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The effect of rotor speed on the flash flotation performance of Au and Cu in an industrial concentrator

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ABSTRACT

Improvement in the performance of a flash flotation cell can be achieved through optimisation of the cells flotation/classification profile via the manipulation of process operating variables such as feed rate, feed per cent solids, rotor speed and dual outlet flow. This paper presents the findings of changing the rotor speed on the internal hydrodynamics and valuable element (Au and Cu) performances in an industrial flash flotation cell.

Two survey campaigns have been conducted on a 1200 tph flash flotation cell to assess the effect of changing rotor frequency (and consequently RPM) on the performance of the cell. Four rotor settings were tested during this work: 45, 50, 55 and 60 Hz. During the first campaign a survey was taken after the flash flotation cell had achieved stable operation for approximately 2 h at each frequency setting; with 50 Hz representative of the normal operation of the machine. The Au recovery results from this initial campaign identified 55 Hz as the optimal setting for the rotor frequency. The second survey campaign was performed to confirm the base case results (50 Hz) and reassess the 55 Hz case after the machine had operated at this frequency for 48 h. The unit recovery of Au and Cu increased by 39% and 28% respectively at the optimised frequency, with a notable increase in the recovery of coarser Au (+150 µm) which is readily recoverable by the downstream gravity devices.

A comparison of the cyclone overflow stream (conventional flotation circuit feed) has shown that when the flash flotation cell is operating in the optimised state, there is a shift in the distribution of Au by size being sent to the conventional flotation circuit. There is a relative 8% increase in the amount of Au within the optimal size range (+20/−150 µm) for flotation recovery, which should therefore increase the overall Au recovery in the conventional flotation circuit. Follow-up analysis of plant data has shown that the final tail Au grade from the conventional flotation circuit has decreased by an average of 0.0235 ± 0.0129 g/t to 0.179 g/t, and that this decrease is statistically relevant at a 95% confidence level.

The effect of rotor speed on the internal flow regime of the cell has been demonstrated through the use of axial profile data and profile normalisation. This has allowed a visual representation of the effect of increasing power input into the slurry and the consequent changes to turbulent flow. How this impacts both the internal classification profile of the machine and the size based performances of the target elements (Au and Cu) is discussed in detail. 3D interpretation of the effect of rotor speed on the size based recovery of Au and Cu within the machine are presented, and are the first such representations to be made for real data obtained from within an operating industrial scale flash flotation machine.

1. Introduction

Flash flotation plays a vital role in the overall performance of the processing facilities at Cadia Valley Operations (CVO), NSW, Australia. Mixing within the machines has previously been identified as an issue, with unit recoveries expected to increase if measures were taken to improve flash flotation cell hydrodynamics. This paper presents the findings from one of the many optimisation projects currently being undertaken at CVO to improve flash flotation performance: the optimisation of rotor speed targeting maximum Au recovery.

Flash flotation differentiates itself from conventional flotation methods by treating the cyclone underflow (CUF) stream within the grinding circuit; while conventional flotation treats cyclone overflow (COF) material. The differences between these two styles of operation have been discussed and analysed in detail by various authors (Newcombe, 2016a,b, 2015, 2013; Newcombe et al., 2012, 2013, 2015;

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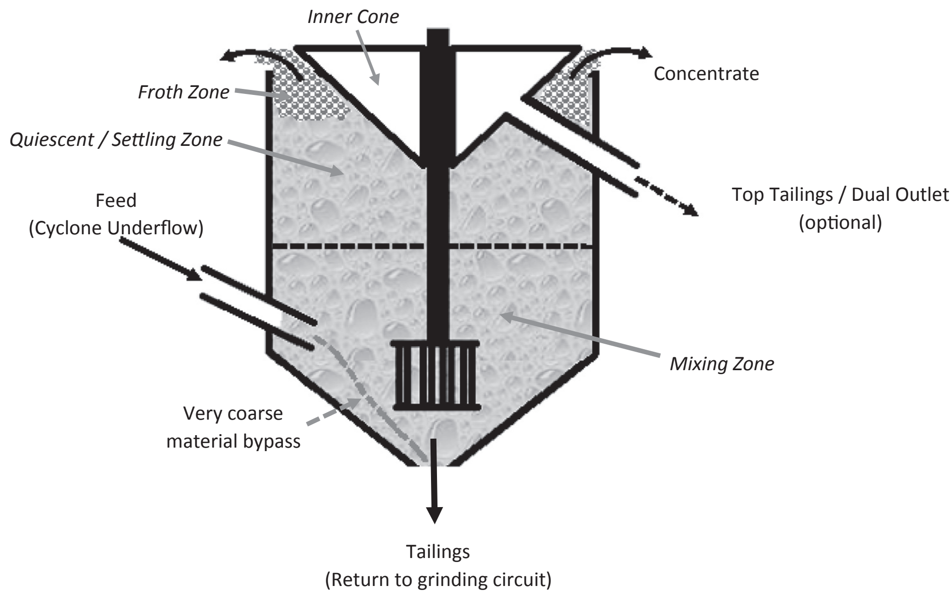

Fig. 1. Schematic of a flash flotation cell (Newcombe, 2016a,b).

