

MODELING BUBBLE RECOVERY PROCESSES IN A VIDEO IMAGE

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ABSTRACT

A study of the gas motion through the froth of a prototype bi-dimensional flotation cell was performed. Using video and image analysis techniques, surface velocity data measured with a Visio froth system were validated by comparing those results with estimations from manually tracking the motion of the bubbles on the froth surface. Images used to manually track the bubbles were recorded using a high-speed video camera. In addition, discharge velocity profiles were measured as a function of the froth height over the launder lip for two froth Crowder angles and two superficial air rates. An increasing froth discharge velocity from the lip level up to the top of the froth was observed. Based on these results, the air recovery was estimated using the velocity profile and these values were compared with those obtained using the surface velocity estimation. Results showed differences from 24% to 47% in the air recovery when the froth flow area at lip was employed. However, both approaches presented the same trend when the J_G and the froth Crowder angle were changed. Using the top-of-froth velocity along with the froth flow area at the Visio froth location allows air recoveries to be closer to those obtained from the discharge velocity profile at lip.

The water flowrate in concentrate was estimated from operational variables and compared with the water flowrate measured in the concentrate stream. A good agreement was observed when the discharge velocities obtained from the Visio froth measurements along with the froth height over the lip at the measurement point were employed. Similar results were obtained when the water flowrate was estimated using the discharge velocity profile at lip.

An increase in the air recovery as a function of the froth Crowder angle and the J_G value was observed. Also, the combined effect of these variables showed a significant impact on the air recovery. A higher concentrate water flowrate was observed when a higher air recovery was obtained. This result favours the concentrate grade decreasing due to the entrainment of non-valuable fine particles. A proper flotation equipment design along with an optimizing control system can improve the metallurgical results in terms of mineral recovery and concentrate grade.

The froth zone has an important role in the performance of flotation equipment because of its effect in the concentrate grade and mineral recovery. Due to the impact that the froth zone has on metallurgical results, several studies have been conducted to describe the froth transport mechanisms. Recent developments include the mathematical modelling presented by Neethling and Cilliers (); the estimation of froth recovery reported by Tsatouhas et al., , Seaman et al., and Yianatos et al.); the studies of entrainment mechanisms carried out by Savassi et al., , Zheng et al., , Zheng et al., and Yianatos et al. (); the impact of the froth zone on the kinetics of flotation equipment reported by Gorain et al., a, Gorain et al., b; and the studies of sub-processes in the froth presented by Ata et al. () and Honaker et al. (

The metallurgical performance of the froth zone depends on the froth stability. Studies by Ventura-Medina et al., , Barbian et al., Barbian et al., , Hadler et al., , Hadler and Cilliers, 2009 and Smith et al. showed that concentrate grade and recovery variations are related to the froth stability, which depends on operational variables. The froth stability has been quantified by air recovery, i.e., the fraction of air entering the flotation equipment that overflows the cell lip as unburst bubbles. Barbian et al, Hadler and Cilliers, and Hadler et al. (2010) have reported air recovery estimations from the froth height over the lip launder (h_{lip}), the froth

air hold-up (ε_{gf}) and measurements of froth surface velocity (at the top of the froth) close to the discharge (v_f). Surface velocity estimations on the top of the froth have been successfully obtained by vision systems to characterise the flotation froth.

The vision devices are based on image analysis and can measure froth velocity, bubble size on the froth surface, froth stability, colour histograms and other properties. The commercial vision devices used in plant applications are: (i) Visiofroth (Metso Minerals, 2010), (ii) METCAM FC (SGS, 2010) and (iii) FrothMaster™ (Outotec, 2011). A control strategy based on the froth discharge velocity (Barriá and Valdebenito, 2008) allows the mineral recovery to be maximised in flotation circuits (Neethling and Cilliers, 2008). This control target can be achieved by suitable adjustments of the air flowrate and/or the froth depth, subject to a concentrate grade range or other process constraints.

In this paper, the froth behaviour in the discharge of a bi-dimensional cell (air–water system) was studied to evaluate the air recovery estimation. First, the method proposed by Hadler et al. (2010) was employed to estimate air recovery using froth discharge velocity obtained by a Visiofroth system. On the other hand, bubbles observed on the side of the cell over the launder lip were manually tracked with a high-speed video camera to obtain a froth discharge velocity profile.

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