STUDIES ON THE EFFECT OF PARTICLE SIZE DISTRIBUTION AND MATERIAL PROPERTIES ON THE RHEOLOGICAL PARAMETERS OF SLURRIES AND THE PERFORMANCE OF SLURRY PUMPS

by

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DEDICATED TO
my
PARENTS

CERTIFICATE

This is to certify that the thesis entitled 'EFFECT OF PARTICLE SIZE DISTRIBUTION AND MATERIAL PROPERTIES ON THE RHEOLOGICAL PARAMETER OF SLURRIES AND THE PERFORMANCE OF SLURRY PUMPS' being submitted by Vinay Kumar Gahlot to the Indian Institute of Technology, Delhi (India) for the award of the degree of Doctor of Philosophy in Applied Mechanics Department is a bonafied 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

Transportation of coal and other minerals through pipelines is an industrial reality. For bulk solids handling over long distances, it has proved to be more economical than several other modes of transportation. For designing an economical and efficient pipe line system, large amount of design data is required as an input.. Rheological characteristics of the slurry at various concentrations and flow rate is one such parameter. This is needed to ensure a stable/energy efficient pipe line transportation and also for the prediction of the head requirement for pumping the slurry. The review of the available literature has shown that the state of the knowledge about the rheological characteristics of the slurry and the effect of material properties on slurry pump performance is rather incomplete. Hence, a study of the rheological behaviour of slurries of solids of different particle size distribution and top particle size has been made, to get an insight into the subject. Also, the effect of solid's properties on slurry pump performance have been investigated.

Rheometric tests have been first performed with the fine particulate slurries of four different materials. The specific gravity of solids used are in the range 1.47 to 2.85. Samples of solids contained all particles finer than

75 microns. The particle size distributions were similar and the weighted mean diameters of the particles were of the same order. The static settled concentration of slurries were also determined. The concentration of solids was varied from 10% by weight to nearly the static settled concentration. The static settled concentration of slurries has been found to be an useful parameter for predicting the rheological behaviour. Correlations have been proposed for the rheological parameters of fine particulate slurries.

To investigate the effect of size distribution and top particle size of solids, coal and zinc tailing samples were used. Samples having different size distributions and top particle sizes were prepared by scalping (removing) the large sized particles from the original sample. Weighted mean diameters of various coal samples varied from 31μ to 223μ and for zinc tailing it was in the range of 18μ to 88μ . Rheometric tests were made for various solids concentrations in the range 10% by weight to nearly the static settled concentration for each sample. From the test results of rheological parameter of different samples, a criterion based on surface area of solids per unit volume of slurry and the reduced volumetric concentration of solids has been proposed. This criterion would help in the prediction of rheology of coarse particulate suspensions based on the experimental measurements on scalped suspensions.

It is well known that the performance of the slurry pumps deteriorate due to the presence of solid particles. Test were conducted with two different types of pumps with different slurries to study the slurry pump performance. The performance of venturimeter for metering the slurry flows was also studied. Based on the experimental results, a correlation has been proposed for the head reduction factor of centrifugal slurry pumps which accounts for the specific gravity of solids, solids concentration, size and size distribution of particles.

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