

**INVESTIGATIONS OF THE FLOW OF MULTISIZED
HETEROGENEOUS SLURRIES IN STRAIGHT
PIPE AND PIPE BENDS**

by

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Thesis submitted

in fulfilment of the requirements for

the degree of

DOCTOR OF PHILOSOPHY



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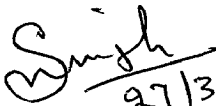
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CERTIFICATE

This is to certify that the thesis entitled "INVESTIGATIONS OF THE FLOW OF MULTISIZED HETEROGENEOUS SLURRIES IN STRAIGHT PIPE AND PIPE BENDS" being submitted by Mukhtar Ahmad to the Indian Institute of Technology, Delhi (India) for the award of the degree of Doctor of Philosophy in Applied Mechanics Department is a bonafide research work carried out by him under our supervision and guidance. The thesis in our opinion, has reached the standard fulfilling the requirements for the Doctor of Philosophy Degree. The research report and the results presented in this thesis have not been submitted in parts or in full to any other University or Institute for the award of any degree or diploma.


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ABSTRACT

Slurry pipeline transportation has become a reliable alternate mode of transportation for bulk materials due to its attractive economics and reliability. For commercial slurries where the size ratio of largest to smallest particle could be greater than 1000, the design procedure of slurry pipe line for such applications is quite complex and may sometimes be unreliable. Thus one has to resort to experimental investigations on Pilot Plant test loops to generate the needed database. Hence, in the present work an attempt has been made to get more insight into some features of multisized particulate slurry flow through pipelines. In particular, pressure drop in a straight pipe and across a pipe bend, concentration and size distribution of solids in both straight pipe and bend as well as the prediction methods for pressure drop and concentration profile have been studied.

IIT Delhi has made a significant contribution in the development of slurry transportation system in India. The data collected over the last two decades for pressure drop on different materials at different concentrations was analysed and compared with predicted pressure drop by the method proposed by Wasp et al. It was found that the deviations were very high and therefore a modified pressure drop prediction method has been proposed which shows improvement in pressure drop prediction to the tune of 20 to 25%. A comparison with the present experimental measurements of pressure drop for two slurries also showed a significant improvement.

Concentration profile measurements for two slurries namely Iron ore slimes and Zinc tailings were done in a pilot plant test loop existing in the Fluid Mechanics Laboratory. Measurements have been made over a wide range of flow velocities and concentrations. The measured concentration profiles at different concentrations have

been compared with the predictions using the methodology of Karabelas. This method gave good matching at low concentrations but failed at high concentrations. Modified concentration profile prediction method proposed by Seshadri et al. has also been tried and it gives better prediction at all concentrations. Therefore it is concluded that the method proposed by Seshadri et al. can be used for concentration prediction in the case of multisized particulate slurries. The distribution of particles belonging to different size fractions has also been studied both experimentally as well as analytically.

Another aspect of the present work is the study of the flow characteristics of multisized particulate slurry through a long radius bend (radius ratio = 4.0) incorporated in the pipeline. This bend was instrumented to facilitate the measurement of the pressure drop and concentration profile in two planes namely horizontal plane and vertical plane. Measurement of pressure drop shows that relative pressure drop in the bend for slurry flow is always less than that for water. This fact could be attributed to the suppression of turbulence and secondary flows in bend due to presence of solid particles. Bend pressure drop increases with increasing velocity and concentration. In comparison to straight pipe the bend pressure drop is always higher except at velocities near the deposition velocity. This is attributed to the fact that at low velocities, the slurry tends to settle in straight pipe whereas it is kept in suspension in the bend due to presence of secondary flows.

Measurement of concentration profile in the two planes inside the bend shows redistribution of particles in the bend. The larger particles move towards the outer wall which would be one of the reasons of rapid wear in bends. Further comparison of concentration profiles in bend with those in straight pipe shows lesser asymmetry inside the bend at low concentrations whereas at higher concentrations, this effect is less pronounced.

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