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Improving the representation of hot flotation testing through the application of a novel, double batch flotation machine

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ABSTRACT

Hot batch flotation tests are often applied to reduce risks in plant trials as they combine the benefits of matching complex plant feed stream compositions with the high precision of lab scale batch flotation testwork. One of the weaknesses of hot flotation tests is the sequential nature of the testwork, where ageing of pulp samples can influence metallurgical performance. When present this interference could at best generate inconclusive results, and at worst, inaccurate conclusions. To improve the reliability of test data, CP Kelco has developed a novel, double batch flotation machine for conducting parallel hot flotation tests on live flotation streams. Hot flotation tests with a sensitive Ni cleaner feed stream, principally containing pyrrhotite, pentlandite, magnesite and talc, were used to demonstrate the principles and potential of the device. Parallel tests with the double flotation machine were shown to afford reproducible Ni recovery-grade curves, while sequential tests conducted with a 30 min ageing period showed a marked change in Ni recovery-grade curves. In this study, selectivity curves have been beneficial in identifying the sources of the changes caused by ageing, which appear to be due to an increased recovery of pyrrhotite.

1. Introduction

When considering the application of new or alternative flotation reagents to existing concentrators, the laboratory scale batch mill-float methods are often the starting point for metallurgists tasked with characterising and benchmarking the metallurgical performance. This methodology is well established, its best practice well documented (Runge, 2010; Wills and Napier-Munn, 2006; Lotter et al., 2014) and relative to any larger scale pilot testwork, serves as a quicker, lower cost option that can achieve a higher degree of precision and reproducibility for a given set of conditions. These tests often form the basis for economic assessments and weighing up the risk of further investment in larger scale testing.

One of the established limitations of the standard lab batch mill-float methodology is the sometimes poor simulation of particular stages of full scale flotation, owing to differences in the milling environment as well as a host of factors that impact feed compositions of complex recirculated loads. Often for this reason the so-called hot batch flotation test, performed with fresh plant-produced pulp samples, is considered a more representative laboratory test and may be used to validate earlier lab batch mill-float development work or further de-risk prospective full scale trials.

Whereas lab mill-float tests can be performed repeatedly over months using a stable bulk ore sample to evaluate a variety of parameters, hot flotation testing by its very nature will only permit very few comparative tests for a limited time, as each pulp sample is unique and has limited time before ageing of the samples will change many of the critical parameters that can affect metallurgical performance. As traditional hot flotation tests can only be performed sequentially, with some very sensitive ores even a single comparative test pair conducted very efficiently may be affected by ageing. Risks of oxidation of pulp samples comprising sulphide ores are often acknowledged (Runge, 2010; Wills and Napier-Munn, 2006) and while some studies have focussed on the specific effects of ageing pulp samples (Galant, 2015) these effects are often not routinely assessed with hot flotation testing. Due to this it has been considered necessary practice by the authors to introduce a random test sequence to the experimental design and extending the number of tests when comparing the metallurgical performance of pairs of hot flotation tests so that potential ageing effects can be assessed, although not eliminated.

In striving to improve the representation of hot flotation tests through the elimination of potential ageing effects, CP Kelco has developed a prototype, portable, parallel batch flotation machine, for conducting comparative batch flotation tests simultaneously. In this approach, controlling the key parameters that affect flotation recovery rates has been the overarching driver behind the equipment design. The

