Surface Forces in Foam Films

Liguang Wang

Abstract

Fundamental studies of surface forces in foam films are carried out to explain the stability of foams and froths in froth flotation. The thin film pressure balance (TFPB) technique was used to study the surface forces between air bubbles in water from equilibrium film thickness and dynamic film thinning measurements. The results were compared with the disjoining pressure predicted from the Derjaguin-Landau-Verwey-Overbeek (DLVO) theory. The contribution from the non-DLVO force was estimated by subtracting the electrostatic double-layer and van der Waals forces from the total force (or pressure) measured. The results obtained in the present work suggest that a strong attractive force (referred to as hydrophobic force) exists at very low surfactant concentrations, and that it decreases with increasing surfactant and/or electrolyte concentrations. In contrast, pH changes have only minor effects on the hydrophobic force.

The changes in the hydrophobic force observed at low surfactant concentration region have been related to foam stability in flotation. In addition, an analytical model applicable to a broad range of surfactant concentration was developed to calculate film elasticity from surface tension. The model finds, however, that the film elasticities change little at low surfactant concentrations. It is, therefore, suggested that bubble coalescence and foam stability at low surfactant concentrations may be largely affected by hydrophobic force.

The TFPB technique was also used to study the surface forces in the foam films stabilized with various frothers such as pentanol, octanol, methyl isobutyl carbinol (MIBC), and polypropylene glycol (PPG). The results were compared with the foam stabilities measured using the shake tests and the film elasticity calculated using the model developed in the present work. It was found that at a low electrolyte concentration foam stability is controlled by film elasticity and surface forces, the relative contributions from each changing with frother concentration and type. It is, therefore, proposed that one can control the foam stability in flotation by balancing the elasticities of foam films and the disjoining pressure in the films, particularly the contributions from the hydrophobic force.