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NOTE

Effect of Different Additives on Viscosity and Flow Behaviour of Fly Ash Slurries

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The quantity of fly ash produced in such power stations is quite enormous. The ash produced in such power stations is at present being disposed to mid sea if the power station is situated near the sea. Otherwise it is disposed in some waste lands. The ash produced in power stations is being mostly transported in the form of water slurry by pumping. Enormous quantity of water is being used for such transportation. From the economical point of view, it is worthwhile to explore the possibilities of reducing this enormous quantity of water being used for slurry making. This is possible only if the solid content of ash-slurry is increased thereby reducing the quantity of water used and at the same time the slurry becomes easily pumpable using slurry pumps. Loading higher solids in ash water slurries becomes possible only if the viscosity of the slurry is reduced by adding surface active agents. An attempt has been made in this study to assess the effect of organic polymers which are surfactants in reducing the viscosity of the ash water slurries. It is proposed to study the combined effect of mineral matter in ash, and different types of organic polymeric substances on the viscosities if ash-water slurries. The results obtained and discussed herein suggest that the organic polymeric substances as additives reduce the viscosity of the ash-water slurries with better reliability.

There are around 75 thermal power plants in the country which currently produce about 60 million tonnes of fly ash per annum. Fly ash is the most harmful environment pollutant. At present huge investments or expenditures are involved in removing fly ash from thermal power plants and dumping it. Actually 2% of the cost of thermal power plants goes towards fly ash disposal systems, like approximately Rs. 20 crores goes in a 210 MW plant. So in the existing 75 thermal power plants, around Rs. 850 crores have been invested just to remove the fly ash. Therefore the fly ash should be transported in the form of slurry which provides a number of spin off benefits, which are listed below.

- Environmental pollution control
- Utilization of minimum space for dumping
- Expenditure employed is less compared to other sources of transportation.

The present work was undertaken to study the preparation of ash-water slurries with respect to two different ash samples. The physical properties of the ash and

its chemical composition influence the solubility of the corresponding ash in water. Viscosities of various slurries with respect to different solid loadings in them were also evaluated[1]. Several additives were utilized to modify the flow behaviour of the slurries and the corresponding viscosity characteristics were evaluated[2].

Initially the loss on ignition[3] (LOI) studied and the two samples were analyzed for SiO_2, Al_2O_3, Fe_2O_3, TiO_2, CaO, MgO, Na_2O, K_2O, SO_3.

The SiO_2, Al_2O_3, Fe_2O_3 and CaO values are normally high which suggest that the particle size of these samples is also high. Particle size analysis is done by the following experimental procedure.

The mesh sieves are kept one below the other in the following sequence: (i) +50 mm, +100 mm, +200 mm, +300 mm, +400 mm and an empty bowl denotes the –400 mm. 25 mL of fly ash sample is taken and transferred to the top of the sieve, and mechanically sieved[4] for 5 to 10 min. After that one by one the content present in each of the mesh sieve is weighed and from that the percentage in each sieve is found out (Table-2).

TABLE-1
THE DATA OF ASH COMPOSITION ANALYSIS

Constituents	% Composition	
	Sample 1	Sample 2
SiO_2	68.10	60.00
Al_2O_3	19.20	22.00
Fe_2O_3	8.90	11.60
TiO_2	0.10	0.40
CaO	2.70	3.50
MgO	0.03	0.03
Na_2O	0.10	0.10
K_2O	0.10	0.10
SO_3	0.05	0.04

TABLE-2
THE MESH SIZE AND THE RESPECTIVE WEIGHT IN PERCENTAGE IN EACH SIEVE

Sample 1		Sample 2	
Mesh size in mm	Percentage	Mesh size in mm	Percentage
+500	1.2	+50	4.0
+100	4.0	+100	10.4
+200	41.5	+200	28.4
+300	27.0	+300	39.2
+400	14.5	+400	10.8
–400	11.6	–400	7.2

TABLE-3
COMPARATIVE STUDY OF VARIATION OF VISCOSITY WITH SHEAR RATE OF ASH WATER SLURRY WITH AND WITHOUT ADDITIVES

Series of testing	Viscosity values Eta [cp]			
	Sample 1		Sample 2	
	without additive (centipoise)	with additive (centipoise)	without additive (centipoise)	with additive (centipoise)
1.	386.3	1465.3	360.4	9871.6
2.	216.5	693.1	334.8	5676.3
3.	217.4	689.0	217.8	3635.7
4.	223.4	669.0	220.6	1637.3
5.	208.6	657.0	205.4	684.9
6.	197.7	571.5	180.4	640.2
7.	195.2	569.7	160.2	610.4

In viscosity measurements[5], viscometry deals with the measurement of the flow behaviour of liquids including those showing a visco-elastic behaviour[6], by calculating the shear stress, shear rate and kinematic viscosity[7]. The slurry is prepared with an additive which further reduces the viscosity to an appreciable extent, which should be pumpable. Again the values are taken and the shear stress and shear rate are tabulated.

The viscosity of the ash-water slurry without additive decreases gradually and attains a minimum value of 195.2 centipoise. Using the additive the viscosity decreases from a maximum of 1465.3 (cp) to 569.7 (cp), for first sample. But for second sample the viscosity of the ash-water slurry without additive decreases gradually and attains a minimum value of 160.2 (cp). Using the additive, the viscosity decreases from a maximum of 9871.6 (cp) to 610.4 (cp).

The effect of various additives on the viscosity of two ash-water slurries: Polyacrylic acid has a greater tendency to reduce the viscosity. It is observed that the solubility is decreased and the results obtained are in good agreement for the second sample.

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