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Pressure Drop Analysis of Water and Bottom Ash Mixture Flow Through Straight Pipeline With Additive

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Abstract: *All the available coals have some percentage of ash. When the coal is burnt about 10 to 20% of quantity of coal used results in ash. In the modern large steam power plants where huge amounts of coal are used, the amount of ash may be go up to many thousands tonnes of ash per year. A slurry transport system is used to disposal the coal ash away from coal burning unit in thermal power plant. Bottom ash slurry is pumped from the common ash slurry sump to the dyke area which is located near slurry pump house. Water and bottom ash are mixed in slurry tank, after that slurry transportation takes place in slurry pipeline with the help of slurry pump. Computational simulation is performed on the slurry flow through pipeline for the analysis of pressure drop. When fluid flows through a pipe, it is subjected to hydraulic resistances which are of viscous frictional resistance and local resistance. Viscous frictional resistance associated with the fluid flow is called major loss of energy. Pressure drop can be reduced in pipe flow by mixing the additive in slurry. Local resistances are essentially due to change of velocity either in magnitude or direction. Modelling of pipeline is developed in Gambit and Fluent is used for the numerical evaluation. Computational simulation has been performed on various concentrations and flow velocities.*

Keywords: *Computational Fluid Dynamics, Finite Volume Method, Slurry Transportation System*

I INTRODUCTION

Ashes coming out after the combustion of pulverized coal in thermal power plants are divided into two main categories first fly ash and second bottom ash. Fly ash is the finest of coal ash particles. It is called fly ash because it is transported from the combustion chamber by exhaust gases. Fly ash is the fine powder formed from the mineral matter in coal, consisting of the non combustible matter in coal [1]. Bottom and fly ash are quite different physically, mineralogical, and chemically [2]. Bottom ash is a coarse, granular, incombustible product that is collected from the bottom of furnaces. The mixture of solids and liquids is known as slurry. The physical characteristics of slurry are dependent on many factors such as particle size distribution, solid concentration in the liquid phase, turbulence level, temperature, conduit size, and viscosity of the carrier [3,4]. Slurry is a mixture of a solid particles and fluid held in suspension. [5] Water is the most commonly used fluid. The speed of slurry flow is sufficiently high to maintain the particles in suspension. Slurry transportation through pipeline provides better effect on material transportation system. This system has various advantages such as very less pollution and less noise. So, there is requirement of detailed study of pipeline slurry transportation system to improve its performance. Slurry pipelines are used to transport solid materials using water for short or long distances [6]. These pipelines are used in many industrial applications involving transportation of coal and disposal of slurry in thermal power plant. In the present work, Rheological properties of bottom and fly ash are studied to know the flow behaviour of coal slurry. The Rheological properties of slurry depend on a number of factors such as particle size distribution, pH value and settling characteristics [7]. Rheometer is used to know the shear rate and shear stress variation for the different concentrations of slurry. Computational simulation is performed on the slurry flow through pipeline for the analysis of pressure drop in pipeline [8]. Computational Fluid Dynamic [CFD] is the analysis of system involving fluid flow by means of computer based simulation [9]. Computational fluid dynamics is one of the branches of fluid mechanics that uses numerical methods and algorithms to solve and analyse problems that involve fluid flows. It has become an indispensable tool in the design, development, evaluation and refinement of new industrial equipment and processes.

II COMPUTATIONAL SIMULATION OF PIPELINE

Computational Fluid Dynamic [CFD] is the analysis of system involving fluid flow by means of computer based simulation. Computers are used to perform the calculations required to simulate the interaction

of liquids with surfaces defined by boundary conditions [10,11]. Computational fluid dynamics is one of the branches of fluid mechanics that uses numerical methods and algorithms to solve and analyse problems that involve fluid flows. It has become an indispensable tool in the design, development, evaluation and refinement of new industrial equipment and processes [12]. The use of computational fluid dynamic reduces the development cost of new products and cuts the time to market of these products [13].

III METHODOLOGY

There are different steps to solve a computational fluid dynamics problem (Figure 1).

