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A Study the Physicochemical Characteristics of Municipal Solid Wastes

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Abstract : The objective of this study was investigate the generation rates, composition, proportion and calorific values each of material in the municipal solid wastes as well as the effect of incineration residual leachate on the environment in Yangsan sanitary landfill site. The results were as follows ; The annual average generation rate of municipal solid wastes in Yang-san is approximately 2.0 kg/c · d. The weight percent of combustible matters is on average 78~87% and the lower heating values of municipal solid wastes is measured to be more than 2,151 kcal/kg after removing the briquette component. The food waste was major source of solid wastes in Yangsan city as 35% and its variation by seasons was negligible. Combustible part was larger than incombustible part of the domestic solid wastes in spring and summer. It is recommended that municipal solid wastes be treated by multiple methods such as the sanitary landfill, resources and recovery, composting and incineration.

Keywords : sanitary landfill, municipal solid waste, Yangsan

Introduction

The term "solid waste" is all-inclusive and encompasses all source, types, classifications, compositions, and properties. Since all wastes disposed of on land are competing for the same limited reserves of landfill space, any subdivision of waste should be regarded with cautions. However, the appropriate method of recycling, recovery, or disposal will depend upon the composition and properties of the waste.

The purpose of this study is to describe some of the major type of waste that are commonly disposed of in municipal landfills in the Yangsan city. Knowledge of the characteristics of solid waste is an essential basis for the planning and design of solid waste management systems. While a general understanding of solid waste is useful, it may not be sufficient to guide local planners and designers. Unfortunately, the characteristics of solid waste can vary considerably from community to community as well as with season, economic conditions, and other factors. This study will also outline a procedure for choosing the waste types to be included in site specific investigations designed to identify the characteristics of solid waste that are generated within a wasteshed.

These investigations are referred to as "waste characterizations" and generally include measurement of waste quantity(by weight) and composition, and optionally include measurement of selected physical and chemical properties. Through the investigation of carefully selected waste types, a well-planned waste characterization should contribute site specific information that elucidates the fundamental characteristics of waste from a wasteshed.

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Experiment

Municipal solid wastes for sampling were selected to have variety of residence and sites were chosen. To estimate the physicochemical characteristics of municipal solid wastes in Yangsan city, two experiments was carried out. One was for the physical characteristics; the other was for the chemical characteristics.

Sampling site of municipal solid wastes are summarized in Table 1.

The analysis of municipal solid wastes was

Table 1. Sampling site of municipal solid was tes in Yangsan city

Sites	Investigation residence
A-1	Farm village area (Kokdo, Sukgyaeo, Dukchan, Munsan, Woongsanup)
A-2	APT + residence (Mulgeum, Hyeopsung, Wondong, Hwanggun)
A-3	APT(Yangsan, Hansung, Jeil)
A-4	Residence(Seochang, Dukgyaeo)
A-5	Commercial (Bukbu, Nambu market)
A-6	APT+residence(Yangsan city, Sangbuk APT)

