World Academy of Science, Engineering and Technology
International Journal of Chemical and Molecular Engineering
Vol:6, No:7, 2012

Study on Characterization of Tuncbilek Fly Ash

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***Abstract*—**Fly ash is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash [1]. In our country, it is expected that will be occurred 50 million tons of waste ash per year until 2020. Released waste from the thermal power plants is caused very significant problems as known. The fly ashes can be evaluated by using as adsorbent material.

The purpose of this study is to investigate the possibility of use of Tuncbilek fly ash like low-cost adsorbents for heavy metal adsorption. First of all, Tuncbilek fly ash was characterized. For this purpose; analysis such as sieve analysis, XRD, XRF, SEM and FT-IR were performed.

***Keywords*—**Fly ash, heavy metal, sieve, adsorbent

I. Introduction

FLY ash is a significant waste. It is released of thermal power plants and defined as very fine particles. The particles are drifted upward with up taken by the flue gases due to the burning of used coal. Emerging the amount of fly ash in the world is approximately 600 million tons per year [2].

Large amounts of fly ash consist by burning of coal in thermal power plants. In recent years, the various application areas started to be investigated due to the nature of fly ash waste and polluting the environment. The fly-ash is capable of removing organic contaminants in consequence of high carbon content, a large surface area per unit volume and contained Al, Fe, Ca, Mg, and Si elements. Therefore, fly ash is used as an effective coagulant and adsorbent [3]-[5].

Heavy metals [6] are one of the most important contaminants in water and soil. Heavy metals are discharged to the environment by several industries, such as mining, metallurgical, electronic, electroplating and metal finishing.

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The removal of heavy metals from wastewaters is of critical importance due to their high toxicity and tendency to accumulate in living organisms. Moreover, heavy metals can not be degraded or destroyed [7].

The aim of this study is to investigate the possibility of use of Tuncbilek fly ash like low-cost adsorbents for heavy metal adsorption. Analysis such as sieve analysis, X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF), Scanning electron microscope (SEM) and Fourier Transform Infrared Spectroscopy (FT-IR) were performed to characterize Tuncbilek fly ash. Depending on the results of the analysis, morphology and chemical composition of Tuncbilek fly ash was investigated.

II. Experimental

A. Materials

The Tuncbilek fly ash was acquired from Electricity Generation Company.

B. Equipments

Equipment used for characterization in the present study are listed below:

XRD analysis: Crystalline structures of solids were determined by XRD technique.

Fig. 1 XRD

The X-ray analysis was carried out at an ambient temperature by using a Philips Panalytical X'Pert-Pro diffractometer with CuKa radiation (k = 0.15418 nm) at operating parameters of 40 mA and 45 kV with step size 0.02° and speed of 1°/min. Phase identification of solids was performed by inorganic crystal structure database (ICSD) (Fig. 1).

A Panalytical-Minipal4 equipped with an array of 12 analyzing crystals and fitted with a Rh X-ray tube target was used. A vacuum was used as the medium of analyses to avoid interaction of X-rays with air particles [8] (Fig. 2).

Fig. 2 XRF

Cam Scan-Apollo 300 Scanning Electron Microanalyzer was used to take the micrograph of the sample. Sample was mounted on aluminum stubs using conductive glue and was then coated with a thin layer of carbon (Fig. 3).

Fig. 3 SEM

FT-IR analysis: Attenuated total reflectance (ATR) of FT-IR spectroscopy (Perkin Elmer Spectrum One) was used in identification of chemical bonds of samples.

Before the analysis, the crystal area had been cleaned and the background collected; the solid material was placed over the small crystal area on universal diamond ATR top plate.

The FT-IR spectrum was achieved after force was applied to the sample, pushing it onto the diamond surface. The IR spectrum was recorded in the spectral range of 4000 to 650 cm^{-1} at ambient temperature and the resolution used was 4 cm^{-1} [9] (Fig. 4).

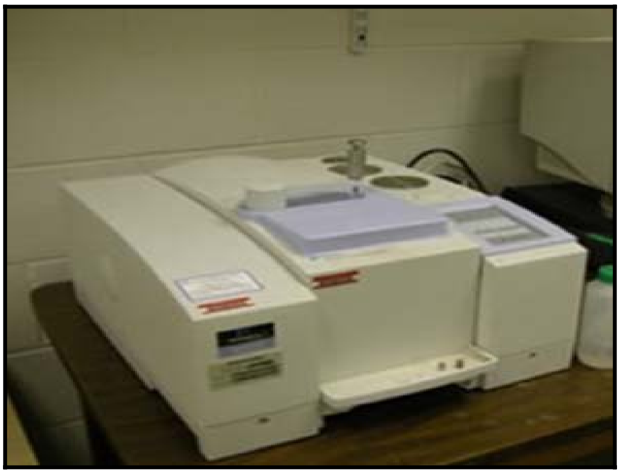

Fig. 4 FT-IR

C. Methods

Fly ashes were characterized by XRD, XRF, SEM and FT-IR to use in adsorption for waste water. Firstly, Tuncbilek fly ash (Fig. 5) was sieved by using 0.841 mm, 0.250 mm, 0.15 mm, 0.075 mm and fly ash was dried at 105°C for 24 hours.

