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A Study on Removal of Harmful Heavy Metals in Fly Ash from Municipal Incinerator

Yoshitaka Nakahiro

Department of Architecture and Civil Engineering, Fukui University of Technology,
Gakuen 3-6-1, Fukui 910-8505, Japan

Big cities in Japan have serious problems due to the shortage of new reclaimed land for municipal wastes. If harmful heavy metals such as cadmium, lea d, copper and etc. are contained in the municipal waste combustion residues, they are not able to fill up according to the environmental law in Japan. In this study, the removal of heavy metals in the fly ash (EP ash) was dealt with chloridizing vaporization method. EP ash as a non-hazardous materials is utilized as covering materials, road bed, and building materials.
Keywords: municipal waste, EP ash, harmful heavy metals

Introduction

As the results of mass production, large quantities of consumption and disposal, municipal wastes have been considerably increasing until 1990. By retreat of the later economy or separate collection of resources trash, as for some quantities of wastes, a tendency of decrease is found. However, a discharge of general waste is not less 500 million tons and enormous quantity in a year. In this way, with increase of discharge of general waste, various kinds of problem with each self-governing body. As for the leftover years of current final disposal land, it is in serious situation for about 8 years on average of Japan and 2~3 years in big cities such as Tokyo or Osaka so that it is shown in Fig.1.
As a processing method of general waste, the incineration treatment holds the biggest ratio with 3/4 of total wastes. Bottom ash and fly ash from incinerator have been dumped in last reclaimed land till now. In other words, it has been thought that inflammable wastes were over with "Ash". If harmful heavy metals such as cadmium, lead, copper and etc. are contained in bottom ash and fly ash, they are not able to fill up according to the environmental law in Japan since 1991. It was necessary to have come to dispose after heavy metals in the ashes have been removed or stabilized. In this study, the removal of heavy metals in the fly ash (EP ash) was dealt with chloridizing vaporization method.

Experimental Materials and Procedure

The fly ash from the electrostatic precipitator, termed EP ash, was used in this study. It was received from incinerator of a city in Japan. In Fig.2, the Stoker's incinerator plant is schematically represented. The results of chemical analysis in EP ash as shown in Table 1. It is expected that heavy metals such as Cd, Pb, Cu and etc. will be able to remove by chloridizing vaporization only with heating treatment. Because Cl is contained about 20% in EP ash. The size distribution of EP ash is as shown in Fig.3. From the results of size distribution measurement, the particle size of 50% distribution was

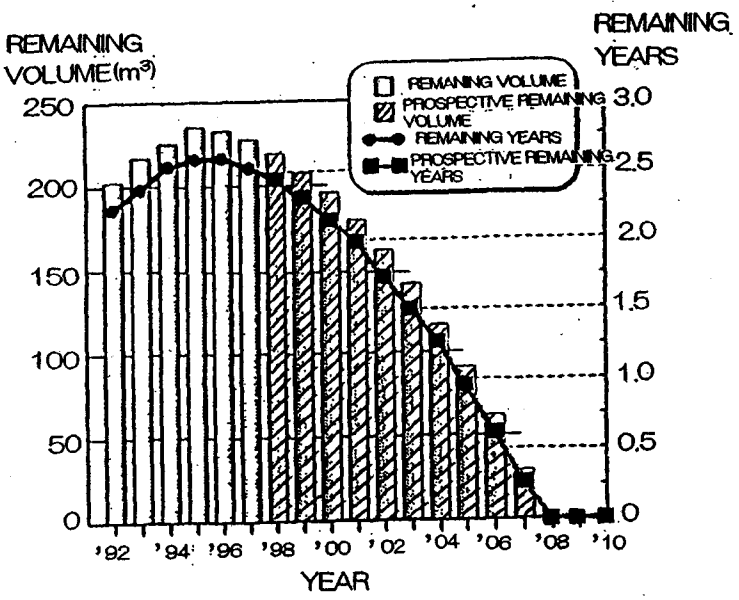

Fig.1 Remaining volumes and years of final disposal land.

