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Characterisation Of Fly Ash From Thermal Power Plant

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Abstract
The fly ash composition analysis may helpful in developing a pollution abatement approach for different uses of fly ash such as cement and ceramics manufacturing. The current study deals with the characterization of fly ash samples collected from NTPC Dadri unit in India for many different oxides (Na_2O, MnO, SO_3, P_2O_5, MgO, K_2O, TiO_2, CaO, Fe_2O_3, Al_2O_3 and SiO_2) by non-destructive technique, SEM, XRD. Among the major elements, the concentration of SiO_2 is found to be the highest 58.0 % and that of Na_2O is found to be the lowest 0.17%. To know the chemical properties, morphology using Scanning (EDX), phase composition using X-ray Diffraction (XRD) has been performed. To know the physical properties of fly ash as average particle size (6.90µm), average moisture content (0.175 %), specific gravity (2.275) and average true density (2.29g/cm^3) have been performed and identified.

***Key words**: Fly ash, Physical properties, Chemical properties, SEM, XRD,*

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I.Introduction

Fly ash (F.A) is a fine particle comes from the combustion of pulverized coal in electric power generation plants. During this process, most of the volatile substances and carbon in the coal are burned off [1]. The ash content in Indian coals varies between 10-40%. An increase of 1% in the ash content can result in an increase in coal consumption of 3-4% affecting calorific value and in turn quality of coal. Presently, National Thermal Power Corporation (NTPC) generates around 59 million tons of coal ash annually from its coal based thermal power plants. The generation of huge quantities of coal ash poses serious disposal and environmental problems [2,3]. F.A is associated with various useful constituents such as Ca, Mg, Mn, Fe, Cu, Zn, B, S and P along with appreciable amounts of toxic elements such as Cr, Pb, Hg, Ni, V, As and Ba [4]. The physical properties of the coal F.A, such as moisture content, particle mass, glass composition, and the portion of unburnt carbon, are dependent on coal properties, the combustion temperature of the coal, the air flow/fuel ratio, coal pulverization size, and the rate of combustion. The mineral constituents of the fired coal are responsible for the chemical composition of F.A [5]. Fly ash is used in the construction industry as a substitute to aggregates and cement in concrete production. Basic fly ash (class-F) is utilized in acid mine drainage mitigation [6]. It has also been used as adsorbent for flue gas cleaning and as raw material in the synthesis of geo-polymers [7, 8]. Two major classes of F.A are specified in ASTM C 618 on the basis of their chemical composition resulting from the type of coal burned; these are designated Class F and Class C. Class-F is fly ash normally produced from burning anthracite or bituminous coal, and Class-C is normally produced from the burning of sub bituminous coal and lignite. Class C fly ash usually has cementitious properties in addition to pozzolanic properties due to free lime, whereas Class F is rarely cementitious when mixed with water alone [9]. F.A usage, particularly in concrete, has noteworthy natural advantages as Increasing the life of concrete roads and structures by improving concrete durability and reduction in amount of coal combustion products that must be disposed in landfills. It is also used for reduction in energy use and greenhouse gas and other adverse air emissions when fly ash is used to replace or displace manufactured cement and used as conservation of other natural resources and materials [10]. The F.A is characterized utilizing a discrete approach together with SEM, EDAX, XRF, XRD, and particle size distribution. This article offers a survey on F.A composition, applications, and characterization techniques.

II.Materials and methods

The following tests have been conducted to characterize the sample of fly ash which has been Collected from NTPC Dadri, U.P, India.

Chemical composition and Physical properties
The chemical composition [11] of the sample has been obtained with the help X-ray fluorescence (XRF) setup (Rigaku RIX 3000).

Table 1: Chemical composition of F.A

S.No	Compound	Content (% wt)
1	SiO_2	58.0
2	Fe_2O_3	4.60
3	Al_2O_3	20.0
4	CaO	8.50
5	MgO	1.30
6	K_2O	0.85
7	Na_2O	0.17
8	SO_3	1.00
9	LOI	4.55

Table 2: Physical properties of F.A

S.No	Color	Whitish grey
1	Average true density (g/cm^3)	2.29
2	Specific gravity	2.275
3	Average moisture (%)	0.175
4	Average particle size (µm)	6.90

Particle size distribution

A laser particle size analyzer, (Mastersizer 2000 of Malvern Instruments Ltd), have been used to study the particle size distribution [12] of the fly ash sample (Fig. 1). The size range of particles is very wide i.e. 1 µ to 100 µ.

