Coal Flyash – Environmental Impact and Utilization: A Review

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Coal flyash is the residue of coal combustion in coal fired power generations. When coal is totally burnt, the constituents of coal viz., principally the oxides of silica and alumina convert into flyash. About 80% of the ash flies along with flue gases and gets entrapped into bag filters or electrostatic precipitators and is identified as flyash. The paper reviews the physic-chemical characteristics of flyash and its environmental impact as well as utilization. It also presents the characteristics of flyash as mould wash in a foundry.

Physico – Chemical Properties of coal Flyash

The physical and chemical properties of coal flyash depend on the composition of the parent coal, conditions during coal combustion, efficiency of emission control devices, storage and handling of the by-product and climate. Microanalysis of flyash shows that it consists primarily of spherical particles of impure alumino silicate glass. The particle size varies from sub-micrometers to 100µm[1]. In one analysis, coulter multisizer was used to determine the size distribution in the particle range of 1-200µm diameter[2]. In another study, interference contrast polarized light microscopy (ICT-PLM) and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDM) had been used and it was found that most of the glassy spheres were between 8 and 50 µm diameter [3]. Upto 75 µm particle diameter sized fractions of flyash had surface areas ranging from 1.27 to 0.45 m^2/g and densities ranging from 2.0 to 2.8 g/cm^3.

Flyash can be separated into three major matrices: glass, mulite-quartz, and magnetite spinal. The ratio of crystalline material to glassy, amorphous material increases with particle size. Magnetic spinel fraction of the ash is important due to its greater reactivity and potential for carrying and releasing toxic elements. The major constituents of the magnetic matrix are magnetite, hematite, ferrite, sulphates and carbonates [5, 6]. Flyashes produced from anthracite, bituminous

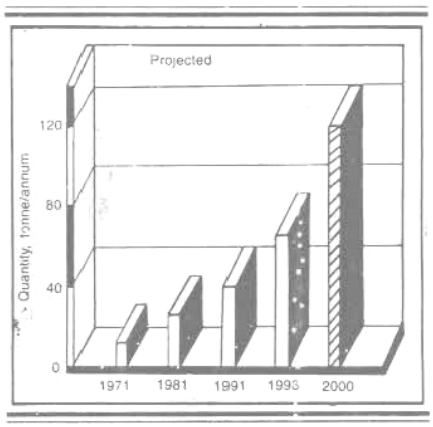

Fig. 1 Estimation of flyash

and lignite coals vary in their chemical composition temperature. One analysis, flyash was examined by X-ray diffractometer (XRD), Thermo Gravimetric Analyzer (TGA), Fourier Transformed Infra Red Spectro Photometer (FTIR) and Scanning Force Microscopy (SFM) [7, 8]. The XRD and FTIR data indicated that the bulk of flyash was composed of mulite, quartz, cristobalite, amorphous alumino-silicates. The TGA indicated a negligible amount of absorbed water in the amorphous alumino silicate phases. The SFM of the bulk flyash showed the presence of amorphous glassy surface and quartz. The amorphous component increased with the decreasing particle fractions. Therefore, the chemical reactivity of flyash will increase with the decreasing particle size. The chemical analysis of flyash is as shown in table 1. The particle size of flyash is 45µm.

Impact on Environment

Improper disposal of flyash to settling ponds may cause environmental contamination, some of heavy metals that are present in flyash, if present in high concentration, are phytotoxic, others are toxic to fish and aquatic organisms. The environmental contamination due to leaching of heavy metals from coal flyash ponds are: phytotoxicity, contamination of soils, and vegetation, ground and surface water pollution.

Coal Flyash Utilization

The flyash of India coals is being used in the production of Portland Pozzolana cement (PPC). With the production of 43 and 53 grades now and opportunities to produce even 63 grades in near future, the scope of blending more flyash has brightened. This encourages to open up opportunities for more flyash input. However, it needs to be ensured that the required grade of flyash is available. This may be achieved through promotion of dry ash collection and delivery system at all thermal power stations.

Fal-G technology has established manufacturing flyash bricks with wide range of strengths from 80 to 300 kg/cm^2. the ease of production is established even at cottage industry level. Even in, mechanization the need of investment ranges from Rs. 2 to 4 lakhs for output of 6000 bricks/shift. Fal-G bricks are providing to be technically superior and competitive in price as compared to clay bricks.

Various sectors like textile, paper and dyeing industries discharge their hazardous coloured dye effluents mainly due to unavailability of a simple as well as cost-effective treatment process and cause large

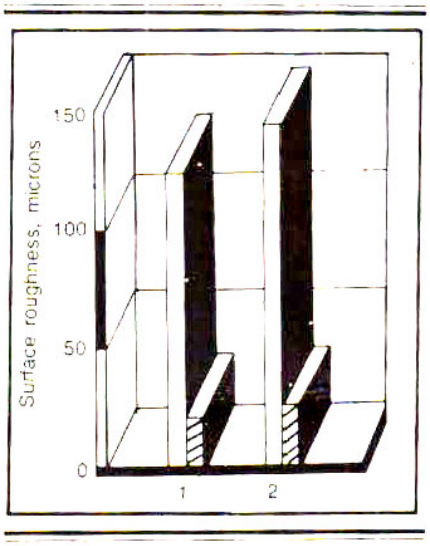

Fig 2. Effect of flyash on surface roughness
1. Al-12% Si alloy, 2. Grey cast iron
☐ Castings without mould wash
☒ Castings with mould wash

scale pollution of environment. Flyash contains SiO_2, Al_2O_3, CaO, Fe_2O_3 and their complexes namely quartz, mullite, spinel, rutile and hematite along with some unburnt carbon in varying amounts. Most of these ingredients of flyash are frequently used to catalyse the aqueous phase decomposition of H_2O_2 in the course of peroxidative degradation of hazardous industrial waste waters to environmentally dischargeable effluents. Flyash therefore seems to be an active and cheap heterogeneous catalyst in the treatment of hazardous industrial effluents using H_2O_2.

The other avenue of flyash use is a land fill and road full.

The effect of flyash as mould wash on the surface finish of various castings was investigated using flyash of 45µm diameter on green sad moulds; the surface roughness of castings as shown in fig.2 was greatly decreased.

Table-1
Chemical Analysis of Coal Flyash

Sl.	Particular	Per cent by weight
1	Sio_2	60.65
2	Al_2o_3	24.25
3	Fe_2O_3	3.35
4	Cao	2.30
5	Mgo	1.39
6	Tio	1.20
7	$K_2o + Na_2O$	3.28
8	V	200 PPM
9	Cr	1250 PPM
10	Ni	860 PPM
11	Co	73 PPM
12	Mo	128 PPM
13	Pb	115 PPM
14	Sn	18 PPM
15	As	112 PPM
16	B	88 PPM
17	Cd	15 PPM
18	Hg	0.008 PPM

Conclusions

Flyash is disposed of in land with high environmental risk. The properties of flyash vary considerably due to several factors during coal combustion. Most flyash is in particle diameter range of 1-200 µm. the three major mineralogical matrices identified in flyash are glass, mulite and magnetic spinel. Trace elements of mainly concentrated on the surface of flyash. Improper disposal of coal flyash causes contamination of ground and surface water. Because of high volume of coal ash produced through coal combustion process, associated expenses of disposal, and more recently because of concern about possible environmental effects, pressures to find ways to safety mansgae and ruse flyash and ruse flyash and recover potentially valuable components that it contains have increased. Certain uses of flyash are flyash cement, flyash bricks, land and road fills, heterogeneous catalyst in peroxidative degradation of aqueous dye solutions and mould wash in foundry.

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