Application Example: Mineral Flotation in a Gold Mine

Motivation

The performance of a flotation process is determined by the separation efficiency of the valuable component and product purity. To ensure smooth operation, there are requirements for both the concentrate grade of the valuable component and fractions of impurities such as sulfur, bismuth and tellurides as well as concentrate moisture. Traditionally the level of automation has been lower in mineral flotation plants than the pulp and chemical industries. This is partly due to the challenging process conditions, which subject measurement equipment to extreme wear. Skilled operators can adjust the process to its optimal stage but cannot work on the flotation cells for the entirety of their 12-hour shifts (Shean & Cilliers 2011). Therefore, automated process monitoring and control have great potential to further improve the flotation outcome eliminating minor disturbances in the process.

Bubble size and bubble size distribution play a major role in the flotation process. Mineral flotation is a popular research topic, but online bubble size measurements in mineral flotation cells have not yet been published on. As the online monitoring and analysis of bubble size enables real-time process control and optimization of process parameters, this type of research would greatly benefit the industry.

Measurement concept and benefits

The Pixact Bubble Monitoring (PBM) system has been developed for continuous operation in industrial mineral flotation cells to measure real-time bubble size distributions. To discover the benefits of the PBM system in real process conditions, an extended measurement campaign was performed at the Dragon Mining gold concentrate production plant in Vammala, Finland. The imaging hardware (Fig. 1) was submersed 1.5 meters beneath the froth layer (Fig. 2) of the mineral flotation cell of the plant, where it analyzed the bubble population in the slurry for six weeks. Despite the challenging conditions, the imaging hardware did not require any maintenance operations during or after the campaign.

As the long-term bubble size trends presented in Figure 3 show, bubble size correlates strongly with the inlet sludge density. High sludge density reduces flow turbulence in the cell and therefore weakens the gas dispersion leading to an increase in bubble size.

Step-change tests were carried out to investigate the sensitivity of the bubble size to changes in process parameters. The effects of froth layer height, mixing speed and air feed on the cumulative volume distribution of bubble size are presented in Figure 4. The intensity of mixing has the greatest effect on bubble size: increased mixing decreases bubble size whereas increased air feed increases bubble size.

The presented trials at the Dragon Mining gold concentrate production plant reveal that the system produces reliable measurement results on the gas bubble population in slurry. The trends measured correctly respond to changes in the process parameters. The system proved to be both reliable and easy to use in these extreme conditions.

Figure 1. Imaging hardware before and after the campaign

Figure 2. Imaging hardware submersed 1.5m beneath the froth layer of the mineral flotation cell

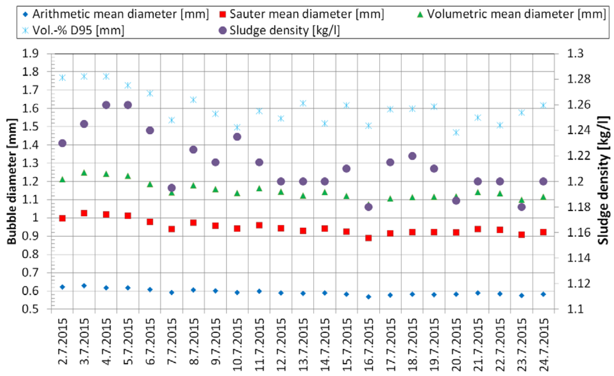

Figure 3. Bubble size and sludge density time trends

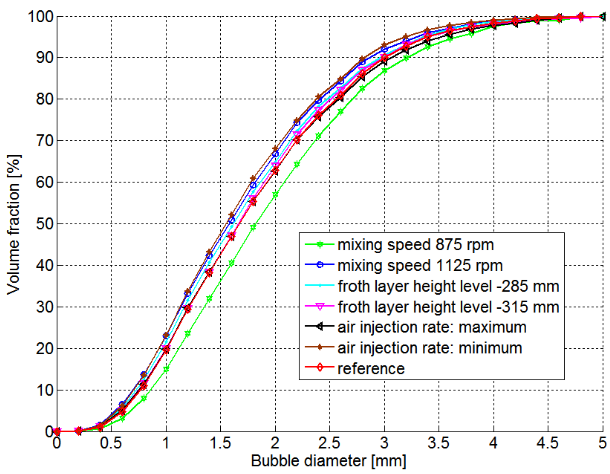

Figure 4. Effects of froth layer height, mixing speed and air feed on gas bubble size distribution in the slurry of an industrial mineral flotation cell

* Shean, B.J., Cilliers, J.J., A Review of Froth Flotation Control, International Journal of Mineral Processing, Vol. 100, 2011, p. 57-71.