Fig. 5 Tuncbilek fly ash

III. RESULTS AND DISCUSSION

A. Characterizations

XRD, XRF, SEM and FT-IR analyses were carried out by using Philips Panalytical-X'Pert Pro, Panalytical-Minipal4, Cam Scan-Apollo 300 and Perkin Elmer-Spectrum One instrument, respectively.

XRD analysis showed that Hematite (Fe_2O_3) and Quartz (SiO_2) were determined in structure of fly ash (Table I) (Fig. 6).

TABLE I
XRD RESULTS OF TUNCBILEK FLY ASH

PDF no	Mineral	Formula
01-089-1961	Quartz	SiO_2
01-073-0603	Hematite	Fe_2O_3

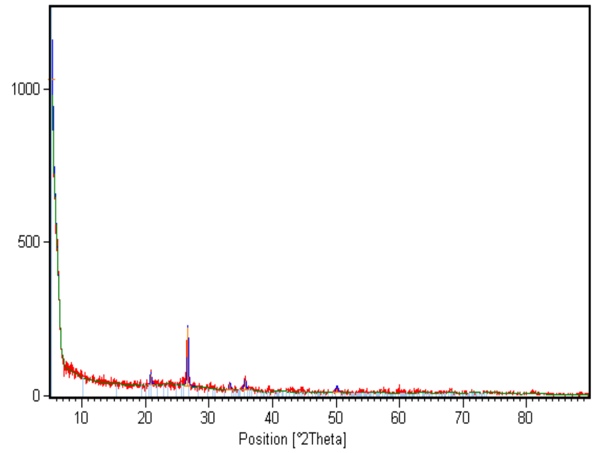

Fig. 6 XRD analysis of Tuncbilek fly ash

Chemical composition of Tuncbilek fly ash was given in Table II. The fly ash is substantial with silicium dioxide. XRF analysis of Tuncbilek fly ash for major and minor components is given in Fig. 7.

TABLE II
CHEMICAL COMPOSITION OF TUNCBILEK FLY ASH

Fly Ash	Compound	Amount (%)
Tuncbilek	MgO	3,70
	Al_2O_3	22,0
	SiO_2	61,5
	SO_3	0,84
	K_2O	1,40
	CaO	1,90
	TiO_2	0,72
	Fe_2O_3	8,00

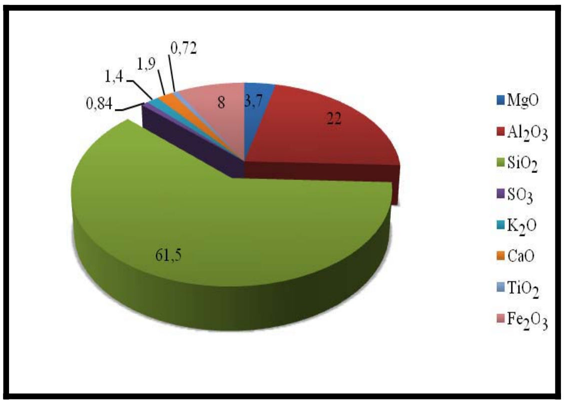

Fig. 7 XRF analysis of Tuncbilek fly ash for major and minor components

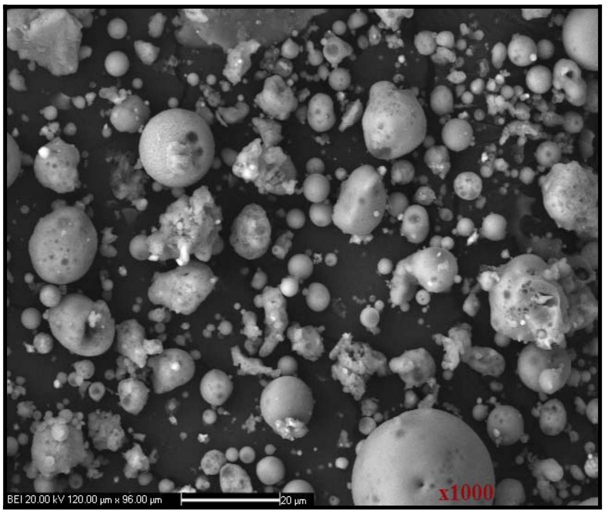

Fig. 8 SEM analysis of Tuncbilek fly ash

SEM was used to determine morphological structure of product. The particle size of fly ash changed in range of 1.35 μm and 6.45μm (Fig. 8).