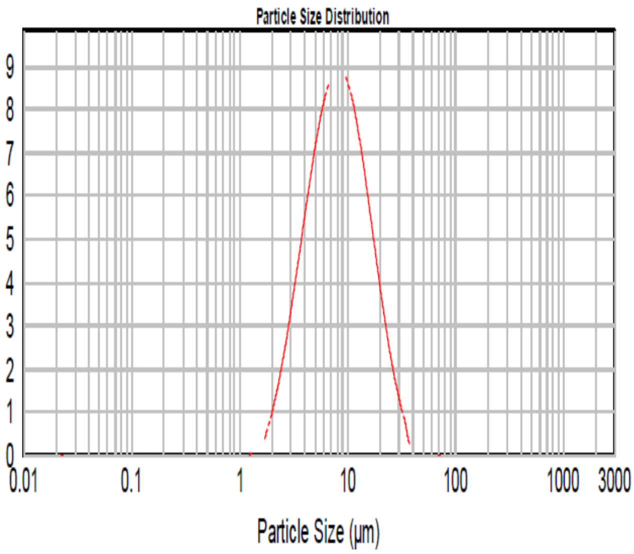

Fig.1. Particle size distribution curve of F.A

Scanning Electron Microscope (SEM)

Cambridge Stereoscan 200 was used to study morphology of F.A particles. Examination under scanning electron microscope showed that samples had usual fly ash morphology and were composed of mostly small, spherical particles. Fig. 2 and 3 show SEM micrographs of the F.A particle. It can be noticed that fly ash sample consists of almost regular spherical particles (RSP) ranging 2 µm to 12 µm in diameter. Usually, F.A composed of mostly small and spherical particles [13].

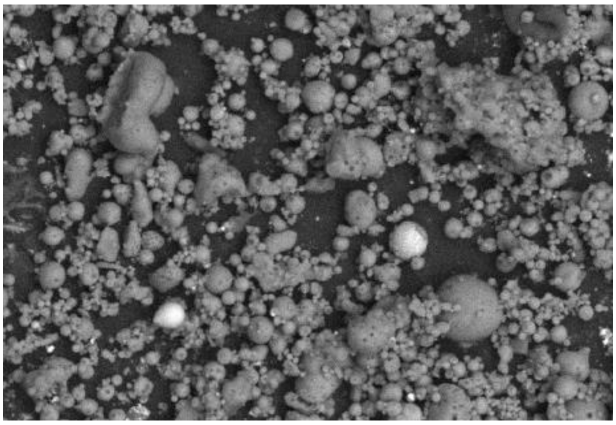

Fig. 2 SEM of fly ash (NTPC Dadri), Magnification at 1000x

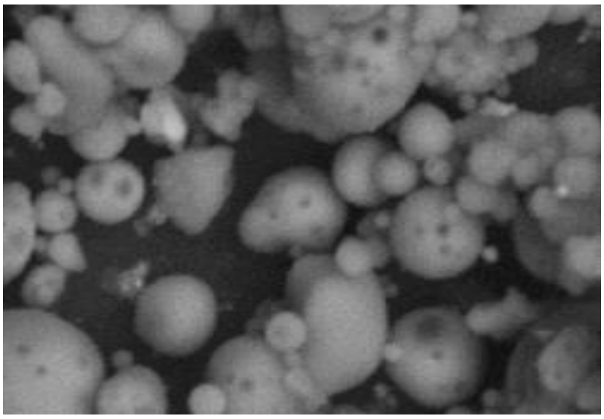

Fig.3. SEM of fly ash (NTPC Dadri), Magnification at 5000x

Mineral Composition

The sample has been appraised for its mineralogical composition by X-ray diffraction (XRD) [14] spectrometer (Shidmazu), with graphite mono-chromator and Fe Ka radiation. The sample is scanned from 2q of 0 ± 80°. The investigation match ICDD data records have been used for recognition of minerals present in sample (Fig. 4 and table 3).