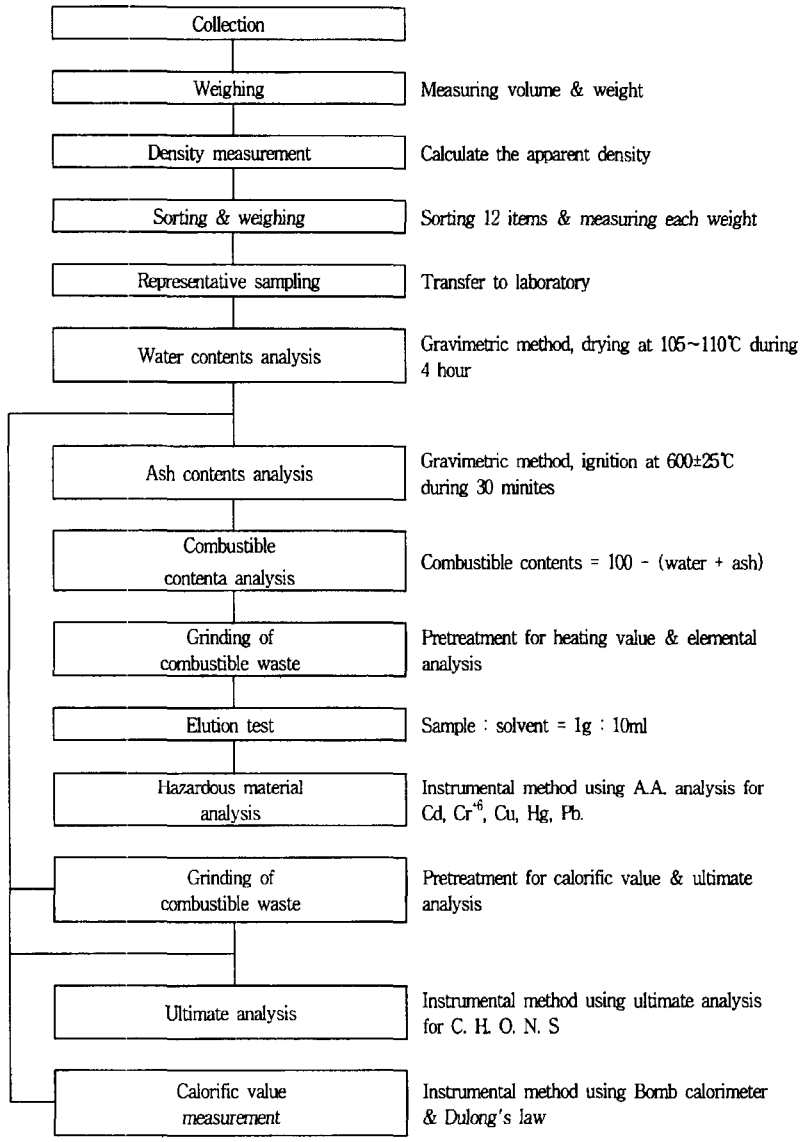

Fig. 1. Analysis of municipal solid wastes in Yangsan city.

carried out with several parameters such as kinds and the density, water content, ash content, elemental analysis and heating value measurement. The heating value of municipal solid wastes was also estimated as compared with theoretically value.

Schematical diagram of municipal solid wastes analysis was illustrated in Fig. 1.

Results and Discussion

Physical composition

Information and data on the physical composition of municipal solid wastes are important in the selection and operation of equipment and facilities, in assessing the feasibility of resource and energy

Table 2. Physical composition of municipal solid wastes

Sites		Combustible composition(%)							Noncombustible composition(%)			
		Total	Food	Paper	Synthetic resin	Wood	Fiber	Leather	Total	Metal	Glass	China
A-1	Spring	83.59	34.15	23.45	14.24	1.29	10.46	0.00	16.41	1.67	14.08	0.66
	Summer	86.20	35.25	25.41	16.01	1.41	8.12	0.00	13.80	5.01	8.65	0.14
	Autumn	84.90	32.59	22.16	17.56	2.36	10.23	0.00	15.10	4.56	10.18	0.36
	Winter	86.46	36.54	23.54	15.38	3.25	7.75	0.00	13.54	3.87	9.05	0.62
	Average	85.29	34.63	23.64	15.80	2.08	9.14	0.00	14.71	3.78	10.49	0.45
A-2	Spring	82.73	35.69	24.87	11.21	1.32	8.43	1.21	17.27	1.50	15.77	0.00
	Summer	76.85	30.15	25.95	13.48	2.74	4.53	0.00	23.15	15.21	7.94	0.00
	Autumn	79.49	35.10	24.25	14.34	1.21	4.59	0.00	20.51	10.83	9.34	0.34
	Winter	77.00	34.15	22.26	13.60	1.89	5.10	0.00	23.00	11.37	11.36	0.27
	Average	79.02	33.77	24.33	13.16	1.79	5.66	0.30	20.98	9.73	11.10	0.15
A-3	Spring	82.65	33.75	27.37	11.25	1.04	8.14	1.10	17.35	3.93	13.21	0.21
	Summer	81.92	31.85	29.31	10.21	2.10	7.21	1.24	18.08	4.92	12.29	0.87
	Autumn	91.63	38.44	32.32	15.24	0.13	5.26	0.24	8.37	4.98	3.24	0.15
	Winter	91.39	37.97	32.71	14.25	0.16	5.17	1.13	8.61	3.67	4.70	0.24
	Average	86.90	35.50	30.43	12.74	0.86	6.45	0.93	13.10	4.38	8.36	0.37
A-4	Spring	85.60	31.13	25.42	12.14	1.22	13.52	2.17	14.40	2.82	11.24	0.34
	Summer	84.78	27.25	31.27	7.21	1.60	15.31	2.14	15.22	2.01	13.21	0.00
	Autumn	86.96	32.65	26.32	13.98	0.92	12.25	0.84	13.04	3.79	8.62	0.63
	Winter	89.91	33.21	26.95	11.82	1.24	15.35	1.34	10.09	3.42	6.22	0.45
	Average	86.81	31.06	27.49	11.29	1.25	14.11	1.62	13.19	3.01	9.82	0.36
A-5	Spring	78.04	25.95	28.63	18.21	4.65	0.60	0.00	21.96	2.01	16.93	3.02
	Summer	77.63	22.43	29.63	17.21	6.21	2.15	0.00	22.37	15.21	7.16	0.00
	Autumn	80.45	32.84	21.99	17.48	5.13	1.66	1.35	19.55	4.03	14.67	0.85
	Winter	78.89	31.11	21.16	18.15	6.12	1.12	1.23	21.11	3.18	16.26	1.67
	Average	78.75	28.08	25.35	17.76	5.53	1.38	0.65	21.25	6.11	13.76	1.39
A-6	Spring	89.00	26.21	27.75	15.98	6.01	10.95	2.10	11.00	1.56	8.21	1.23
	Summer	83.25	34.21	27.51	14.21	0.00	7.32	0.00	16.75	11.21	5.54	0.00
	Autumn	71.66	34.20	17.92	13.47	1.11	4.96	0.00	28.34	16.25	11.86	0.23
	Winter	71.07	33.29	17.58	11.75	1.68	4.88	1.89	28.93	13.25	15.52	0.16
	Average	78.75	31.98	22.69	13.85	2.20	7.03	1.00	21.26	10.57	10.28	0.41
Annual average		82.59	32.50	25.66	14.10	2.28	7.29	0.75	17.41	6.26	10.64	0.52

