Effects of Bias Flow and Numerical Simulation of Liquid Component Transport in Flotation Column Models

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Abstract

This work presents findings on a one-dimensional flotation column model that accounts for liquid drainage within the froth layer. The model consists of two PDEs describing bubble aggregates and gangue solids, incorporating a discontinuous convective flux, singular source terms, and a degenerate diffusion term modeling capillary action. The presentation focuses on two interconnected aspects related to wash water addition. Wash water, which is introduced either as a fine spray over the froth or directly injected into it, promotes impurity removal (slimes), enhances froth stability, and supports improved recovery rates [1, 2, 3]. While some wash water flows out with the froth bubbles, the remainder flows downward through the froth, counter to the gas phase, creating what is known as bias water. In flotation literature (see [1, 4, 5]), this net downward water flow is referred to as "positive bias." This condition is beneficial as it minimizes the amount of feed water that reaches the froth product. First, we establish that "positive bias" aligns with a condition for a stable bubble concentration profile. Steady-state solutions are constructed, and their existence is mapped using operating charts. Second, we develop numerical schemes for the transient model [6, 7, 8]. A novel aspect is subdividing the liquid phase into components, each represented by a vector of percentages summing to one, similar to [9, 10]. The model tracks liquid from the feed, wash water, and pre-existing column liquid. The proposed numerical scheme ensures nonnegative solutions that preserve mass conservation. The framework is adaptable for tracking contaminants, reagents, or slimes. Key mathematical properties and numerical examples are discussed. This work is in collaboration with R. Bürger (U. de Concepción), S. Diehl (Lund University), and M. C. Martí (U. de València).

MCA 2025 internal code: SS38-T19

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