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Properties of Fly Ash from a Thermal Power Plant in Vietnam

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Abstract: In this paper, some properties of fly ash from Uong Bi thermal power plant in Vietnam were characterized by using several techniques. The morphology and chemical composition of fly ash were characterized by SEM-EDS. The properties of particles were studied by particle size distribution. Oxide phases were characterized by X-ray diffraction (XRD) technique, the characteristic surface species of the sample were studied by FT-IR spectrum. Thermal analysis (TG) and nitrogen adsorption-desorption isotherm were used to determine the unburned carbon and the surface area of the sample, respectively.
Keywords: Fly ash, Uong Bi thermal power plant.

1. Introduction

Thermal power is still an important power in many countries [1-3]. Uong Bi thermal power plant is one of the biggest power stations in Vietnam. This plant generates about 1000 MW of power, and produces a huge amount of fly ash (a waste solid) as a byproduct. The managements of fly ash remain a major problem in Vietnam and many countries. Generally, fly ash is disposed as landfill in the fulfilment of dams and lagoons, or is being used as sorbent, catalyst, construction material [2-6] In Uong Bi thermal power station, large amount of fly ash is not used and this requires disposal.

The application of fly ash is closely related to its properties. Therefore, the properties of fly ashes have been considered for their eventual applications. However, the characteristics of fly ashes from thermal power plants in Vietnam appeared in the literatures are very limited.

The main objective of this study was to access the characteristic of fly ash from Uong Bi thermal power plant in Vietnam.

2. Experimental section

Material

Fly ash was collected from Uong Bi thermal power plant where located in Quang Ninh province, Vietnam. The samples were dried in an oven at 105 ^{o}C for 24 h, and stored in a sealed jar at room temperature for experiments.

Characterization of fly ash

Scanning electron microscopy (SEM) and EDS spectrum of the sample were carried out in a S-5000 FESEM-EDS (Hitachi, Japan) at an accelerating voltage of 25 kV. X-ray diffraction was performed in a Bruker

D8-Advance diffractometer (Germany) using Ni filtered Cu $K\alpha=1,5406\,\mathring{A}$, with 2θ range of 20-70°. The texture properties of the samples were evaluated by nitrogen adsorption-desorption isotherm which recored on a conventional volumetric nitrogen adsorption apparatus (Micromeritics ASAP2420, USA). To remove preadsorbed gases, a degasification step was carried out under N_2 flow for 6 h before the adsorption-desorption analysis. The specific surface areas of the materials were calculated using the Brunauer-Emmett-Telller (BET) method in the relative pressure (P/P_0) range of 0.03–0.1. Thermogravimetric (TG) curve was obtained with an analyzer (Thermo Plus TG-DTA 8120, Rigaku, Japan) in air flow with a rate of 300 mL/min. For TG analysis, the samples (mass of ca. 10 mg/sample) were heated from ca. 30 °C to 1000 °C at a constant rate of 5 °C/min. Fourier transform infrared (FT-IR) spectra of the samples were recorded using IRPrestige-21 FT-IR (Shimadzu, Japan).

3. Results and Discussion

SEM image of fly ash in the Fig. 1 indicated that the typical aspect of globules is close to an ideal sphere in shape. This result is in good agreement with previous report [7]. The particle size distribution of fly ash in Fig. 2 showed that fly ash is composed of fine particles, about 55% of them below 10 μm .

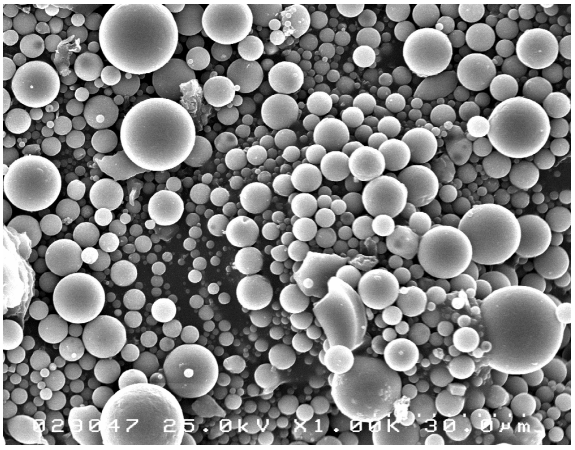

Fig.1. SEM image of fly ash.