recovery, and in the analysis and design of disposal facilities.

The physical composition of municipal solid wastes is shown in Table 2 according to the sites. As shown in the Fig. 2, the weight percent of combustible and noncombustible fraction were 78-87% and 12-13% respectively. The food, paper and resin were highest fraction in municipal solid wastes, followed by fiber, wood and leather.

As shown in the Fig. 3, metals were the most abundant in municipal solid wastes and followed by glass and china.

The percentages of municipal solid waste components vary with location, the season, economic conditions, and many other factors.

Food wastes constitute about 32.50% of all municipal solid waste. Paper and synthetic resin constitute about 10% or greater.

Waste generated by residential and commercial sources can be viewed as a conglomeration of materials resulting predominantly from the durable goods, non-durable goods, containers and packaging, food, yard waste, and combustion ash.

Except in areas serviced by recycling programs, wastes from residential and commercial sources have traditionally been collected in a mixed form,

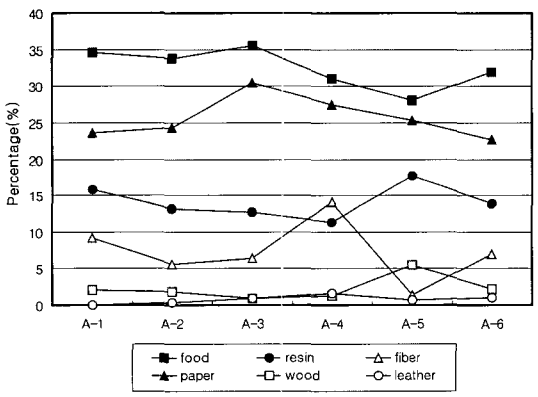

Fig. 2. Physical composition of municipal solid wastes (combustible).

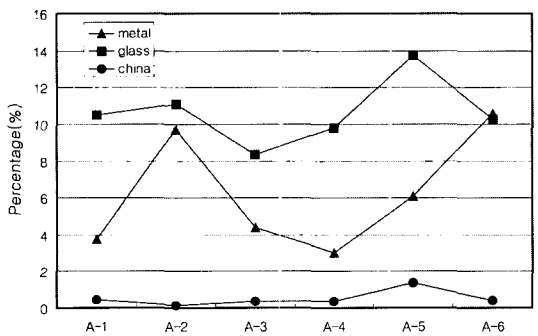

Fig. 3. Physical composition of municipal solid wastes (noncombustible).