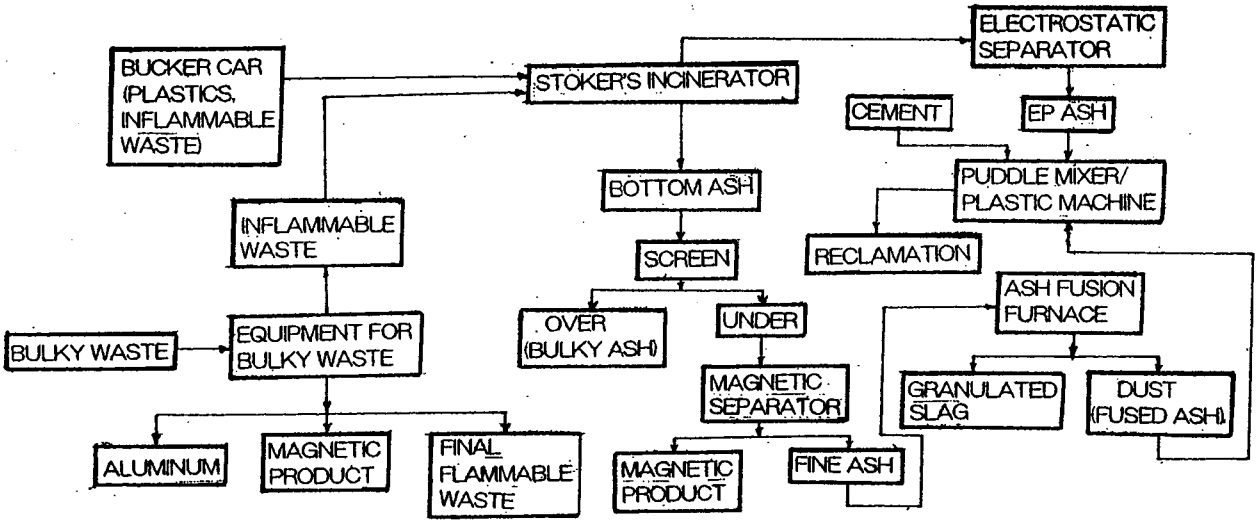

Fig.2 Flowsheet of waste incinerator in a city of Japan.

Table 1 Chemical composition of EP ash.

