A Comprehensive Dynamic Model of the Column Flotation Unit Operation

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(ABSTRACT)

The core of this project was the development of a column flotation dynamic model that can reasonably predict the changes in the concentrations of all solid and bubble species, along the full column height. A dynamic model of a process is normally composed of a set of partial or ordinary differential equations that describe the state of the process at any given time or position inside the system volume. Such equations can be obtained from fundamental material and/or energy balances, or from phenomenological derivations based on knowledge about the behavior of the system. A phenomenological approach referred to as population balance modeling was employed here.

Initially, a two-phase model was formulated, which represents the behavior of the gas phase in a frother solution. The column was viewed as consisting of three main regions: a collection region, a stabilized froth and a draining froth. Experiments were carried out, based on conductivity techniques, for obtaining empirical data for model validation and parameter estimation. After testing the two-phase model, the equations for the solid species were derived. Consideration of the effects of bubble loading, slurry density and slurry viscosity on bubble rise velocity and, therefore, on air fraction is included in the model. Bubble coalescence in the froth is represented as a rate phenomenon characterized by a series of coalescence efficiency rate parameters. Auxiliary equations that help describe the settling of free particles, the buoyancy of air bubbles, and the processes of attachment and detachment, were also developed and incorporated into the model. The detachment of solids from the bubbles in the froth zones was attributed to coalescence, and it was assumed to be proportional to the net loss of bubble surface area.

Almost all parameters needed to solve the model equations are readily available. The set of differential equations that comprise the model can be solved numerically by applying finite difference approximation techniques. An iteration has to be performed, which involves calculating the product flowrate at steady state, modifying the tailings rate and solving the model again until a mass balance is satisfied.

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