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Effective Test Studies on Fly Ash Fragments

Arunkumar.G
M.Tech (Thermal Engineering), PRIST University, Thanjavur,

ABSTRACT

In our Country, maximum electrical energy is obtained from thermal power plants which creates tones of fly ash accumulates in the power plants. Now fly ash is carried out in pipe lines which took 90% of water with high energy input. The aim of this study was to evaluate fly ash characterization-mainly size of particle distribution, material density, sedimentation tests, rheological analysis for measuring viscosity, and pipe loop tests studies in specific diameter pipes for the 150 MW and 120 MW power plant ash samples generated at Thermal power plant Tamilnadu. The sedimentation tests conducted on the two ash samples for the proposed HCSD systems . The rheological analysis to check viscosity to be carried out The pipe loop tests conducted in specific diameter pipes using the two ash samples indicated that it is quite feasible to transport the ash slurry at higher solids concentration in turn saves energy and most precious water.

Keywords: ***Rheology, Fly ash, viscosity***

INTRODUCTION

In Our country the only natural resource is coal and fossil fuel available in plentiful. Accordingly it is used widely as a thermal energy source and also as fuel of producing electricity for thermal power plants. With the blast of population and industrial growth, the requirement for power has altered manifold. Almost 83% of Our country's total installed power generation capacity is thermal, of which 95% is coal-based generation, with diesel, wind, gas and steam making up the rest. To fulfill the projected demand in 2017-18, the requirement of additional capacity of about 9,800 MW is demanded Thermal power generation is anticipated to continue to play a major role in power generation sector. The main problem in using coal is low calorific value and contains very high ash. The ash content is as high as 65-70%, with an average value of about 45-50%. Huge amount of coal ash produced due to low calorific value and ash content up to 50% of Our countryn coals of 6-7 tonnes per MW per day. Alternatively, many power stations in developed countries create far lower quantum of ash, about 0.7-0.8 tonnes per MW per day due to high calorific value and lower ash content around 12% in their coals.

Fly ash is obtained in huge quantities in thermal power stations and constitutes about 90% of the total ash produced. The rest 10% of the ash is in granular form and poses no threat to the environment or any disposal problems. The fly ash being of the fine size is environment pollutants and need to be transported with utmost care so that they don't cause any hazard to the ambience. This is generally done in the ash handling plant employing electrostatic precipitators and transported to places of its utilization using hydraulic transportation through pipelines.

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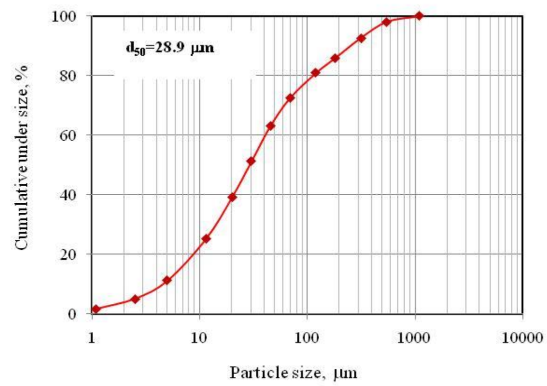
This process has been accepted as an economic and efficient method of transportation of fly ash also. A majority of power plants in our country have installed short pipelines for the transportation of fly ash to the disposal ponds. Unfortunately this transportation is being done at low concentrations of solids, generally in the range of 10-20% by weight. This is extremely uneconomical as it results in the high requirement of carrier water and high operational cost since the power consumption for transporting until weight of fly ash through unit distance. Besides, this high concentration fly ash slurry can be effectively used for back filling the coal mine cavities. Hence the hazard posed by fly ash can be controlled to a great extent. The present investigation aims at establishing the feasibility of a fly ash slurry handling system with pipeline transportation of fly ash slurry at higher concentrations in order to provide an Eco-friendly, economical and effective process of fly ash disposal.

