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Flow Properties of Suspensions Rich in Solids

A mathematical evaluation is reported (ref. 1) of flow properties of fluids carrying high concentrations of solids in suspension. Flow rates, viscosity, density, and particle size were considered, and experimental flow data were obtained for several suspensions.

The design of pipe-flow systems for suspensions having high concentrations of solids requires detailed knowledge of non-Newtonian laminar-flow properties. Normally the flow properties of suspensions of interest must be determined experimentally over a wide range of flow rates. Mathematical models, such as the well-known Bingham plastic model, that relate shear stress to shear rate are helpful in describing the flow properties of non-Newtonian fluids. However, for most suspensions (particularly where particle size, shape, and degree of dispersion differ) the parameters in the mathematical models must be measured for each suspension.

The purpose of this study was a general rheological study of solid-liquid suspensions in order to relate suspension viscosity to physical properties of the solids and liquids, and to provide a means for prediction of flow behavior. Earlier investigators had proposed equations for relating suspension viscosity to properties of the constituents, but none had been concerned simultaneously with the non-Newtonian flow region and suspensions rich in solids.

Equations were developed for evaluation of the flow behavior of solids-rich suspensions from the physical properties of the liquid and solid components. A technique was developed for calculating a suspension's flow rates, as a function of pressure drop, that is applicable to the design of pipelines.

Flow rates were measured in pipeline viscometers of a unique design that minimized entrance and exit effects. Experimental flow data were obtained for suspensions of between 28 and 55% by volume of nickel, alumina, copper, or glass solids in sodium, xylene, or glycerin. The basis for correlation of the data was an analytical investigation of the flow behavior that considered the particle–particle interaction in a settled suspension. The correlation equations fit all systems investigated, and take into account the effects of liquid viscosity; liquid and solid densities; size, size distribution, and surface area of particles; and the volume fraction of solids in the suspension and at maximum settled conditions.

The application of suspensions as fluid fuels for nuclear reactors also was surveyed.

Reference:
1. Gay, E. C.; Nelson, P. A.; Armstrong, W. P.: Flow Properties of Suspensions with High-Solids Concentration. Argonne National Laboratory, Feb. 1968.

Notes:
1. Fluid-suspension piping is currently of great interest to the mining, petroleum, and chemical industries.
2. Inquiries concerning this information may be directed to:

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Reference: B69-10622

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(ARG-10481)

(continued overleaf)

Patent status:

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