Table 3: NTPC Dadri

Zones	Highest Peak Value	Lowest Peak Value	Mean Value
0-30	26.876	20.977	23.926
30-60	57.641	30.991	44.316
60-90	79.873	59.857	69.865

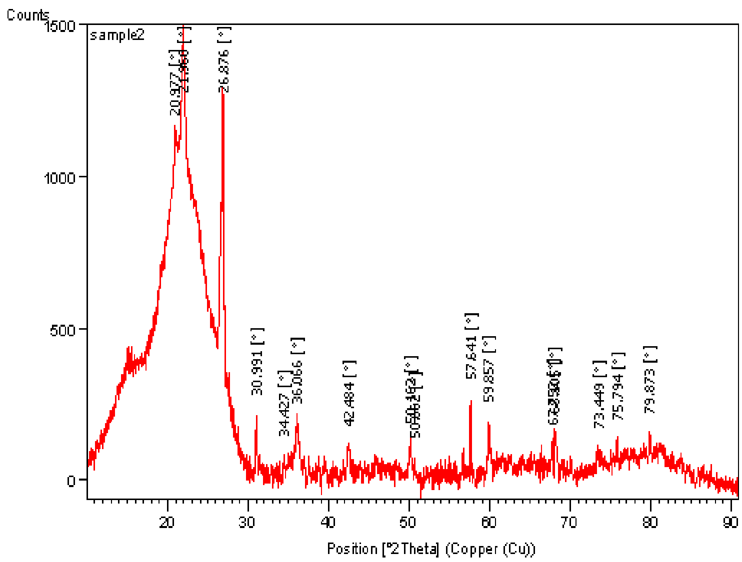

Fig. 4: F.A sample of NTPC Dadri

III. RESULT AND DISCUSSION

Results of the tests conducted, and mentioned above, on the F.A sample are being presented in this following report. The results of XRF study are presented in Table 1. It can be noticed that for F.A sample, the percentage of SiO_2, Al_2O_3, and Fe_2O_3 is 58.0%, 20.0%, and 4.6 %, respectively. Fig. 1 presents particle size distribution of F.A sample using a laser particle size analyzer. From Fig. 1, it can be noticed that F.A sample consists of particles with diameter ranging from 2 µm to 12 µm. However, few particles with maximum diameter of 14 µm are also noticed in the sample. Fig. 4 shows the X-ray diffraction pattern of the F.A sample. From figure, presence of quartz, mullite and cristobelite can be noticed. However, quartz is the most predominant mineral present in F.A sample. The average specific gravity of F.A sample is found to be 2.275 as shown in table 2. The average particle size of F.A sample is 6.90 µm. X-ray diffraction (XRD) spectrometer showed that highest and lowest peaks are 79.873 and 59.857 in 60-90 zone.

IV. CONCLUSION

The results obtained from this chemical categorization study confirm the fact that coal F.A found in NTPC Dadri samples have high percentage oxides of Si, Al, Fe and Ca and therefore makes them good applicants for industrial application. F.A is the remains from the combustion of bituminous coal, normally as a result of production of electricity at NTPC plant. In India about 60-70 % of national electricity is provide by thermal power plant that is using coal as fuel. As a result it will create 15 to 20 tones FA / hour. Millions of tons of F.A formed per year due to immense expenditure of coal. The industry is facing trouble to develop competent and economical procedure recycles these materials. Recycling of F.A will preserve natural raw materials and condense disposal rate. It will also produce new revenues and business occasions while shielding the environment. Chemical compositions of sample have been inspected and F.A is of ASTM C618 Class F. With problem of ash management and leachate contamination of groundwater, coal F.A dumping on land or lagoons should be depressed. This study has instead supplied information to enable sustainable use of coal F.A in various industries such as construction industry, zeolite synthesis, ceramic industry catalysis, waste-water management and valuable metal recovery. Our next examination is on the potential use of the coal F.A in water treatment and to compare it to traditional water treatment processes.

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