Before the experimental studies, sieve analysis was performed with ASTM standard sieves (20, 60, 100 and 200 mesh) and the mechanical shaker was used for sieve analysis (Fig. 9). The result is presented in a graph of percent retained in each sieve versus the sieve size as shown in Fig. 10.

These results indicate that size 20-200 mesh of the particles is the main fraction of Tuncbilek fly ash.

Fig. 9 Sieving procedure

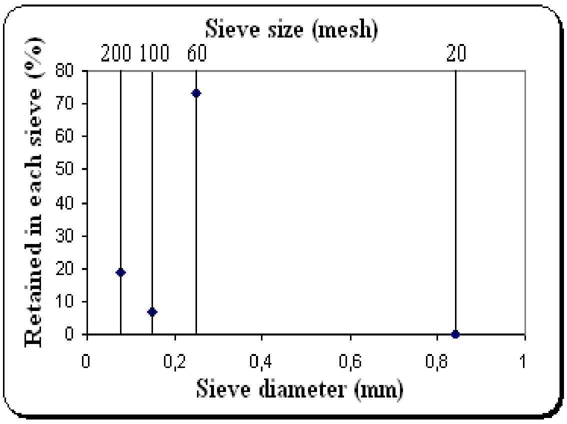

Fig. 10 Sieve analysis of Tuncbilek fly ash

The FTIR spectrum of the fly ash is shown in Fig. 6. The results show a broad band 800 cm^{-1}. Three characteristic band centered at around 1100 has been identified. The strong and broad band at 1100 cm^{-1} is due to (Si-O-Si) asymmetric stretching vibration.

Tuncbilek fly ash sample centered at this band has the highest SiO_2 content. The band at 850 cm^{-1} can be described for the SO_4^{-2} group (Fig. 11).

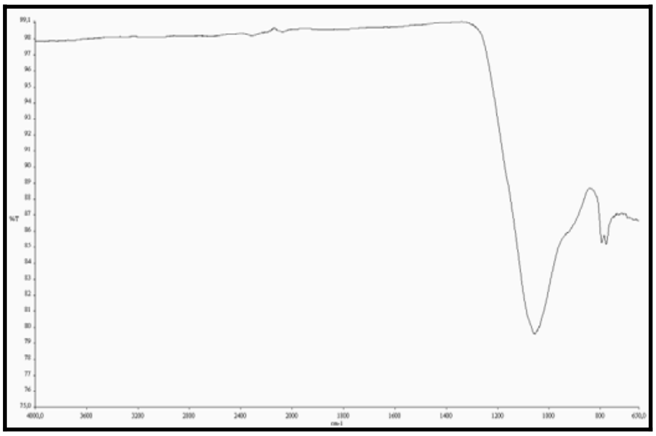

Fig. 11 FT-IR analysis of Tuncbilek fly ash

IV. Conclusion

In this study, Tuncbilek fly ash will be used in heavy metal adsorption by preparing pellets. Therefore, the selection of proper fly ash is very important. Sieve analysis, XRD, XRF, SEM and FT-IR analysis results showed that Tuncbilek fly ash can be used as an adsorbent material for heavy metal adsorption. By this means, Tuncbilek fly ash is convenient for adsorption by pelletization.

Acknowledgment

This work is funded by YTUBAPK project no 2011-07-01-KAP01.

References

[1] http://en.wikipedia.org/wiki/Fly_ash

[2] A. Bilodeau, and V. M. Malhotra, "High- volume fly ash system. Concrete solution for sustainable development", *ACI Mater.J.*, vol. 97, pp. 41-49, 2000.

[3] P. K. Deb, A. J. Rubin, A. W. Launder, and K. H. Mancy, "Removal of COD from wastewater by fly ash", Proceedings of 21st. Ind. Waste Conf., Purdue Univ., Indiana, Ext.Ser., vol. 121, 1967, pp. 848-860.

[4] P. Cheremisinoff, "Coal fly ash: power plant waste or by-product", *Power Eng*., vol. 92, pp. 40-41, 1988.

[5] M. B. Vandenbusch, and N. J. Sell, "Fly ash as a sorbent for the removal of biologically resistant organic matter", *Resour. Conserv. Recy*., vol. 6, pp. 95-116, 1992.

[6] H. Polat, and D. Erdogan, "Heavy metal removal from waste waters by ion flotation", *J. Hazard. Mater*., vol. 148, pp. 267–273, 2007.

[7] M. J. González-Muñoza, M. A. Rodrígueza, S. Luquea, and J. R. Álvarez, "Recovery of heavy metals from metal industry waste waters by chemical precipitation and nanofiltration", *Desalination*, vol. 200, pp. 742–744, 2006.

[8] http://www.waternet.co.za/we/docs/vernon_removal_of_mercury_and_lead_ions.pdf

[9] http://www.scribd.com/doc/40053128/NaBH4-ulexite

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