Solid-liquid mixing studies in lab-scale flotation tank using electrical resistance tomography

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Introduction

Flotation is a complex multiphase process used in the mineral processing industry to separate valuable minerals from accompanying gangue minerals. The recovery in the flotation process is known to strongly depend on the hydrodynamic conditions in the tank. The optimal mixing kinetics is achieved using an agitator mechanism that suspends incoming mineral particles throughout the tank.

The purpose of this study is to investigate the effect of various operating conditions, such as impeller agitation rate, impeller clearance and weight percentage of solids, on particle suspending characteristics of a lab-scale flotation tank using a state-of-the-art real-time electrical resistance tomography (ERT) system.

Experimental methods

A cylindrical tank 46 cm (18 in.) diameter and height fitted with 128 electrodes (8 planes, 16 electrodes per plane) was used (Fig. 1). Electrodes were connected to the data acquisition system (DAS) and a computer to collect, process and analyze the results in real time. The measurements were normalized by the tank diameter (D). The impeller clearance was adjusted to $D/12$ and the impeller size to $D/4$. Technical-quality solid glass spheres from Potters Industries of diameter 160-515 μm were used for all tests. Four vertical baffles were mounted to the tank wall to contain turbulence in the tank, which could have caused water to spill out of the tank while the speed was increased, and also to allow more homogenous mixing.

Results and discussion

The homogeneity of the system used to evaluate the degree of concentration variation from the theoretical

mean was shown to improve with an increase in impeller speed. Figure 2 shows a homogeneous condition achieved at a particular speed. Once the homogeneity is achieved, further increase in impeller speed has a detrimental effect on the flow characteristics and results in substantial water-air interface rippling and vortex formation. The impeller speed at which the maximum homogeneity occurred was shown to be dependent on impeller clearance; homogeneity was achieved under lower agitation rates for smaller impeller clearance. Finally, homogeneity is achieved under lower agitation rates for lower solids loading.

Conclusions

Electrical resistance tomography (ERT) was successfully employed to monitor the characteristics of solid liquid mixing in a batch lab-scale flotation tank. Impeller agitation rate, off-bottom clearance and solids loading were all found to have a significant effect on the homogeneity of solid-liquid suspension. Adequate particle suspension conditions can be achieved by increase of impeller agitation rate to optimal speed, decrease of impeller off-bottom clearance and decrease of solids loading. More experiments will be performed in the future to include additional particles sizes and densities, impeller designs and scales, and number of baffles.

Figure 1 — Flotation tank design and ERT system electrode configuration and principle of operation.

Figure 2 — Solids concentration profiles for eight measurement planes and a 3D tomograph. Conditions: $D/12$ impeller clearance, and 10% w/w solids, particle size 515 μm and speed 894 rpm (4.26 m/s).