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Research Paper

Measurement of Froth Stability in Flotation Cells and Investigation of the Impact of Factors Affecting It

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Abstract: Froth stability is of particular importance and has a significant impact on the flotation process. Froth stability can be defined based on the formation of froth (maximum froth height or froth retention time) or the froth decay (froth half-life). Froth stability is influenced by various factors such as the superficial air velocity (J_g), the collector dosage (C_C), frother dosage (F_C) and the sample particle size (d_{50}). In this work the effects of these factors were examined. The results showed that increasing the Jg, the C_C and the F_C will increae the froth stability. For example, by increasing the F_C from 60 to 140 g/liter, the froth retention time (FRT) and the half-life froth ($t_{1/2}$) increased by 92% and 71%, respectively. Sample particle size behaved differently in froth formation and decay, so that by reducing the d_{50}, the froth retention time increased but the froth half-life decreased.

Keywords: : Froth stability, Gas velocity, Collector dosage, Frother dosage, Sample particle size (d50).

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INTRODUCTION

Froth stability plays an important role in determining the selectivity and recovery in flotation [1]. It should be noted that froth with very high stability is not good because in addition to recovering the particles attached to the bubble, it creates favorable conditions for entrainment [2]. Froth stability can be defined as froth retention time, which depends on the structure of the froth and the size distribution of the bubbles [3], or decay time of the froth [4].

Froth stability can be determined by dynamic and static tests. The froth dynamic is determined by measuring the maximum froth height, and the froth static is determined by froth decay to prevent the froth formation [1].

Dynamic froth stability is the ratio of froth volume to aeration value; If the cross-sectional area of the whole cell is assumed to be the same, the dynamic froth stability is equal to the froth retention time and is calculated using Equation 1:

$$\mathrm{FRT} = \frac{V_f}{Q} = \frac{H_{max}}{J_g} \quad (1)$$

Where:
V_f: froth volume
Q: air volume flow rate
H_{max}: maximum froth height
J_g : is superficial gas velocity.

The effect of particle size has been investigated by several researchers [5-7]. In general, fine particles affect the froth stability and the role of hydrophobic particles is significant. In fact, fine particles can increase the froth stability of the overflow.

The type and amount of frother is also effective on the froth stability. Ata [8] examined the separation of particles during the bubble coalescence, and she found that increasing the frother dosage resulted in increasing the contact surface and decreasing the particle separation, and thus reducing the bubble coalescence and increasing froth stability [8].

Another factor that affects froth stability is the pH. The pH can change the chemical level of the minerals in the pulp by affecting the charge level of the particles. Farrokhpay and Zanin [9] examined the effect of water quality on the froth stability for a zinc concentrate in Australia. They found that by decreasing the pH, the froth half-life increases, which is due to the decrease in zeta potential and increase in the viscosity [9].

MATERIALS AND METHODS

In order to measure the froth stability and examine the effect of some operational parameters, a special column was used on a laboratory scale. This device was designed based on the column used by Zanin et al. [10] and McFadzin et al. [11].

The experiments were designed and performed using Design-Expert software version 10 (DX10). Independent variables or input parameters for this study were: collector and frother dosage, superficial air velocity, and particle size (d50). The dependent variables or responses were froth half-life and maximum froth height.

To perform the experiments, a sample of iron ore concentrate containing sulfide minerals from Gole-Gohar Sirjan Company (Iran) was used.

RESULTS AND DISCUSSIONS

According to the results of analysis of variance, the parameters examined at the 95% confidence level are significant. Also, the interaction between the superficial air velocity –frother dosage and frother dosage – d50 are significant.

Figure 1 shows the effect of various factors on the froth retention time (FRT). It is observed that increasing the superficial air velocity, collector dosage or frother dosage increases the froth retention time while increasing the d50 reduces the froth retention time.