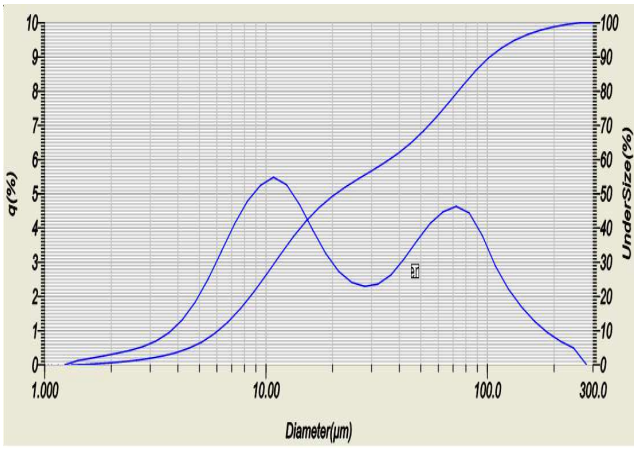

Fig. 2. Particle size distribution of fly ash.

The chemical composition of the fly ash usually depends on their sources. In this study, elemental composition was verified using an energy dispersive EDS. The results in the Fig. 3 and Table 1 confirmed that the predominant elements in the sample were carbon, oxygen, silicon, aluminium, and iron in various compounds. Lower contents of the elements potassium, titanium were also observed. This result is in good agreement with XRD result which showed in the Fig. 4. XRD pattern of the sample indicated that the main compounds in the fly ash were hematite, mullite, and quartz. The results in this study showed the significant difference between the chemical composition of fly ashes which produced from the combustion of coal and biomass [8].

Table 1. Elemental composition of the fly ash

Element	Wt%	Element	Wt%
C	32.90	Fe	4.43
O	34.11	Ti	0.55
Si	17.49	Na	0.16
Al	10.29		

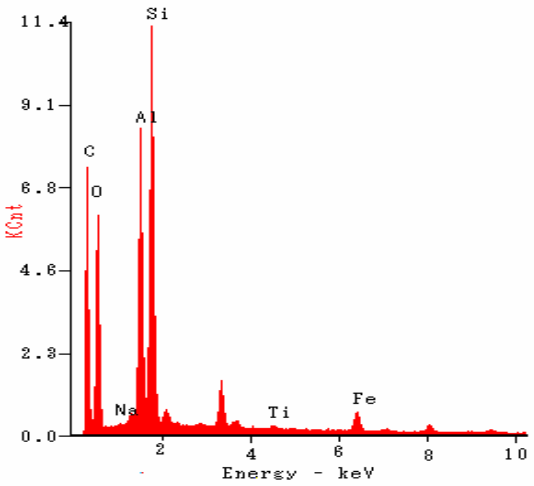

Fig. 3. EDS spectrum of fly ash.

Thermal analysis was carried out under air flow in order to find out the content of unburned carbon in the fly ash. The result in the Fig. 5 indicated that fly ash was stable under ca. 625 ^{o}C, about 17% of the sample was unburned carbon. This result confirmed that the unburned carbon content in the fly ash used in this study is relatively high. However, this sample has low surface area, ca. 7.59 m^2/g (Fig. 6). Because of low surface area, this is necessary for modification of fly ash before using this material as an adsorption or a catalyst [2,9,10].