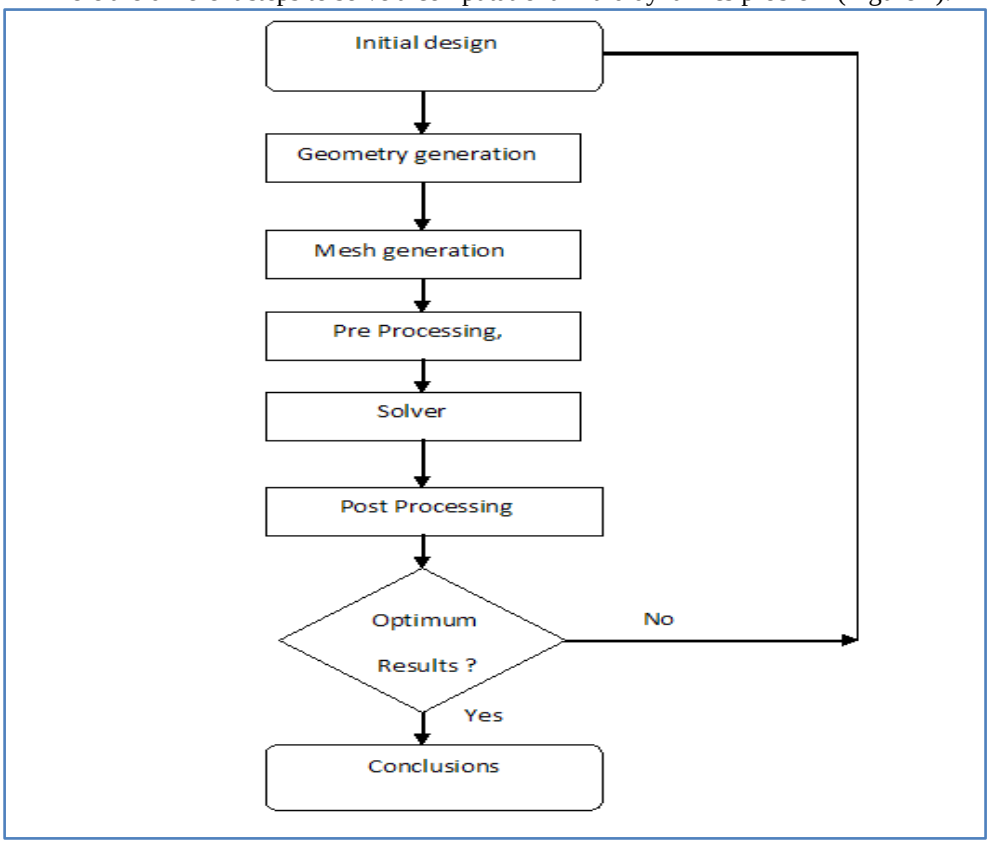

Fig.1.Methodology

IV SIMULATION RESULTS OF STRAIGHT PIPE

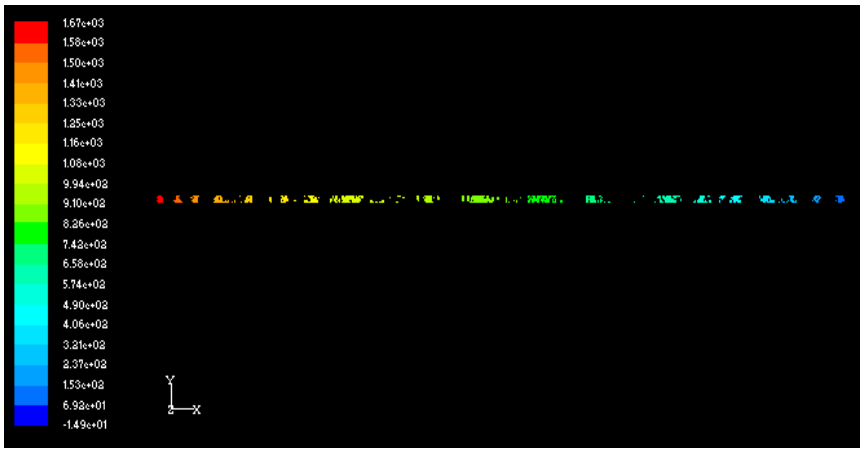

Fig.2. Pressure Display of Bottom Ash at 40% Concentration in 100 meters Straight Pipe

The figure 2 shows that pressure drop in 100 meter straight pipe is increased from inlet to outlet. When concentration of bottom ash is increased in slurry then pressure in pipe is also increased. Pressure will be increase, when velocity of slurry in straight pipe will be increase. It can be observed that pressure loss difference at high velocities is considerably more than pressure loss difference at low velocities.

