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Physical Characterization Comparative Study of Fly Ash

A. D. Dahegaonkar

Department of Physics, N.S. Science and Arts College, Bhadrawati, Dist. Chandpur, India

ABSTRACT

Fly ash is a waste material rich in silica and alumina. It is important to investigate various types of fly ash. Physical properties of fly ash characterized by XRD and SEM techniques. The results showed that type of fly ash depended on amount of Si-based of Ca-based compound, which consisted of spherical morphology. To identifying fly ash, character becomes more complicated due to its physical properties and heterogeneous composition. The varying composition of fly ash depend on type of coal, boiler type, operation condition, combustion technology and power plant technology. XRD and SEM techniques conducted in order to identify physical character of fly ash. XRD performed in order to discover crystalline mineral component of fly ash on the other hand, SEM is required to analyze the shape, surface and internal structure of fly ash particle.

Keyword: Fly Ash, Physical Characterization, XRD and SEM

1. Introduction

There were many experimental analyses on fly ash to undertake basic compositional, physical properties for technical studies and applications [1]. Raw fly ash consists of quartz and mullite as crystalline phases and some quantity of glassy phase [2]. North East India produces a large quantity of fly ash from its coal-fired power plant. In India, substantial part of electric power (about 65%) generated from coal or lignite fired thermal power stations. One of the major pollutants generated in a coal based thermal power plant is fly ash. Silica (SiO_2), alumina (Al_2O_3), iron oxide (Fe_2O_3) and titanium oxide (TiO_2) are major constituents of fly ash, which forms morphologically porous matrix, and have improved thermal stability The morphology of fly ash is an important aspect that requires thorough evaluation based on examination using light microscopy, fly ash particles can classified into eleven morphologic classes [3]. Several techniques such as XRF, pH, XRD and SEM was conducted in order to identify physical and chemical character of fly ash. XRD test performed in order to discover crystalline mineral component of fly ash [4]. On the other hand, SEM is required to analyze the shape, surface and internal structure of fly ash particle [5]. In this paper, author compare physical characterization of Indonesian, Japanese, Australian and Indian fly ash performed through XRD and SEM techniques and it is observe that different places of fly ash shows the different physical characterization results.

2. Physical characterization

[2.1] - X-ray Diffraction Spectroscopy (XRD)

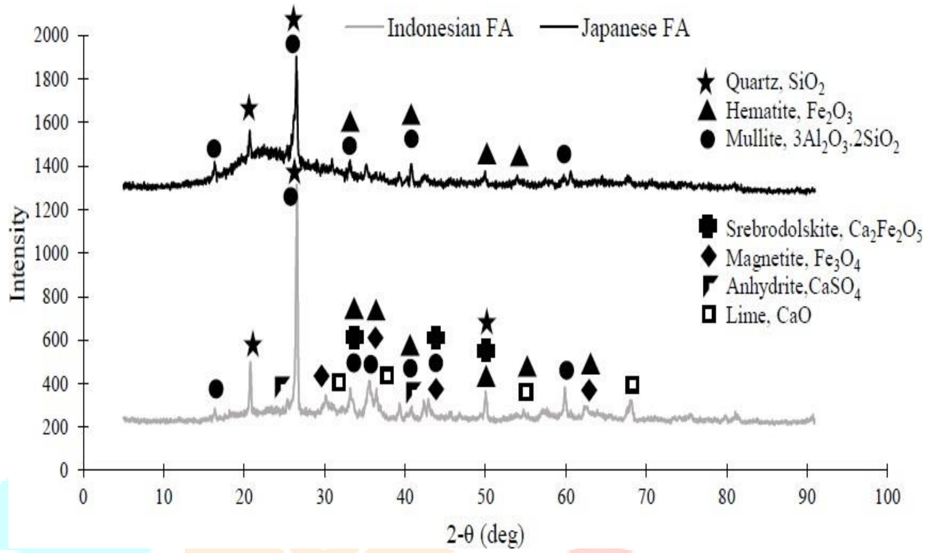

Fig.1 XRD Spectra of Indonesian and Japanese Fly Ash [10]