CHEMICAL COMPOSITION (%)					
Cu	Pb	Cd	Zn	Cl	CaO
0.08	0.88	0.20	1.60	20	57

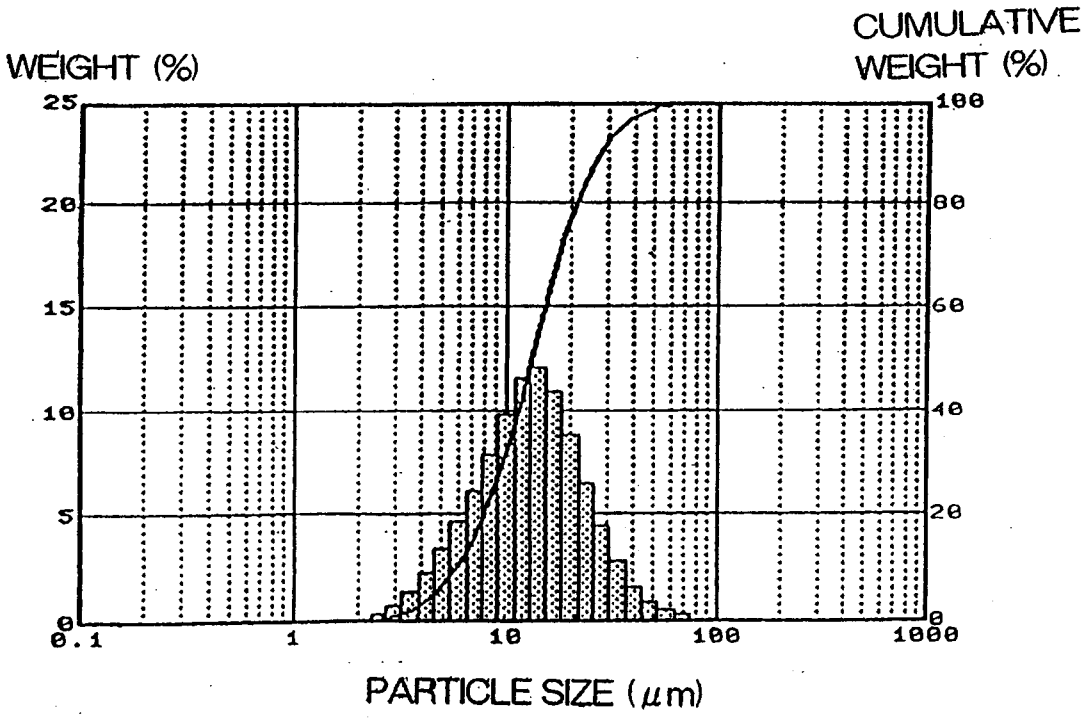

Fig.3 Size distribution of EP ash.

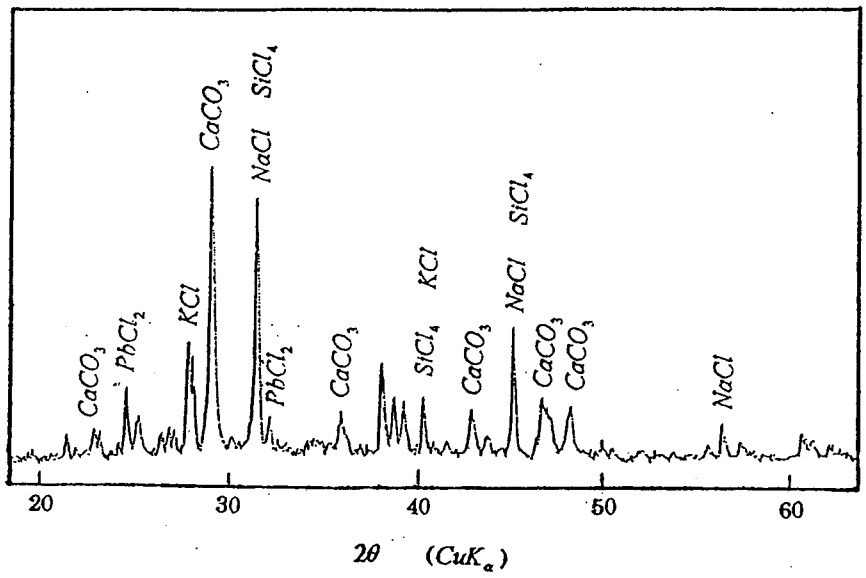

Fig.4 X-ray diffraction pattern of EP ash.

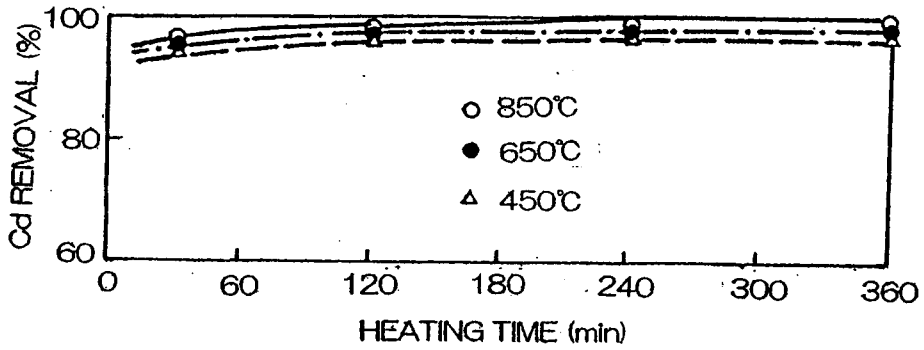

Fig.5 Effect of treating temperature on the removal of Cd from EP ash.