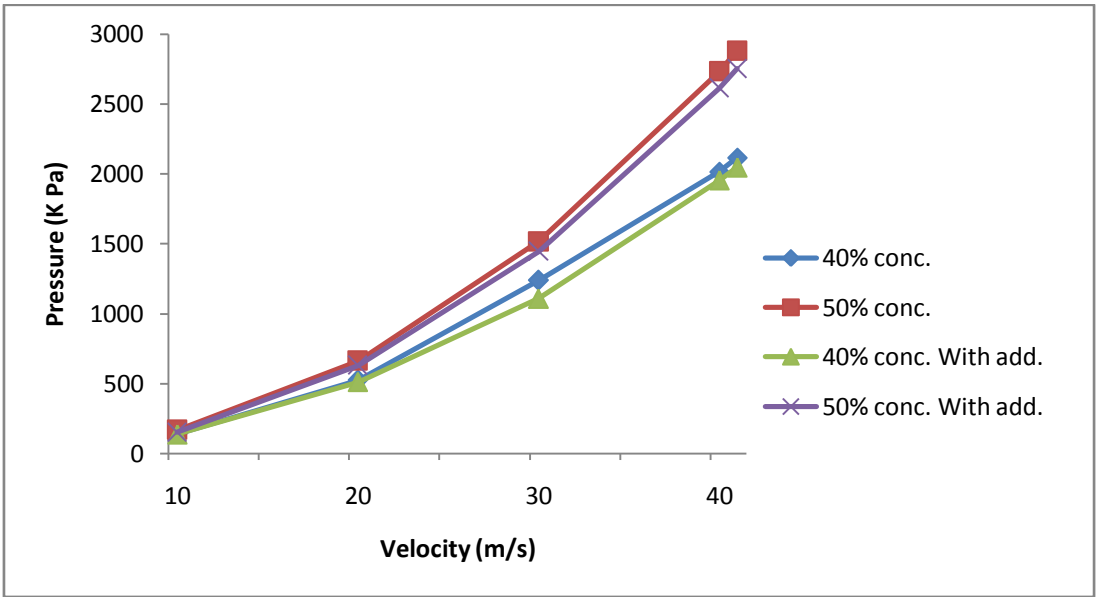

Fig.3. Pressure Drop per 100 meter Length with Different Flow Velocity and % Concentration for Water and Bottom Ash Mixture with 2% Additive in Straight Pipe

Table.1. Pressure Drop per 100 meter Length with Different Flow Velocity and % Concentration for Water and Bottom Ash Mixture with 2% Additive in Straight Pipe

Velocity [m/s]	Pressure [k Pa] 40%	Pressure(Additive) [k Pa] 40%	Pressure [k Pa] 50%	Pressure(additive) [k Pa] 50%
10	139.87	136.54	167.31	151.41
20	524.09	510.65	661.98	630.63
30	1138.65	1109.46	1515.55	1445.52
40	2019.05	1953.96	2742.48	2613.01
41	2125.06	2048.27	2890.57	2752.08

V. Conclusion

The present paper investigated the effect of different parameters such as concentration and velocity in straight pipe. The findings showed that pressure drop per 100 meter length across the straight pipe increases as increase in concentrations and flow velocities. Further, results indicated that pressure drop was achieved 2752.08 k Pa at 50% concentration and velocity having 41 m/sec.

References

[1] C. Logos, Q.D. Nguyen [1996] "Effect of particle size on the flow properties of South Austriala coal water slurry", *Power technology*, Vol-88, pp. 55-58.

[2] Zeki Aktas, E.Ted Woodburn [2000] "Effect of addition of surface active agent on the viscosity of a high concentration slurry of a low-rank British coal in water", *Fuel Processing Technology*, Vol-62, pp. 1–15.

[3] Hiromoto Usui, Lei Li and Hiroshi Suzuki [2001] "Rheology and pipeline transportation of dense fly ash-water slurry", *Korea-Australia rheology journal*, Vol- 13, pp. 47-54.

[4] E. Harmadi, Suwarmin, S. Machmudah, and S. Winardi [2002] "Effect Of Particle Size Distribution On Rheology And Stability Of High Concentration Coal-Water Mixture (Cwm) With Indonesian Low Rank Coal", *Jurnal teknik mesin*, Vol-2, pp. 3-98.

[5] F. Boylu, H. Dinc¸er, G. Atesok[2003] "Effect of coal particle size distribution, volumefraction and rank on the rheology of coal–water slurries", *Fuel Processing Technology*, Vol-85, pp. 241–250.
[6] A. Al- Sarkhi and A. Solemani [2004] "Effect of drag reducing polymers on two-phase gas –liquid flows in a horizontal pipe", *Chemical engineering research and design*, Vol-82, pp. 1583-1588.
[7] Ibrahim Can [2005] "Simplified equations calculate head losses in commercial pipes", *The Journal of American Science*, Vol-1, pp. 1-3.
[8] Abhai Kumar Verma, S N Singh and Seshadri [2006] "Pressure drop for high concentration solid-liquid mixture across 90° horizontal circular pipe bend", *Indian journal of engineering & material sciences*, Vol-13, pp. 477-483.
[9] K. Ekambara, R.S. Sanders, K. Nandakumar, J.H. Masliyah [2008] "CFD simulation of bubbly two-phase flow in horizontal pipes", *Chemical Engineering Journal*, Vol-144, pp. 277–288.
[10] Naik, H.K ,Mishra, M.K. and Roa Karanam [2009] "Rhelogical characteristic of fly ash slurry at varying temperature environment with and without additive", *world of coal ash conference, Lexington,KY, USA.*
[11] P.K. Senapati , B.K. Mishra, A. Parida [2010] "Modeling of viscosity for power plant ash slurry at higher concentrations: Effect of solids volume fraction, particle size and hydrodynamic interactions", *Powder technology*, Vol-197, pp. 1–8.
[12] Naik, M.K.Mishra and Roa Karanam [2011] "Evaluation of flow characteristics of fly ash slurry at 40% solid concentration with and without an additive", *World of coal ash conference in Denver, CO, USA.*
[13] Kunal Singh, Kundan Lal [2012] "Effect of cetylpyridinium chloride,Triton x-100 and sodium dodecyl sulphate on rheology of fly ash slurry", *International journal of scientific and research publications*, Vol-2, pp. 2250-3153.
[14] Stefan Nicolici, Ilie Prisecaru, Daniel Dupleac [2013] "Two-phase flow CFD modeling for evaluation of particulate erosion", *U.P.B. Sci. Bull., Series D*, Vol-75, pp. 1-3.