Particle Size Distribution of ash samples

The particle size distribution of different ash samples supplied for the proposed high concentration ash disposal pumping stations were carried out using Malvern Particle Size Analyzer and standard BS sieves.



RHEOLOGICAL STUDIES

The rheological studies for the two ash samples (proposed ash slurry pumping stations 1 & 2) were conducted using a Haake rheometer (Model: RheoStress 1) in the slurry concentration range of 65-70% by weight. The shear rate-shear stress data obtained for the two ash samples at different weight concentrations and the rheogram of two ash samples

Rheology of ash slurry, C_W=70%

Shear rate, s^{-1}			Apparent
1.		Shear stress, Pa	viscosity, as.
2.	7.51	13.24	1.763
3.	13.81	17.34	1.26
4.	20.76	20.77	1
5.	27.73	26.25	0.095
6.	34.35	27.95	0.813
7.	41.34	30.06	0.727
8.	48.32	31.8	0.658
9.	55.12	33.3	0.604
10.	62.28	34.56	0.555
11.	69.06	36.52	0.529
12.	75.88	38.18	0.503
13.	82.68	39.47	0.477
14.	89.65	40.7	0.454
15.	96.62	43.2	0.447
16.	103.6	44.18	0.426
17.	110.4	47.18	0.427
18.	117.2	47.22	0.403
19.	124.2	48.64	0.392
20.	131.2	49.69	0.379
21.	138	50.68	0.367
22.	144.8	51.71	0.357
23.	151.8	52.72	0.347
24.	158.8	53.4	0.336

25.	165.8	54.22	0.327
26.	172.5	54.77	0.318
27.	179.6	55.21	0.307
28.	186.5	55.82	0.299
29.	193.3	56.44	0.292
30.	200	56.73	0.284

DESIGN PARAMETERS AND SPECIFIC POWER CONSUMPTION OF ASH SAMPLES

In order to transport the ash slurry at high solids concentration, the various hydraulic and design parameters such as slurry head loss, solids conveying rate, specific power consumption, hydraulic power requirements, specific power consumption (SPC) etc. have been evaluated. In the present study three candidate pipes having nominal diameters of 100, 150 and 200 mm are considered. Since the slurry head loss data in Specific diameter pipes quite satisfactorily agree with the power law head loss model developed by IMMT, therefore, this power law model was used to compute the head loss of ash slurry in higher size pipelines.

Solids Flow rate

$$W_S = Q.\rho_m .C_W$$

Where W_S is solids flow rate (tonnes/hr.)
Q = Slurry flow rate (m^3/hr.)
ρ_m = slurry density (tonnes/m^3)
C_W =weight concentration of solids, (fraction)
D =pipe inside diameter (m)

Specific Power Consumption (SPC)

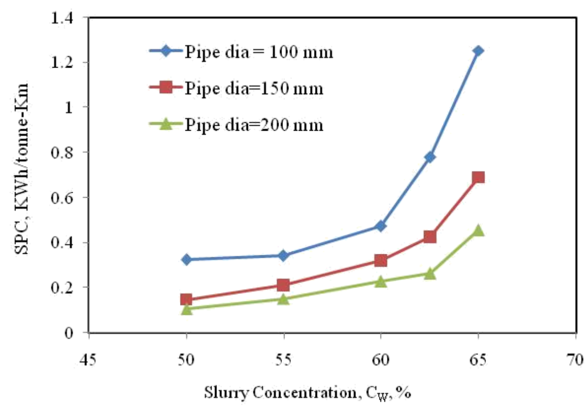
$$SPC = \frac{P_H}{W_S} \quad \text{(kWH/tonne-km)}$$

P_H =Hydraulic power (KW)

W_S is the solids flow rate through the pipe line, the specific power consumption

Optimum transport concentration

The transport concentration of the mixed ash slurry for the two proposed pumping stations were optimized with respect to specific power consumption. The computed values of SPC obtained for the two ash samples at different slurry concentrations



Pumping Station-1 mixed ash samples increases with increase in slurry concentration for the three candidate pipes considered. The SPC value is found to be minimum at C_W=50% and the SPC value increases gradually and steadily up to a slurry concentration of 60%. Beyond a slurry concentration of 60% by weight, the SPC value sharply rises. Therefore, for hydraulic disposal of the proposed Pumping Station-1, the optimum transport concentration range of 50-60% may be considered suitable for operating the ash slurry pipelines from specific power consumption point of view.