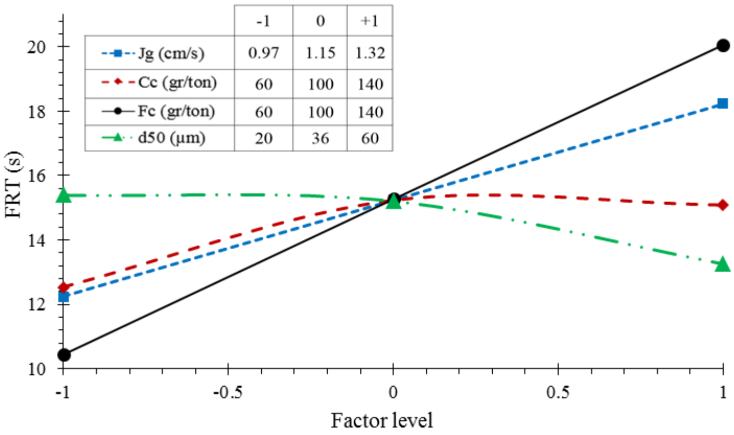


Figure 1. The effect of factors on froth formation

The superficial air velocity significantly changes the composition and structure of the froth, however, it is not entirely clear what effect superficial air velocity has on the characteristics of the froth and which feature of the froth is the main factor in determining the froth rheology. Due to the fact that increasing the superficial air velocity increases gas holdup, so increases the probability of the number of collisions and the attachment of particles-bubble, which increases the volume of solid particles in the froth phase. Therefore, the greater presence of particles in the froth phase leads to an increase in the froth height. However, excessive superficial air velocity will result in the formation of large bubbles, which can reduce the volume of particles in the froth phase.

The increase in the bubble load depends on the collector dosage, at higher collector dosage, the amount of particles presents in the froth phase increases due to the increased bubble-particle attachment. However, excessive collector will cause the bubble-clustering phenomenon and has a negative effect on the bubble loading.

An increase in the frother dosage will reduce the bubbles size and form more stable bubbles. The probability of collision of a particle with a bubble also increases. Therefore, the bubble loading increases, which will stabilize the froth. Although small bubbles have the stated benefits, the absence of large bubbles may reduce the flotation recovery.

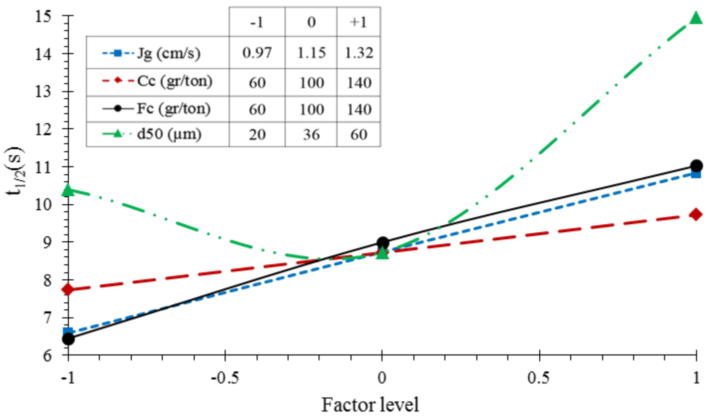
The results of analysis of variance show that the effect of the independent variables is significant with 95% confidence, while the confidence level for frother dosage-d50 is 90%. It should be noted that the effect of the superficial air velocity (Jg), the collector dosage (Cc) and the frother dosage (Fc) is similar with the froth formation.

Figure 2 shows that the froth half-life increases with increasing the superficial air velocity, collector dosage, frother dosage and particle size (d50).

When the froth decays, the increase in fine particles accelerates the process of froth decay, perhaps due to the presence of more water along with the fine particles, which causes the froth to move. If the number of very small particles increase, the presence of these particles in the froth phase and increased viscosity will prevent the rapid froth decay.

CONCLUSION

The effects of various parameters on the froth stability were examined. It was shown that increasing the superficial air velocity, the collector or frother dosage results in the increasing of the froth formation and froth decay. However, the behavior of the particles was different and the froth retention time increases with decreasing the particle size. This indicates that an increase in the fine particles has a positive effect on the froth formation due to the increased viscosity, but when the froth decays, the higher amount of fine particles accelerates the process of froth destruction probably due to the presence of more water along with the fine particles.



	-1	0	+1
Jg (cm/s)	0.97	1.15	1.32
Cc (gr/ton)	60	100	140
Fc (gr/ton)	60	100	140
d50 (μm)	20	36	60

Figure 2. The effect of various factors on froth decay

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