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Measurements of particle loading on bubbles in froth flotation

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Abstract

This work explores the measurement of particle loading on bubbles in the collection zone during flotation. Existing methods and instruments are critically reviewed to form a basis for developing a new bubble load meter. The new bubble load measuring device which is based on the Dyer (1995) and Seaman et al., (2004) concept is presented.

It was noted that the Dyer (1995) concept as improved by Moys et al. (2010) had advantages that with refinement could yield a more robust working instrument. The device had to meet the following objectives: It must measure bubble loads accurately without particle losses as a result of bubble coalescence, or break up. Secondly the instrument should also be capable of collecting a solid sample in excess of 200 grams which is the minimum mass required for PGM analysis as function of particle size.

Results of applying this newly designed bubble load meter in the laboratory and industrial plant are presented. It was shown at laboratory level through salt tracer experiments that the 20mm and 30mm riser worked well for the bubble load meter without sampling unattached particles. The intensity of the axial mixing in the 50mm riser resulted in some salt transport up the riser, to an extent that would compromise the bubble load quality.

An axial mixing model with 16 tanks in series was developed for the bubble load meter riser and parameters were estimated using Matlab's Simulink toolbox. A satisfactory fit was obtained after the inclusion of an additional parameter that accounts for salt transport as a result of mechanical push by bubble swarms and the salt adsorbed on the bubble lamella.

Industrial work at Lonmin's EPC plant yielded a maximum sample mass of 35.5grams with the 20mm ID riser instead of the target mass of 200grams. This was attributed to a number of factors which include that the sample was taken using small diameter riser (20mm ID) which meant that fewer bubbles were collected per unit cross sectional area and also the occasional breakage of the filter paper due to blinding which reduced sampling times. A froth recovery parameter R_f of 0.68 was obtained on the primary cleaner cells while a froth flow number (R_{fn}) of 1.55 was obtained on the primary rougher cell, this value of froth flow number in the primary rougher cell indicated high entrainment. A froth flow number was calculated for the primary rougher cell data

instead of a froth recovery parameter because of the unavailability assays due to low sample masses. While the froth recovery parameter was defined as the fraction of particles that are recovered by true flotation that reports to the concentrate, the froth flow number was defined as the ratio between the total mass of solids recovered in concentrate (by true flotation +entrainment) and the mass of solids entering the froth by true flotation, i.e. collected mineral (particle-bubble aggregates). A froth flow number can assume any value less than, equal to or greater than one depending on the contribution of entrainment and true flotation. It was also demonstrated that bubble load values in conjunction with certain assumptions can be used to estimate entrainment. Results of applying bubble load data revealed that chromite recovery in the concentrate is a contribution of both true flotation and entrainment. The results also indicated that 2.4% of the total concentrate flow in this primary cleaner was chromite and was mainly constituted of -25μm particles. It was also discovered that 3.1% of the bubble load was Chromite. Comparison of the bubble load assays per size class with concentrate assays and mass balances showed that most of the floatable chromite drains back into the pulp phase.