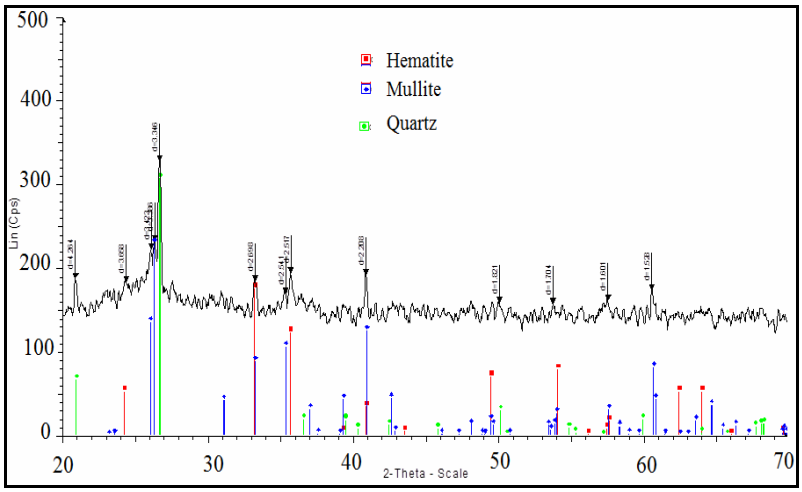

Fig. 4. XRD pattern of fly ash.

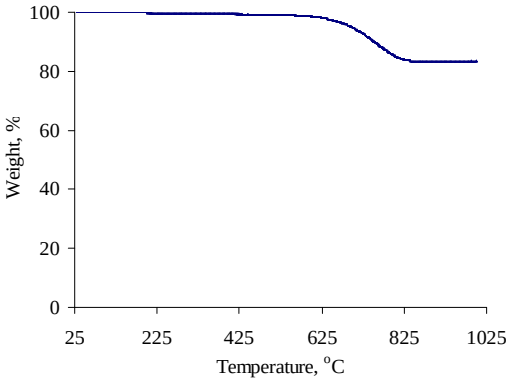

Fig. 5. TG curve of fly ash.

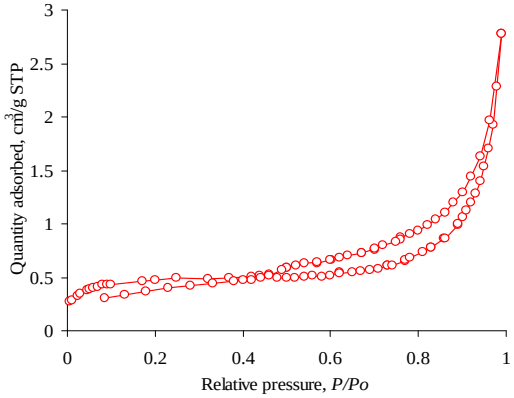

Fig. 6. N_2 adsorption-desorption isotherm of fly ash.

The FT-IR spectrum of fly ash in Fig. 7 showed a broad band between 3500 and 3000 cm^{-1}, which can be attributed to surface –OH groups of –Si-OH and adsorbed water molecules in the surface. A peak at 1650 cm^{-1} in the spectra of the sample is assigned to bending mode (δ_{O-H}) of water molecules [10]. The main absorption band of the valence oscillations of the groups Si-O-Si in quartz appears with a main absorption maximum at 1073 cm^{-1}. A peak at 440 cm^{-1} attributed to Si-O-Si bending [10].

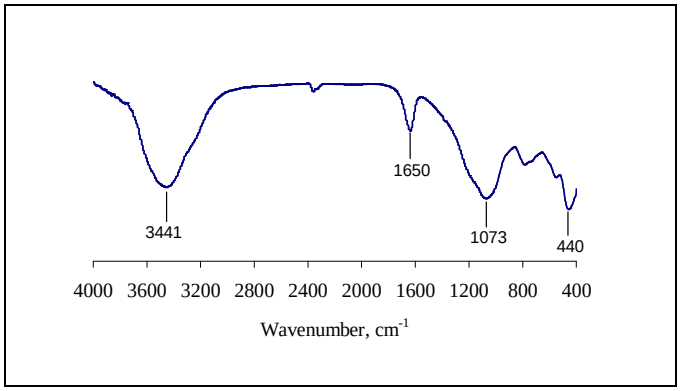

Fig. 7. FT-IR spectrum of fly ash.

4. Conclusions

Fly ash from Uong Bi thermal power plant was characterized by SEM, EDS, XRD, TG, nitrogen physisorption, IR techniques. Those results in this study are important to modify and use fly ash from Uong Bi thermal power plant as a useful solid waste.

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