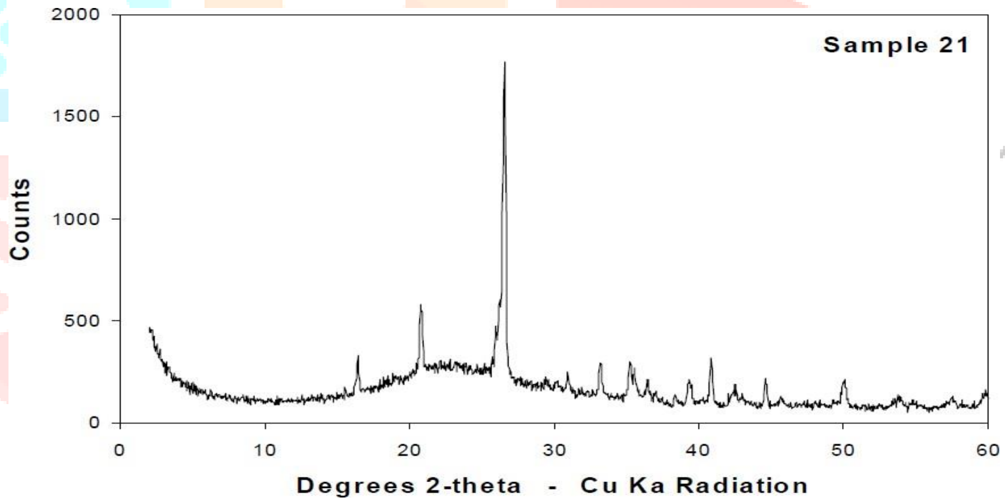

Fig. 2 XRD Spectra Australian Fly Ash [10]

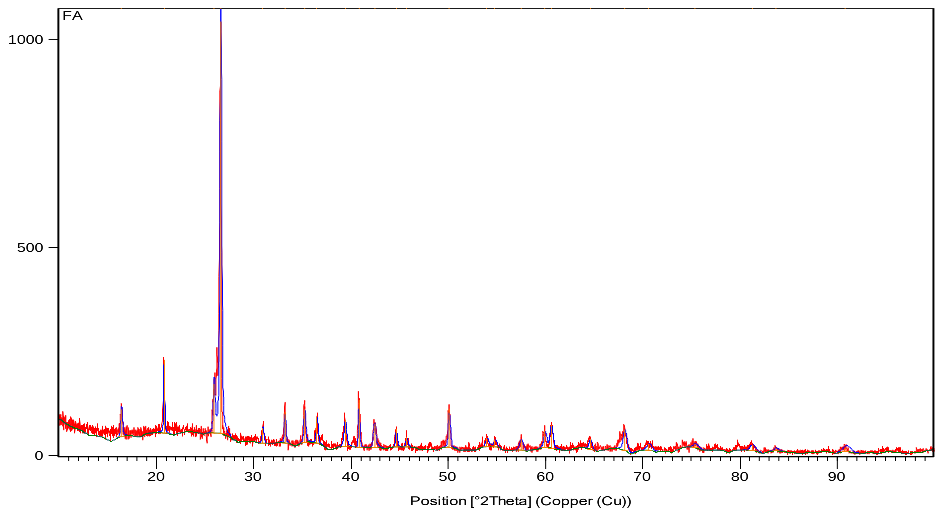

Fig. 3 XRD Spectra of Indian Fly Ash

X-Ray diffraction with CuKα radiation, Kα= 0.89 and wavelength λ = 1.54056 Å was used to determine the crystal structure [18]. Fig. 1 shows the XRD pattern of compared between Indonesian Fly Ash and Japanese Fly Ash. The results show that both ash types have a same major peak of crystalline phase i.e. quartz (SiO_2). Besides, Japanese fly ash also contained crystalline phase of hematite (Fe_2O_3), and mullite ($3Al_2O_3.2SiO_2$). In addition, Indonesian fly ash also contained srebrodolskite ($Ca_2Fe_2O_5$), magnetite (Fe_3O_4), anhydrite ($CaSO_4$) and lime (CaO) [6]. The second major peak presents that both of Fly Ash contain Fe-based material with different oxidation state (hematite and magnetite). It seems that Indonesian Fly Ash is easier to oxidize compared to Japanese Fly Ash. Indonesian Fly Ash also contains more $SiO_2$and CaO than Japanese Fly Ash although the major peak happened at the similar 2-theta degree at 20-30. Quartz identified as peak phase of fly ash crystal occurred in the range degree of 20-30 with the intensity ranged 1200-1800 [7]. From the Fig. 2 and Fig.3, it is clear that Australian fly ash and Indian fly shows mostly similarities.

[2.2] Scanning Electron Microscopy (SEM):

Scanning Electron Microscope (SEM) conducted in order to investigate the morphology of particles [8]. Morphology data can used for predicting the mechanical and physical properties of material [9].

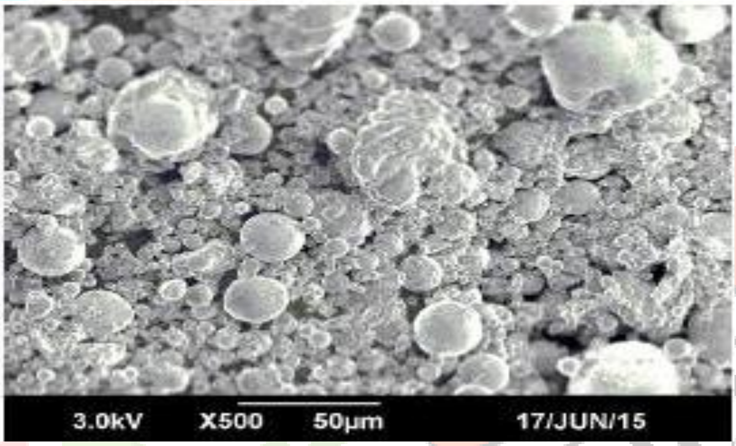

Fig.4 SEM result of Indonesian Fly Ash [10]

