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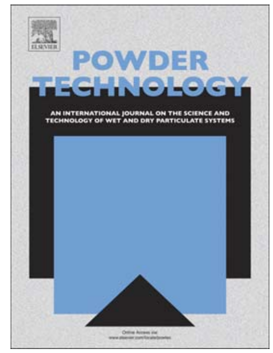

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Effect of Particle Shape on the Apparent Viscosity of Liquid−solid Suspensions

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Abstract

The viscosities of liquid−solid suspensions were experimentally determined for castor oil−paraffin and acrylonitrile butadiene styrene (ABS) plastic particle systems at room temperature and for a Fe-C melt at various temperatures. The degree of sphericity of the particles was introduced as a parameter for characterizing the effect of the particle shape on the apparent viscosity of liquid−solid systems. The results indicated that with an increase in the degree of sphericity of the particles, the apparent viscosity decreased. However, the presented well-known prediction models, such as Krieger-Dougherty's model and Batchelor's model only consider the effect of the particle fraction on the apparent viscosity of liquid−solid suspensions, whereas the effect of the particle shape is neglected. Based on the experimental data, the particle shape was introduced to modify Krieger-Dougherty's and Batchelor's models. The apparent viscosity can be successfully predicted using the modified model.

Keywords: Liquid−solid suspensions, particle shape, Krieger-Dougherty model, Batchelor model

1. Introduction

Studies on the apparent viscosity of liquid−solid suspensions have been performed in different fields, such as metallurgy and chemical, civil, and geophysical engineering [1, 2]. During the process of solidification, a metal in the semi-solid state comprises both solid and liquid components [3] and the apparent viscosity of such liquid−metal suspensions is of importance in numerous applications [4−6]. In view of the importance of the apparent viscosity of liquid−solid systems as a guide for the production of these materials, many researchers have used different models to estimate the apparent viscosities of liquid−solid mixtures.

Numerous empirical, semi-empirical, and theoretical models have been proposed for predicting the apparent viscosity of liquid−solid suspensions and mixtures. However, most of these models were found to be limited when applied to practical situations. For example, Einstein's model [7−9] requires a uniform distribution of rigid, spherical, solid particles with a uniform diameter dispersed in a suspension, and is only valid for dilute systems without any interaction between the particles. Consequently, new models for predicting the viscosity of