It is further observed that the SPC value is minimum at a slurry concentration of 55% for the proposed Pumping Station-2 mixed ash samples. Beyond a slurry concentration of 70%, the SPC value increases sharply for the three candidate pipes considered. Therefore, it is recommended, to transport the mixed ash slurry for the proposed Pumping Station-2 at a slurry concentration of 65% to have substantial pipe economics.

CONCLUSIONS

The chemical analysis of the mixed ash samples for the two proposed Pumping Stations indicated that the alumina and silica contents of the mixed ash samples of Pumping Station-2 is higher than that of Pumping Station-1. The alumina and silica contents of Pumping Station-1 are 42.65% and 62.25% respectively. Similarly, the alumina and silica contents of Pumping Station-2 are 32.87% and 65.5% respectively.

The particle size distribution of the ash samples procured from various sources of generation indicated that the ash samples of AFBC boilers are comparatively coarser in nature than those of CFBC boilers. The ESP ash samples of both AFBC and CFBC boilers, WHRB ash samples and de-dusting ash samples are relatively finer in nature and the median particle sizes (d_{50}) of these ash samples were found to be in the range of 18-36 **µ**m. The d_{50} of Economizer ash samples from CFBC and AFBC boilers were determined to be 64.6 **µ**m and 285.8 **µ**m respectively. The particle sizes of the bed ash generated in both the cases are quite large. The median particle size (d_{50}) of CFBC bed ash and AFBC bed ash samples were found to be 390 **µ**m and 550 **µ**m respectively. The particle size of air pre-heater ash samples generated in AFBC boilers was also quite large and the d_{50} of this APH ash was found to be 346 µm.

The particle size distribution of the mixed ash samples for the proposed two HCSD pumping stations indicated that the mixed ash samples of Pumping Station-1 is relatively finer than that of Pumping Station-2.

The ash samples of the Proposed Pumping Station-2 were found to be acidic in nature while the ash samples of the Proposed Pumping Station-1 were found to be alkaline in nature.

It was observed from the maximum static settled concentration tests (sedimentation tests) that the mixed ash slurry at the proposed Pumping Station-2 can be transported at higher solids concentration than that of Pumping Station-1. The C_{W-max} value achieved by the mixed ash samples of Pumping Station-1 and 2 were found to be 70.15% and 71.48% respectively.

The rheological studies conducted on the ash samples in the slurry concentration range of 65-75% by weight quite reasonably fitted to power law model. The viscosity ash slurry increased with increase in slurry concentration.

The pipe loop tests conducted in specific mm dia pipe using the high concentration slurry test loop facility at IMMT indicated that mixed ash slurry samples of the proposed HCSD Pumping Station-1 incurred higher head loss/pressure drop than that of Pumping Station-2 in the studied concentration range of 65-70% by weight.

The Specific Power Consumption (SPC) values evaluated for three candidate pipe sizes 100 mm , 150 mm and 200 mm indicated that the SPC values were quite high for operating the pipe lines beyond a slurry concentration of 70% by weight (Pumping Station 1 and 2). The computed values of SPC for the proposed Pumping Station-1 mixed ash samples indicated higher values than that of Pumping Station-2.

Therefore, it is recommended that the proposed HCSD system at Pumping Station-1 may be operated in the slurry concentration range of 60-65% while the Pumping Station-2 may be operated at a slurry concentration of 65% by weight to have substantial pipe economics from specific power consumption point of view.

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