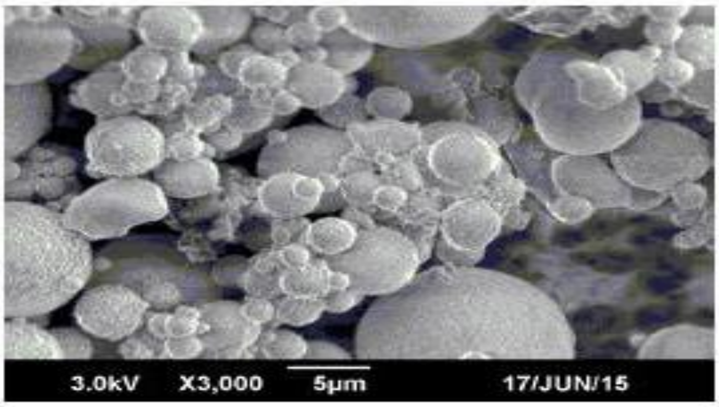

Fig. 5 SEM result of Japanese Fly Ash [10]

The results of SEM technique for several fly ashes obtained from different sources of Indonesia and Japanese illustrated in Fig.4 and Fig. 5. Fly ash obtained from Indonesia power plant has irregular shape pattern (bulky) compared to Japanese fly ash. The bulky particle shape of Indonesian fly ash has short particle distance compared to a homogeneous Japanese fly ash.

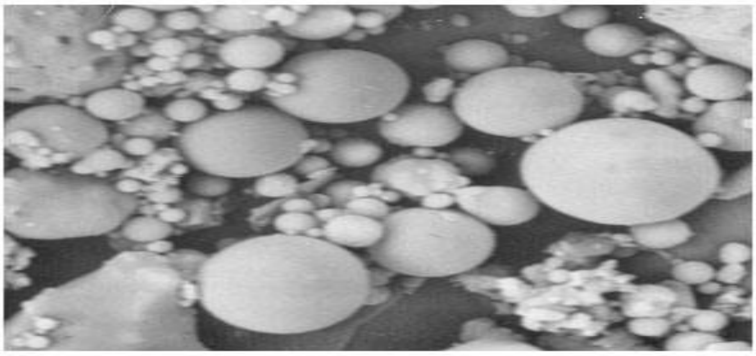

Fig. 6 SEM image of Australian Fly Ash [11]

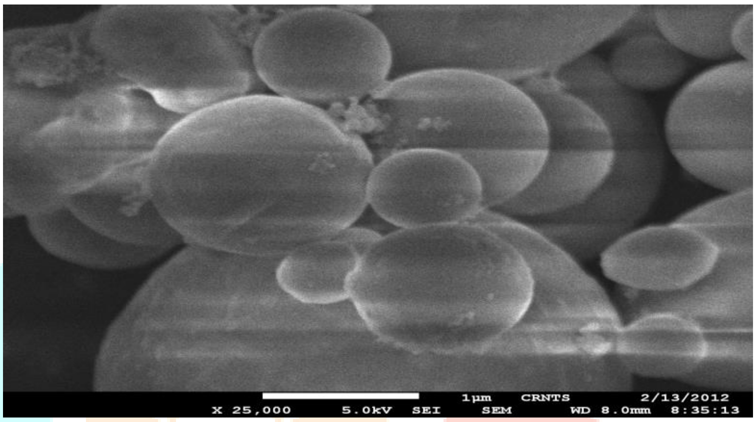

Fig. 7 SEM Image Indian Fly Ash

In Fig. 6 and Fig. 7 shows the shape of Australian fly ash and Indian fly ash are generally spherical shape. Previous, study by Fernandez stated that particles size distribution of fly ash play an important role in mechanical properties of fly ash [17]. Surface morphology of several fly ash are in spherical shape seems heterogenic and has various distances between particles due to large difference of particle diameter. The fly ash produced in Australia is categorized as F type – being mainly silica and alumina (80-85%). F type ash is pozzolanic and reacts with various cementitious materials. About 85% of the current beneficial use of fly ash is to enhance the properties of concrete and other building materials, and used to good effect with road base binders and asphalt filler [11]

3. Conclusion

The various type of fly ash resulted in different characterization results. Japanese fly ash consists of Ca-based compound and magnetite, Indonesian fly ash consists of Si-based compound and hematite, while Australian and Indian fly ash consists of quartz, hematite, magnetite, and CaO. All diffraction patterns of fly ash showed the major peak at 20-30 two-theta degree. The morphology of fly ash particles was mostly in spherical shape. Indian fly ash is characterize by its physical (lightweight, small spherical particles, hardness) that gives it with an economic value as a raw material in many applications. Physical Properties of fly ash particles are very fine, spherical refractory and have pozzolanic ability. Fly ash grey to blackish grey and is dependent on coal type and combustion process. Fly ash has dielectric property and can used in electronic application.

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