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Improving the recovery of coarse coal particles in a Jameson cell

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Abstract

It has been observed in several Jameson cell installation where the source for flotation feed is deslime screens, that the recovery of coal particles greater than 0.5 mm is not as great as that of finer material. Consequently, a research project was undertaken at a CHPP in the Bowen Basin Queensland to assess the possibility of increasing the recovery of coarser particles (+0.5 mm) within the downcomer of the Jameson cell. The effect of decreasing turbulence and agitation in a commercial-scale downcomer was investigated to assess the effect on the recovery of both coarse and fine coal particles.

This paper details the findings of the test work, summarising the results relating to differences in the operating parameters within the downcomer.

Keywords: Coal; Froth flotation and particle size

1. Introduction

Coal flotation has been active in Australia since 1970 when there were 16 mechanically agitated cells in operation (Post, 1975). However, it was not until 1990 that it became widely accepted as an economical method of treating fine coal. The first Jameson cell was installed at Newlands Coal Handling and Preparation Plant (CHPP) in 1990 treating coal slimes. Since that time the Jameson cell flotation machine has become the recognised technology in Australia for fine coal flotation with 90 cells installed in Australia and 115 worldwide (Xstrata Technology Website). The Jameson cell is a high intensity flotation device, which utilises induced air as the medium for froth flotation. It was developed jointly by Mount Isa Mines and Prof. G.J. Jameson of the University of Newcastle in the 1980s.

Initial applications of the Jameson cell focused on the flotation of fine size ranges, i.e., <150 μm, commonly referred to as slimes, because of the inability of conventional flotation cells to effectively float material at this size fraction (Jameson et al., 1991). In the past, due to the absence of appropriate and economical technology, many coal preparation plants discarded this size fraction to tails.

Current plant design philosophies tend to direct fine coal not recovered in spirals or released by deslime cyclones, nominally −350 μm to feed the Jameson cell. Due to operational and maintenance issues it is possible for material over this size to report to flotation, and in some applications where the Jameson cell feed is directly from a deslime screen material up to 1.5 mm can be misplaced to flotation.

It has been observed in several Jameson cell installations that the recovery of coal particles greater than 0.5 mm is not as great as that of finer material. Fig. 1 shows the inverted U-shape curve obtained from averaged industrial data describing combustible percentage recovery versus size curve (Nicol, 2001).

Klassen and Mokrousov (1963) reviewed the conditions necessary for flotation of coarse particles and established

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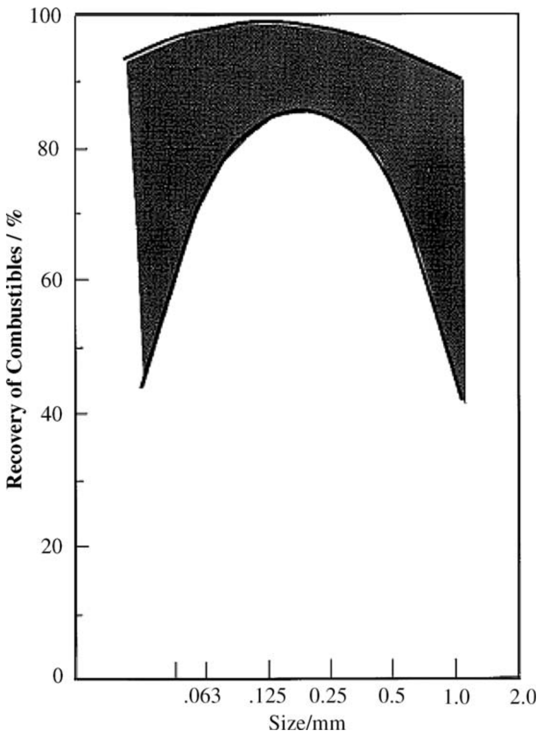

Fig. 1. Example of combustibles recovery vs size fraction for coal (Nicol, 2001).

that several factors could increase the recovery of coarse coal including:

- increasing the hydrophobicity of the surface using an appropriate collector;
- flotation by clusters of air bubbles;
- increased aeration and;
- lowering of intensity of agitation.

Three of these factors have been addressed by developments within the industry and the technology it now implements:

The use of collectors in coal flotation is commonplace with most installations employing diesel due to its low cost and adequate performance.

The high intensity zone within the downcomer of a Jameson cell allows for high probabilities of collection and flotation by clusters of bubbles and operation at high volume of induced air.

The final point regarding lowering the intensity of agitation was investigated in this paper.

The objective of this project was to develop further understanding of the effects of turbulence and air-entrainment on coarse coal flotation. The effect of these parameters were investigated in a practical way by conducting full-scale demonstration studies in a coal preparation plant using a fully-instrumented, self contained, full-scale size single downcomer Jameson cell. This allows the results of the findings to be easily translated to full-scale plant operations without risking a loss in recovery.

2. Reasons for loss of coarse particles

There are several potential reasons why recovery decreases as the particle size increases and have been subject to a recent review by Tao (2004). One major possibility is the level of turbulence in the flotation cell, another being the drag forces subjected to the bubble–particle aggregate as it flows to the froth zone.

2.1. Mechanical flotation

In mechanical flotation cells the impeller has three major functions:

- to create bubbles;
- to make bubbles and particles collide and subsequently attach;
- to keep the particles in suspension.

As the particles in the flotation feed become coarser, the impeller speed is generally increased to keep particles in suspension. In mechanical cells the impeller is immersed inside the flotation tank and is an integral part of the machine. Consequently it is not possible to adjust impeller speed in order to affect one of its functions (i.e., particle suspension) without affecting the other functions (i.e., bubble creation and bubble–particle collision/attachment).

2.1.1. The Jameson cell

Compared to mechanical cells, the functions of producing bubbles and particle–bubble collision/attachment in a Jameson cell are done separately inside the downcomer. A schematic diagram of the downcomer is shown in Fig. 2. The following steps occur within the downcomer:

1. the jet created by the slurry passing through the orifice and promotes the inducement of air into the downcomer;
2. the shearing action of the jet generates fine bubbles and transports them through the mixing zone;
3. the particles and the bubbles collide and attach to each other and subsequently travel down the downcomer; through the pipe flow zone;
4. bubbles are removed by hydrostatic pressure from the downcomer creating a vacuum for further air entrainment.

It can be seen that the performance of the downcomer (and subsequently the Jameson cell) is proportional to the energy being imparted by the jet slurry, which in turn is a function of jet velocity. It can be easily shown that the jet velocity V (m/s) is a function of the pulp flow rate, Q_p (m^3/s) and the area of the orifice, A (m^2).

$$V\ (\mathrm{m/s}) \propto \frac{Q_p\ (\mathrm{m^3/s})}{A\ (\mathrm{m^2})}$$