)	8/Sep/00 pm7:30-
B	90t/d	Car Shredder Dust	Obtained before pulverizing (B1)	12/Oct/00 pm3:30-
			Obtained after pulverizing (B2)	12/Oct/00 pm3:30-

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3. METHOD

The procedure of experiments are shown in Figure 2.

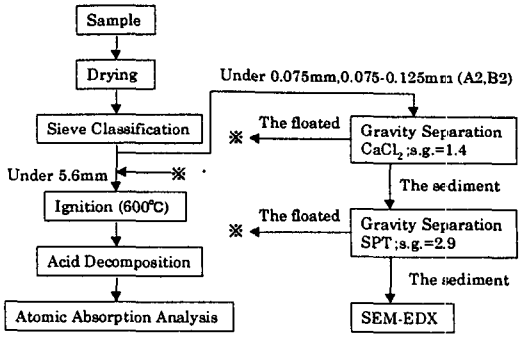

Figure 2 Experimental flow chart

3.1 PARTICLE SIZE DISTRIBUTION

All samples were manually sieved into 8 groups: over 16mm, -5.6, -2.0, -1.0, -0.5, -0.25, -0.125, under 0.125mm. Additionally, the 0.125mm under samples of A2 and B2 were screened by the 0.075mm sieve.

3.2 SEPARATION by GRAVITY

To investigate the possibility to recover metal in the form of particles, fractions of 0.125-0.075mm and under 0.075 mm size were separated by the saturated calcium chloride solution (specific gravity: s.g.=1.4) and Sodium Polytungstate (SPT: $Na_6(H_2W_{12}O_{40})\cdot H_2O$: s.g.=2.9) solution. Firstly, the samples were separated by the calcium chloride solution. The floated particles in the solution were recovered, and the contents of heavy metals were determined. The sediment were recovered, separated by SPT, then the contents of heavy metals in the floated particles and metal compounds in the sediment were determined.

3.3 ANALYSIS OF CONTENTS AND COMPOUND OF HEAVY METALS

For preparation of the heavy metals content analysis, the sample was ignited at 600℃ in the electric heating furnace to remove the organic matter. The ignited sample was decomposed with a 40mL mixed acid solution (HNO_3:HCl=1:1). After the decomposition, the solution was filtered through a grade 5B filter, then heavy metals (Fe, Al, Cu, Pb, Zn, Mn, Ni, and Cr) was analyzed by an atomic absorption spectrophotometer. The metal compositions of sixty particles in the sediment were analyzed by SEM-EDX, one by one.

4. RESULTS

4.1 CONTENTS BY PARTICLE SIZE

The particle size distribution of the samples are shown in Figure 3. By pulverizing process, the particle size were reduced by one order of magnitude: from A1 to A2, and B1 to B2.

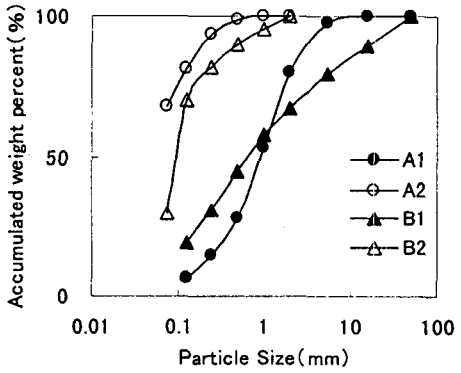

Figure 3 Accumulated particle size distribution

Heavy metal contents by particle size are shown in Table 2. Total contents were calculated by combining the particle size distribution and the contents of heavy metals in each classified particle size. The content of metals in B1 and B2 were larger than those in A1 and A2. The higher content of metal in waste (CSD) burned in Facility B is considered the reason for the difference. The different metal contents are observed between samples before and after

pulverization, e.g. Aluminum in Facility A and Nickel in Facility B. A fluctuation of waste characteristics and different sampling date may be the reason for the discrepancy.

The distribution ratio of the contents of Cu, Cr, Mn, Ni, Pb and Zn in each classified sample by particle size are shown in Figure 4. Compared with A1 and B1, metals exist in smaller particles in A2 and B2. This result indicates that metals are also shredded into pieces by the pulverizer. Metal might be present as fragile compound such as chloride compound, not in the form of metal particle.

4.2 CONTENS IN SEPARATED FRACTION BY DENSITY

The amount of sediment in SPT solution were only 0.2-0.5% of whole samples. Metal particles were not found in the sediment, and metal contents were also small. Since metals might be present as mixture with carbon, the most particles contained metals could not be settled by SPT. So gravity separation by SPT seems to be unsuccessful.

5 CONCLUSION

Pyrolysis residue contained heavy metals such as Cu, Zn, and Pb. These metals were concentrated in the fraction of small particle size, such as under 0.125mm due to pulverizing in the facilities. In the sediment of SPT (s.g.=2.9), metal particles were not detected.