Table 3. Proximate analysis of municipal solid wastes

Sites		Moisture (%)	Volatile matter (%)	Ash (%)
A-1	Spring	56.97	26.79	16.24
	Summer	57.24	27.55	15.21
	Autumn	57.20	29.48	13.32
	Winter	58.24	29.22	12.54
	Average	57.41	28.26	14.33
A-2	Spring	53.76	28.03	18.21
	Summer	55.21	25.58	19.21
	Autumn	53.76	32.26	13.98
	Winter	55.41	31.25	13.34
	Average	54.54	29.28	16.19
A-3	Spring	53.44	29.35	17.21
	Summer	57.77	25.50	16.73
	Autumn	50.77	35.26	13.98
	Winter	51.30	34.55	14.15
	Average	53.32	31.16	15.52
A-4	Spring	56.04	28.35	15.61
	lSummer	54.19	29.60	16.21
	Autumn	54.89	31.85	13.26
	Winter	53.10	33.54	13.36
	Average	54.56	30.84	14.61
A-5	Spring	50.11	30.03	19.86
	Summer	54.11	27.52	18.21
	Autumn	53.14	32.25	14.61
	Winter	55.36	30.75	13.89
	Average	53.18	30.14	16.64
A-6	Spring	56.22	29.56	14.22
	Summer	56.61	26.96	16.43
	Autumn	57.29	30.15	12.56
	Winter	59.25	27.30	13.45
	Average	57.34	28.49	14.17
Total average		55.06	29.69	15.24

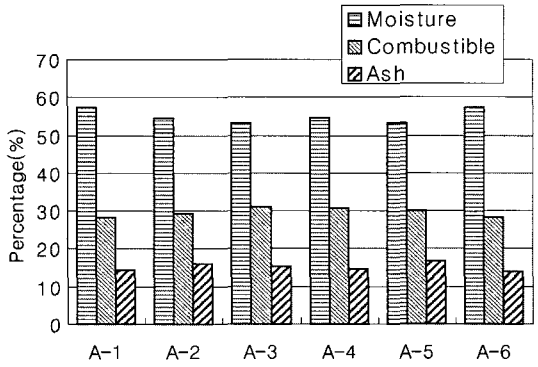

Fig. 4. Proximate analysis of municipal solid wastes.

without any source separation.

Chemical composition

Information on the chemical composition of solid wastes is important in evaluating alternative processing and recovery options. For example, consider the incineration process. Typically, wastes can be thought of as a combination of semimoist combustible and noncombustible materials. If solid wastes are to be used as fuel, the four most important properties to be known are moisture analysis, volatile matter, ash, and fixed carbon.

As the results of municipal solid waste analysis, moisture were the most abundant in municipal solid wastes and followed by volatile matter and ash as shown in Table 3 and Fig. 4.

The amount of moisture, volatile matter and ash was about 53-58%, 28-32%, and 14-17% in respective.

Commercial waste will depend on types of commerce, e.g. restaurants, retail outlets, office, etc. The commercial waste of A-5 site was made up of 53.18% moisture, 30.14% combustible fraction, and 16.64% ash.

Moisture content of wastes are relevant when estimating the calorific value, landfill sizing, reactor sizing, etc.

Density

The density of municipal solid wastes with its composition, its moisture content and its degree of compaction. Density can also be calculated with the weight and volume data of municipal solid wastes. The density of municipal solid wastes

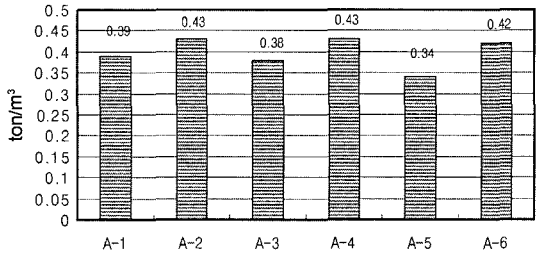

Fig. 5. Density analysis of municipal solid wastes.

estimated according to weight and volume are shows in Fig. 5.

As the results of density analysis, the average density of sites was estimated 0.34-0.43 ton/m^3.

Fig. 5 also suggests that A-5 site has lower the density than other sites. Food wastes range from 0.1 to 0.5 ton/m^3 with corresponding moisture contents at 50 to 80%. Municipal solid wastes normally compacted in landfill has a density of 0.2 to 0.4 ton/m^3 with a moisture content of 15 to 40%.

Calorific values

Experimental results for calorific value municipal solid wastes shown in Fig. 6.

In this study, calculations are normally based on the lower heating value, the energy content of municipal solid wastes can be determined from Dulong equation.

Calorific value range from 2,083 to 2,308 kcal/kg. A-3 site has higher the calorific value than sites, because it was collected apartment residence. This was due to higher combustible fraction and low moisture content.

Ultimate analysis of municipal solid wastes

The most important elements in solid waste

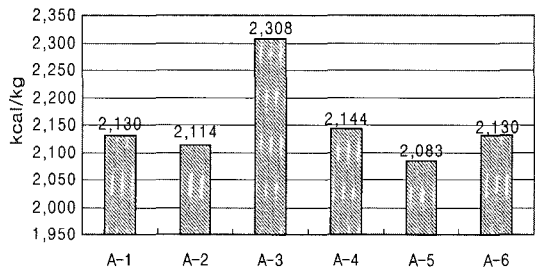

Fig. 6. Calorific value analysis of municipal solid wastes.

energy transformation are carbon, hydrogen, oxygen, nitrogen, sulfur, and chloride. It is relevant to know the chemical composition or ultimate analysis for the purpose of waste to energy processes by combustion or biological transformation. For instance, a waste high plastics is vary suitable for incineration but is totally unsuitable for biological transformation.

Carbon were the highest fraction in municipal solid wastes, follow by oxygen, hydrogen, nitrogen, sulfur, and chloride. The mass fraction of carbon in municipal solid wastes for summer was increased more than for autumn. In summer, the content of carbon was increased but the content of sulfur was decreased compared with winter.

Extraction test for ash

Experimental results for extraction test for ash are shown in Fig. 8. As shown in the figure, Cr^{+6} were the highest fraction in ash, followed by Cu, Pb, Cd, and CN. The mass fraction of Cr^{+6} in ash for summer was increased more than for winter.

Table 6 lists the extraction standards for ash. In this study in which hazardous materal exit at

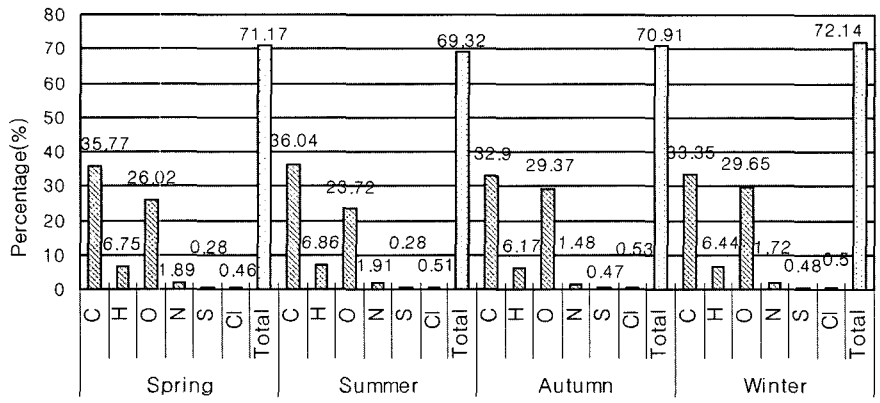

Fig. 7. Ultimate analysis of municipal solid wastes.

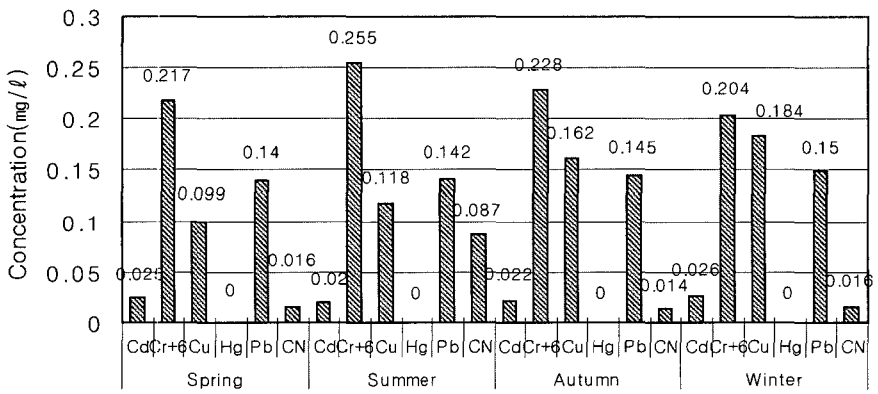

Fig. 8. Extraction test for ash.

Table 6. Extraction criteria in ash

Items	Pb	Cu	As	Hg	Cd	Cr^{+6}	CN	Organic Phosphorus	TCE	PCE
mg/*l*	3	3	1.5	0.005	0.3	1.5	1.5	1	0.1	0.3

concentrations lower than extraction standards in ash.

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