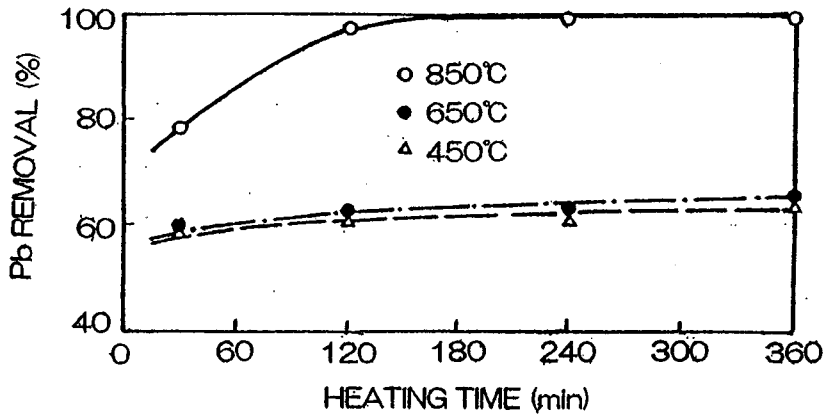

Fig.6 Effect of treating temperature on the removal of Pb from EP ash.

13.17 μm. Fig.4 shows the results of X-ray diffraction measurement. As shown in Fig.4, it was recognized that such heavy metals as lead exists on chloride. It was surmised that other heavy metals than lead also exist in the form of metal chlorides.

The experimental procedure is as follows. EP ash sample of 6 grams weighs exactly and then it is heat-treated in electric furnace with various temperature. Metal contents, such as Cd, Pb and Cu were determined using an inductively coupled plasma atomic emission spectrometry after dissolving then heat-treated sample in aqua regia. From the results of ICP analysis obtained, the removal of heavy metals after heat-treatment was calculated. Furthermore, the elution property of harmful heavy metals after heat-treated ash sample was examined in accordance with arranged procedure of Availability Test. A series of this tests is carried out as follows. Pure water is added in heat-treated sample so that solid/liquid ratio becomes 1:100. After pH adjustment to pH 4 by nitric acid, stirring was carried out for two hours by magnetic stirrer and then the filtrate was analyze by ICP analysis.

Results and Discussion

Fig.5~7 show the effect of treating temperature on the removal of heavy metals in EP ash. As shown in Fig.5, the removal of Cd was over 90% even in case of relatively low temperature of 450℃. Figs.6 and 7 show the removal

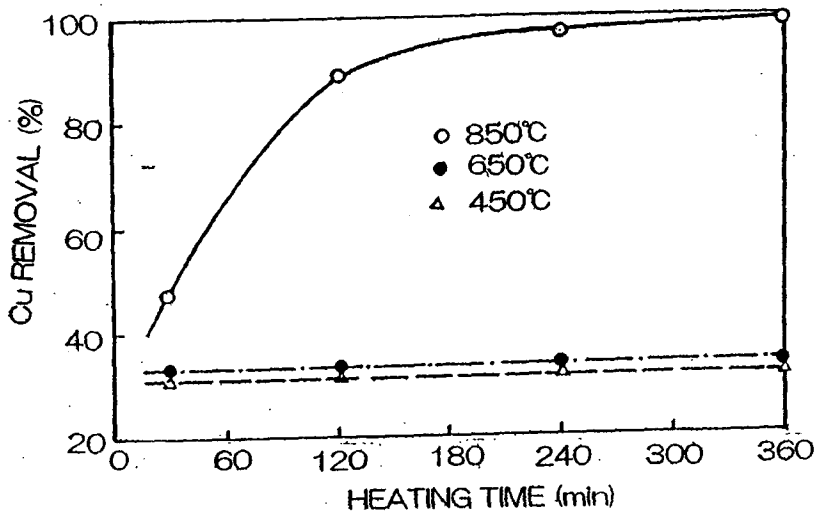

Fig.7 Effect of treating temperature on the removal of Cu from EP ash.