Table 2 Heavy metal contents in the samples [mg/g]

	Particle Size (mm)									Particle Size (mm)							
	-0.075	*	0.125 -0.25	0.25 -0.5	0.5 -1.0	1.0 -2.0	2.0 -5.6	Total		-0.075	*	0.125 -0.25	0.25 -0.5	0.5 -1.0	1.0 -2.0	2.0 -5.6	Total
Fe									Pb								
A1	-	5.07	13.54	10.31	6.78	4.24	11.17	7.62	A1	-	0.34	0.13	0.11	0.10	0.03	0.03	0.08
A2	5.71	3.38	9.77	9.78	8.97	-	-	6.83	A2	0.18	0.73	0.60	1.11	34.01	-	-	0.68
B1	-	36.57	83.23	66.65	71.25	139.44	103.89	61.26	B1	-	3.30	1.79	1.06	2.01	1.55	1.10	1.53
B2	50.26	66.23	69.77	73.52	90.32	156.54	-	67.85	B2	0.40	1.44	3.12	1.50	1.30	2.04	-	1.35
Al									Mn								
A1	-	63.73	80.33	88.45	43.07	85.20	406.82	126.49	A1	-	0.16	0.24	0.23	0.23	0.10	0.16	0.17
A2	22.27	9.53	32.97	26.68	166.99	-	-	23.44	A2	0.25	0.21	0.24	0.35	0.94	-	-	0.26
B1	-	102.31	23.58	26.77	24.19	54.48	52.41	40.72	B1	-	0.92	1.22	1.50	1.59	0.83	1.03	0.94
B2	29.74	91.02	35.29	9.07	17.92	57.01	-	53.98	B2	0.65	0.98	0.87	1.13	1.48	1.43	-	0.93
Cu									Ni								
A1	-	0.06	0.10	0.12	0.10	0.04	0.06	0.07	A1	-	0.009	0.009	0.018	0.048	0.006	0.009	0.019
A2	0.09	0.08	0.26	0.78	3.10	-	-	0.18	A2	0.018	0.004	0.026	0.037	0.031	-	-	0.018
B1	-	2.43	2.45	4.71	21.23	71.30	137.84	27.60	B1	-	0.301	0.452	0.713	0.952	1.941	6.211	1.266
B2	2.34	2.46	3.07	28.01	53.81	3.13	-	7.46	B2	0.113	0.117	0.212	0.286	0.414	0.777	-	0.187
Zn									Cr								
A1	-	0.78	1.45	1.99	4.23	0.44	0.26	1.68	A1	-	0.04	0.04	0.04	0.03	0.03	0.03	0.03
A2	0.54	0.53	0.68	3.69	14.56	-	-	0.85	A2	0.06	0.07	0.16	0.08	0.08	-	-	0.08
B1	-	17.92	19.65	4.60	0.60	0.58	0.27	6.56	B1	-	0.13	0.30	0.15	0.38	0.76	1.66	0.40
B2	13.33	16.41	18.74	9.60	9.13	8.70	-	14.45	B2	0.13	0.15	0.17	0.21	0.49	2.47	-	0.28

1) - : not measured
2) * : under 0.125mm (A1, B1) or 0.075- 0.125mm (A2, B2)
3) Value are metal contents in each classified by the particle size, except total metal contents are calucuated from the particle size distribution ratio and the metal contents of each classified sample.

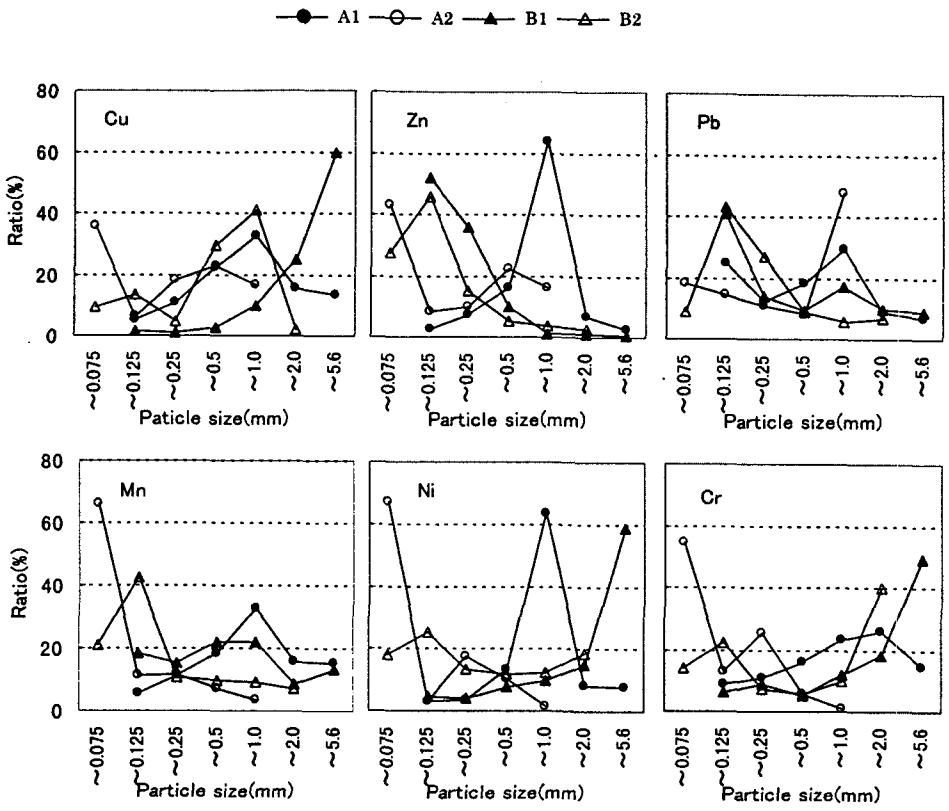

Figure 4 Distribution ratio of metal by particle size