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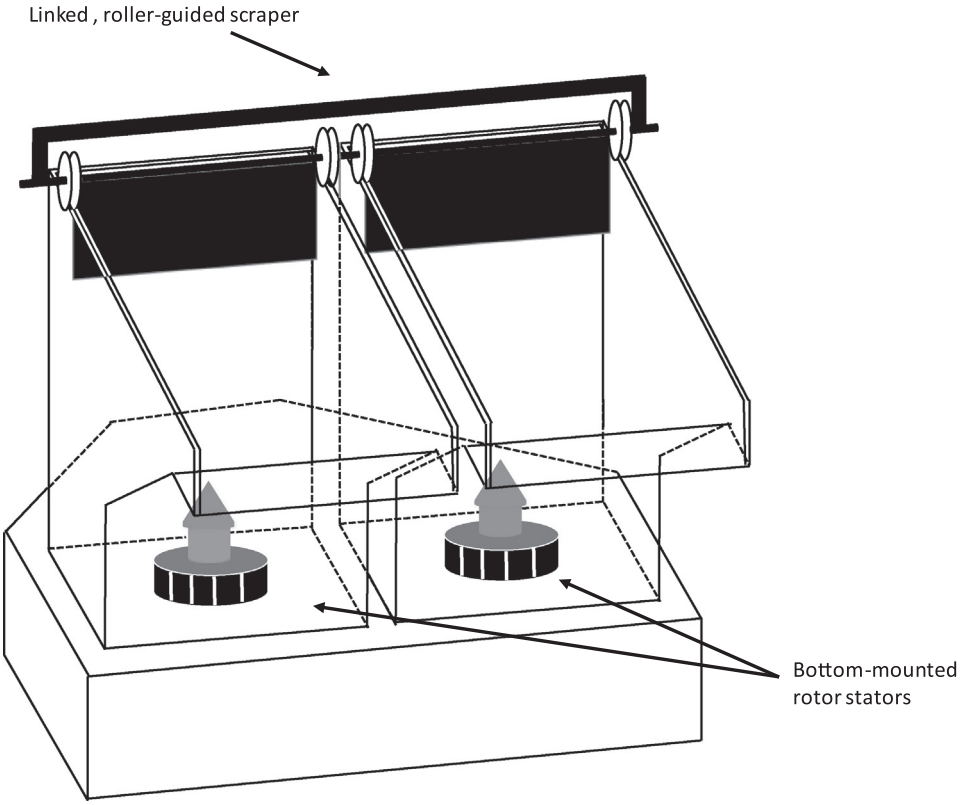

Fig. 1. Front view representation of parallel batch flotation cells showing orientation and scraper.

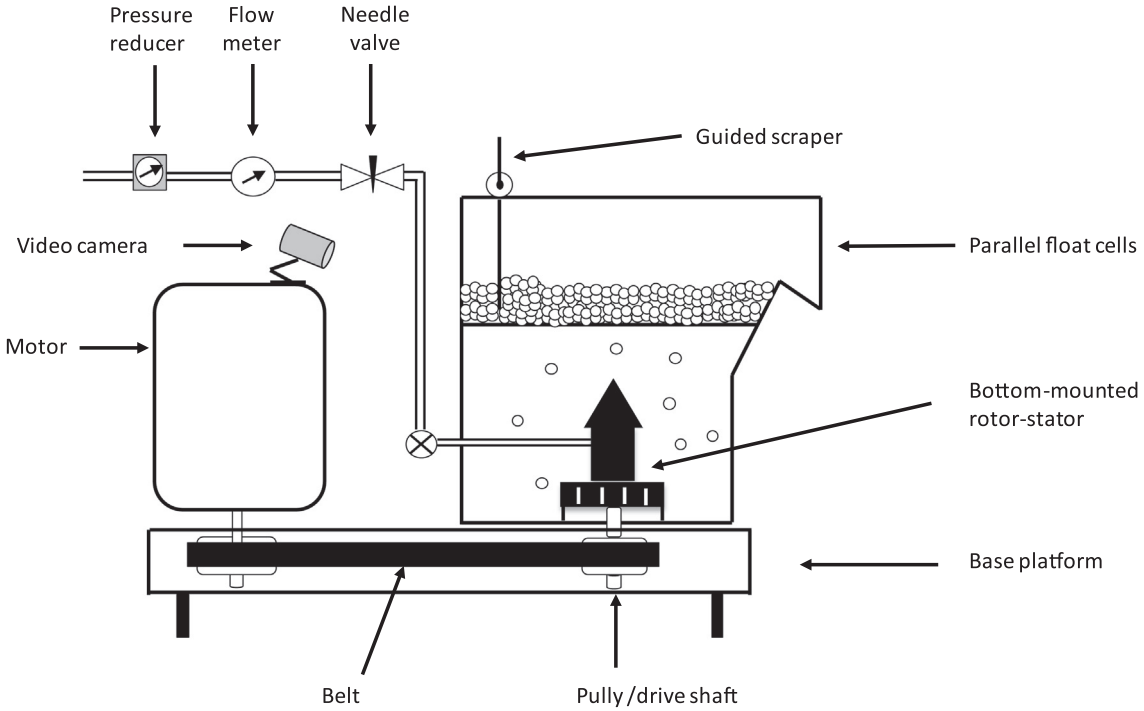

Fig. 2. Cross-sectional side view of the parallel batch flotation rig, depicting key components.

key design features of this equipment are disclosed in this work and its application to onsite hot flotation testwork with a sensitive nickel sulphide pulp is investigated in a detailed case study.

2. Materials and methods

2.1. Parallel batch flotation machine

The prototype double batch flotation machine used in this work comprised a pair of 4 L perspex flotation cells, arranged in a fixed