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Original Research Paper

An investigation into the effect of water quality on froth stability

Saeed Farrokhpay *, Massimiliano Zanin

Ian Wark Research Institute, University of South Australia, Mawson Lakes, SA 5095, Australia

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ABSTRACT

Froth stability plays a major role in determining the mineral grade and recovery in flotation operations, and it depends on the type and amount of both frother and suspended particles. Furthermore, there are other parameters such as quality of the process water which may affect the froth stability. In plant practice, the recycling of process water instead of using fresh water is increasingly being common. However, using recycled water normally leads to building up salts and surfactants in solution. Therefore, the effect of the process water chemistry on froth stability and metallurgical performance is important. In this study, the effect of water quality, including pH, and type and concentration of salts ($CaCl_2$, $AlCl_3$ and NaCl) on froth stability and its relationship with mineral particles zeta potential and slurry viscosity was studied. It was found that the forth stability is higher in the presence of multivalent metal ions. Addition of $CaCl_2$ and $AlCl_3$ considerably increased both froth stability and pulp viscosity. This may be due to bridging effect of polyvalent metal ions between the ore particles.

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1. Introduction

Froth flotation is widely used in mineral processing. Froth flotation utilises differences in physicochemical surface properties of various minerals to achieve separation. Frothers are added to stabilise bubble formation in the pulp phase and to create a stable froth. The significance of froth stability in mineral flotation has been reviewed recently [1]. The froth phase has a major influence on the overall flotation rate in industrial circuits [2]. It is known that froth recovery is proportional to froth stability, the more stable the froth the higher the probability for an attached particle to be retained until reaching the cell launder, and inversely, to the froth retention time [3]. The froth retention time is a measure of the average lifetime of an air bubble in the system. The higher the froth retention time the higher is the probability for an attached particle to be dropped back into the slurry. Retention time is related to the physical properties of the froth. A widely used indicator of froth stability is the half-life time ($t_{1/2}$) which is the time needed for the froth to collapse to 50% of its initial equilibrium height [4]. The froth half-life time depends on both frother and solids load in the froth [5]. At plant scale, $t_{1/2}$ can be varied, to a certain extent, by changing frother concentration, or by using frothers with different chemistry.

Froth structure and froth stability are known to play a major role in determining the valuable mineral grade and recovery in flotation process. Froth stability not only depends on the type and concentration of frother, but also on the amount and properties of the suspended particles [6,7]. Furthermore, there are other parameters, such as quality of process water, which may affect froth stability. A review on the effect of ions on flotation has been published recently by Ozdemir et al. [8]. While Ozdemir et al. [8] have focused on the flotation of soluble minerals but the idea is applicable to the general theory of flotation in the presence of salts (for example in saline water). Availability of fresh water sources for the mineral processing industry is becoming problematic and 'water management' is becoming more important for mineral industry [9]. Several flotation plants around the world use process water with high inorganic salt content. This arises from a combination of soluble components of the ore, using recycle water, sea or well water in some locations. Extreme examples include Mt Keith operation in Western Australia with salt concentrations around 60,000–80,000 ppm and processing of potash in saturated brine [10,11]. Therefore, the effect of process water chemistry on plants metallurgical performance is important [12]. Kurniawan et al. [13] studied the effect of salts ($MgCl_2$, NaCl, and $NaClO_3$) on the froth stability in coal flotation. They showed that the froth stability increases with increasing salt concentration, with $MgCl_2$ giving the highest, and $NaClO_3$ the lowest stable froth. Quinn [14] compared the effect of salt on gas dispersion and froth properties using MIBC as frother, and NaCl, $CaCl_2$ and $Al_2(Cl)_3$ as water contaminants. They showed that the gas holdup (volume% of air on the froth phase) increases with salt concentration and aluminium chloride had the strongest response, followed by $CaCl_2$ and NaCl. The result suggested that gas holdup directly depends on the ion valence of

* Corresponding author. Present address: JKMRC, University of Queensland, 40 Isles Road, Indooroopilly Qld 4068, Australia. Fax: +61 7 3365 5999.
E-mail address: S.Farrokhpay@uq.edu.au (S. Farrokhpay).

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