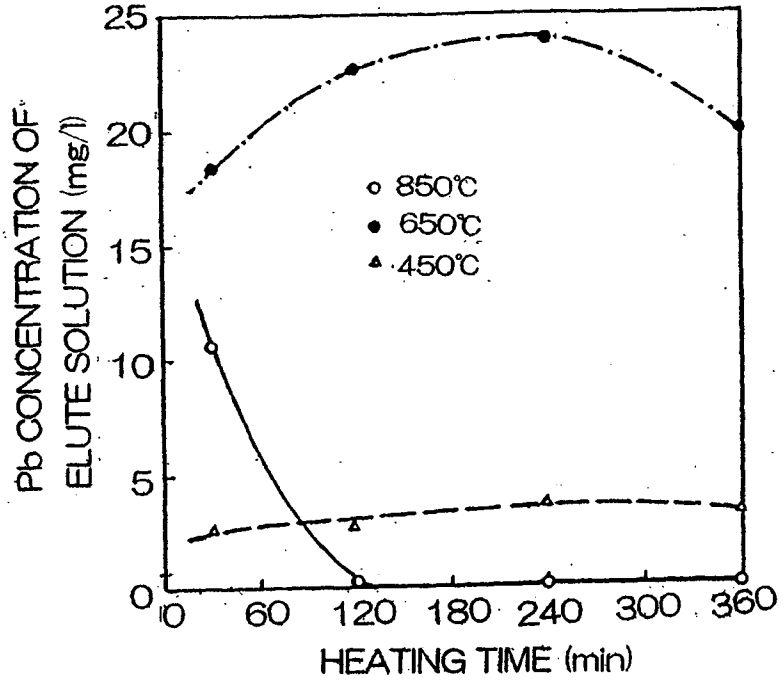

Fig.8 Pb elute concentration of residue after heat-treatment by Availability test.

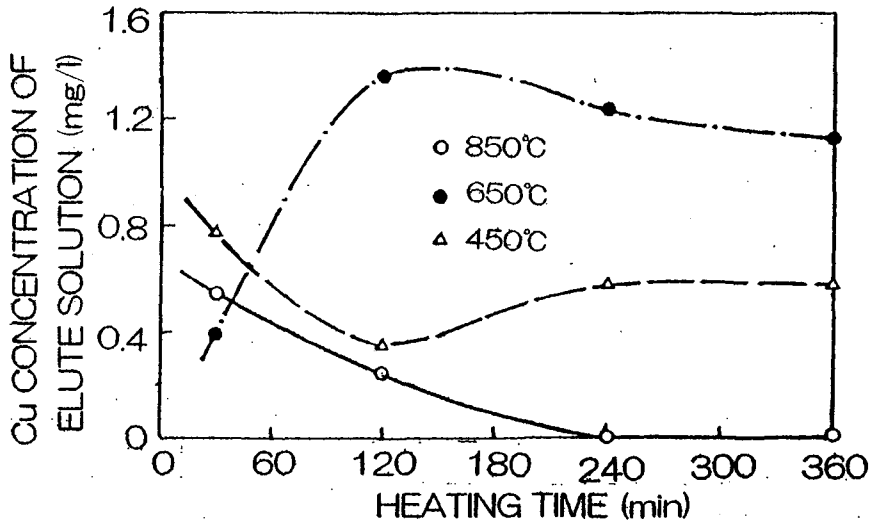

Fig.9 Cu elute concentration of residue after heat-treatment by Availability test.

of Pb and Cu respectively. In case of treating temperature of under 650℃, the removals of Pb and Cu were about 60% and 30% respectively even if treating time was lengthened. In case of treating temperature of 850℃, both removals of Pb and Cu showed about 100% in treating time of over 240 min and 360 min respectively.

In order to examine whether EP ash after heat-treatment is satisfied with the standard of reclamation law in Japan, a series of modified Availability tests was carried out on Pb and Cu in ash. Fig.8 sows the results of Pb on Availability test. As shown in Fig.8, it was recognized that Pb concentration of elute solution in case of heat-treated EP ash of 850℃ and over 120 min was under 0.3 ppm which is satisfied with regulated value of reclamation law. Fig.9 shows the results of Cu on Availability test. Copper in elute solution was not at all found in case of EP ash sample in heat-treating conditions of 850℃ and 240 min.

Conclusions

In this study, the removal of such heavy metals as Pb, Cu, Cd and etc. in the fly ash (EP ash) was investigated with the help of chloridizing vaporization method. It can be concluded that removing harmful heavy metals from EP ash is possible. That is, it was found that the removal of Cd showed over 90% even in case of relatively low temperature of 450℃ and then the removals of Pb and Cu was approximately 100% in treating temperature of 850℃ and treating time of over 240 min.

From the results of a series of Availability tests, it was confirmed that the concentrations of Pb and Cu in the elute solution were satisfied with regulated value of reclamation law in Japan.