

Studies on the Film Elasticity and Adsorption Behavior of Some Commercial Frothers

Hamid Khoshdast*

Mining Engineering Department, Faculty of Engineering,
Shahid Bahonar University of Kerman, Iran
khoshdast_hamid@yahoo.com

Abbas Sam

Mining Engineering Department, Faculty of Engineering, Shahid
Bahonar University of Kerman, Iran
sam@mail.uk.ac.ir

ABSTRACT

The surface activity, film elasticity, and adsorption behavior of several commercial frothers, including n-pentanol, n-hexanol, n-octanol, methyl isobutyl carbinol (MIBC), methoxy polypropylene glycol (D250), and polypropylene glycol (PPG-400) were evaluated through the analysis of surface tension data. Results showed that alcohol frothers with higher molecular weight and lower hydrophile-lipophile balance (HLB) value produce more closed packed cohesive film improving film elasticity and surface activity. In spite of equal molecular weight and HLB, simple straight chain molecules of n-hexanol provided higher surface activity compared to MIBC of large dimension branched structure which was confirmed by their molecular area plots. Ether frothers were found to be more surface active than alcohol frothers, since they have higher molecular weight and several oxygenated units in their structure, increasing film elasticity more significantly. The comparison of HLB value and molecular area of ethers insinuated that molecular weight is the most dominant parameter controlling interfacial behavior of frothers.

Keywords: Flotation frother; Surface tension; Adsorption density; Film elasticity.

INTRODUCTION

Better understanding of the mechanisms involved in the stability of bubbles and foams is of crucial importance in many scientific and technological fields. In flotation, for example, bubbles laden with hydrophobic particles rise to the surface of a pulp, forming a three-phase foam (froth), which is subsequently removed mechanically or by displacement. The importance in controlling the froth stability in flotation is widely recognized in recent years (Mathe et al., 1998; Ata et al., 2003; Neethling and Cilliers, 2003).

The stability of foam is affected by various factors such as surface tension, surface rheological properties, film elasticity, and surface forces. Thin film lamellae are essentially, the primary elements in the froth structure and the stability of the film is determined by its ability to resist rupture and thinning which results from drainage, evaporation and deformation. The adsorption of the frother molecules at the interface assists the stability of the thin film when it is subject to vibration and shock. This is achieved by increasing the elasticity and surface viscosity of the film and reducing the gas permeability. Therefore, the most important physical parameter concerning the stability of the froth is the so called (Pugh, 1996; Prins, 1999; Langevin, 2000; Wang and Yoon, 2006).

Elasticity, by definition, is the ratio of stress to strain. It is a measure of the property of returning to an initial form or state following deformation. Therefore, the elasticity of foam films

is sometimes deemed as the “self-healing” capacity against external disturbance. It is often defined as Gibbs elasticity, the ratio of the change in surface tension to the change in film surface area. Recently, Christenson and Yaminsky (1995) derived a simple analytical model for calculate the Gibbs elasticity from surface tension gradients ($d\gamma/dC$). It is a useful model in a sense that the parameter $d\gamma/dC$ can be readily obtained from surface tension isotherm.

The elasticity of foam films is defined by Gibbs as follows (Wang and Yoon, 2008):

$$E = 2A \frac{d\gamma}{dA} = 2A \frac{d\gamma}{dC} \frac{dC}{dA} \quad (1)$$

where E is elasticity (m/Nm), A is the film surface area (cm^2), γ is the surface tension (m/Nm), and C is the bulk surfactant concentration (mol/cm^3). For a closed system, the volume of a foam film, $V=AH$, is constant, i.e. $dV=0$, where H is film thickness (cm). Also, the total number of the surfactant molecules is constant. After several mathematical steps, including using the Gibbs adsorption isotherm, Wang and Yoon (2006) derived an expression for E (mN/m) as follows: