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Modeling Flotation from First Principles

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Abstract

Many investigators developed flotation models in the past, most of which were empirical and incorporated only physical parameters such as particle size, bubble size and energy dissipation. As a result, these models could not be used to predict flotation from some of the key chemistry parameters such as particle hydrophobicity (or contact angle) and surface charges (or ζ-potentials) of bubbles and particles. Yoon and Mao (1996, 1997) derived a first-order flotation rate equation by using both surface chemistry and hydrodynamic parameters. Furthermore, this model was derived from first principles and therefore it had diagnostic and predictive capabilities. The model was developed based on the premise that bubble-particle adhesion is induced by the hydrophobic force, a strong attractive force between two hydrophobic surfaces in water, measured for the first time by Israelachvili and Pashley (1982). This model, however, was applicable only for flotation under laminar flow conditions, and did not consider the events taking place in froth phase.

In the present work, a turbulent flotation model has been developed by considering the recovery processes occurring in both the pulp and froth phases. In this effort, Abrahamson's collision model (1975) is used with appropriate corrections for collision efficiency, while the probability of adhesion is obtained by relating the energy barriers created by surface forces to the kinetic energies resulting from turbulence. In calculating the kinetic energies, the particle velocities near the bubble surface are calculated by considering the turbulent velocity fluctuations and the hydrodynamic resistance to film thinning. Similarly, the probability of detachment is calculated by relating the work of adhesion to the maximum kinetic energies available in a flotation cell. The predictions from the model developed in the present work agree well with the general trends observed in plant practice with regards to the effects of bubble size, particle size, energy dissipation, contact angle, and ζ-potentials. In this presentation, methods of improving the flotation of fine and coarse particles will be discussed in view of the model predictions.