Newcombe and Semini, 2014; Mackinnon et al., 2003; Bourke, 1995; Sandström and Jönsson, 1988; Kallioinen and Nitti, 1985) and the reader is directed to those publications if detailed information is required on the use, operation and applicability of flash flotation. Fig. 1 presents a schematic of a flash flotation machine, and highlights some of the design elements in place that allow a coarse and high % solids stream to be fed into the machine, including (Newcombe, 2016b):

- A conical bottom discharge (tailings) outlet, which, in combination with the angle of feed addition, provides a by-pass mechanism to allow very large particles (small rocks) to go directly to tails and minimise damage to internal mechanical parts;
- An inner cone to drive mineral-rich bubbles up and out into the concentrate launder; and
- A dual outlet line which provides a secondary tailings stream that is drawn from within the inner cone at the top of the cell.

This paper examines the impact of varying rotor speed (via the use of a variable voltage variable frequency (VVVF) drive) on the consequent performance of Au and Cu within the flash flotation cell itself, and investigates the impact of the change on the final tail grade of Au leaving via the conventional flotation circuit. Two survey campaigns have been conducted on a 1200 tph unit cell (Outotec SkimAir). Four rotor frequency settings were tested during this work: 45, 50, 55 and 60 Hz, these settings equating to 91, 101, 111 and 121 rpm respectively. During the first campaign (March 2016) a survey was taken after the flash flotation cell had achieved stable operation for approximately 2 h at each Hz setting; with 50 Hz representative of the normal operation of

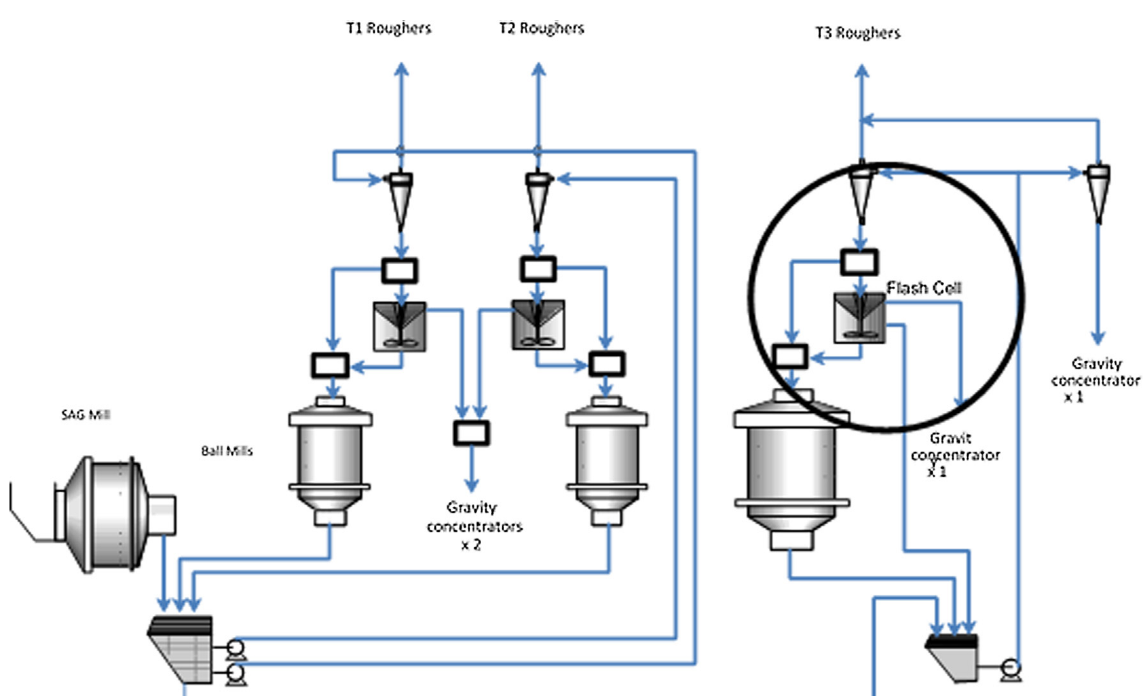

Fig. 2. Concentrator 1 primary grinding circuit – indicating the location of the flash flotation cells.