

**JAMESON CELL SCALE-UP EXPERIENCES AT BHP COAL'S  
GOONYELLA COAL PREPARATION PLANT**

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## ABSTRACT

In 1993, BHP Coal investigated several different flotation technologies for the replacement of the ageing mechanical (sands) flotation cells in its Goonyella coal preparation plant. The study included pilot scale testing using two 0.5 metre (1.6') diameter Jameson Cells, having a throughput of 7.5 m<sup>3</sup>/h (33 USGPM). The results showed that the cell could deliver superior metallurgical results compared to the mechanical flotation cells. In the following year, BHP Coal decided to replace the mechanical cells with Jameson Cells installed in a two stage (rougher - scavenger) configuration.

In 1995, BHP Coal initiated a project to confirm the ability of Jameson Cells to be scaled up from pilot to industrial scale. The aim of the study was to determine whether the full scale downcomer could deliver the results predicted by test work with a smaller sized downcomer. For the scale-up confirmation study, BHP Coal purchased two demonstration scale Jameson Cells, each having a diameter of 1.25 metres (4'), and a full-scale, 60 m<sup>3</sup>/h (264 USGPM) capacity downcomer. The size of the demonstration cell's tank was calculated using parameters determined during the pilot scale test work. The results from the demonstration scale trials were found to be in line with the pilot scale results.

Having demonstrated the scale up from the pilot scale Jameson Cell to the demonstration scale cells with industrial scale downcomers, BHP Australia Coal proceeded with the installation of eight model 5000/16 cells (16.5' diameter cell with 16 downcomers) in two-stage, in series, configuration. These industrial scale Jameson Cells, each treating 960 m<sup>3</sup>/h (4227 USGPM) used the same size downcomer as the demonstration cell. The installation of the Jameson Cells at Goonyella was part of a major fines circuit upgrade.

Commissioning of the refurbished fines circuit was completed in two weeks, with maximum throughputs achieved shortly thereafter. The full-scale Jameson Cell optimisation data are seen to closely match the pilot scale performance data. The results show that the pilot scale tests were able to accurately predict the performance of the full-scale Jameson Cells.

Several months of Jameson Cell operating data show that the full-scale installation has consistently been able to deliver the results predicted by the pilot scale testing. The Jameson Cell's performance is also demonstrated to be much less variable than that of the preceding mechanical flotation cells.

The ability of the Jameson Cell to deliver a consistently low ash product has allowed the recoveries from the coarse circuit to be increased, thereby paving the way for a 3.5% increase in plant yield, and the setting of BHP Coal production records.

## INTRODUCTION

Goonyella / Riverside Mine is one of seven mines managed and operated by BHP Coal Pty Ltd (formerly BHP Australia Coal Pty Ltd) in central Queensland's Bowen Basin. While Goonyella (owned by Central Queensland Coal Associates) and neighbouring Riverside (owned by BHP Mitsui Coal) were amalgamated in 1989, the mines are on separate leases, and have their own coal preparation facilities. The two operations combined will produce approximately 10.7 million tonnes of coal this financial year, 7.2 million tonnes being from the Goonyella operation (Gosnell, 1996).

The Goonyella mine and coal preparation plant commenced operations 25 years ago, with an output of 4.4 million tonnes per year. In the original plant, the feed stock was split into two process streams:

- coarse coal (+0.5 mm wedge wire), comprising 80% of the plant feed, which was treated by six modules of heavy media cyclones, and
- fine coal (-0.5 mm wedge wire) which was treated by "sands" flotation in a common circuit consisting of four banks of 4 x 300 cubic foot Wemco mechanical cells. The ultrafines were discarded.

Subsequent modifications included the addition of a slimes flotation stage (1979), the incorporation of tailing scavenging spirals (1985) and a one third plant expansion in 1987 to increase the production rate to 6.7 million tonnes per year.

By August 1993, when Goonyella sold its one hundred millionth tonne of coal, the coal preparation plant could treat 1800 tonnes per hour, and consisted of eight heavy medium cyclone modules, split flotation consisting of four banks of 4 x 300 cubic foot Wemco cells for sands flotation and four banks of 4 x 300 cubic foot Wemco cells for slimes flotation, and scavenging spirals. Overall, the flotation circuit typically gave products with ash contents in the order of 9 to 10%, with combustibles recoveries ranging between 71 and 83%. However, the coarse flotation cells were severely corroded, and required replacement. New flotation technologies were investigated for this replacement due to the potential to increase the overall plant yield by achieving lower ash products from the flotation circuit.

In 1993, BHP Coal initiated an intensive on-site test work program to investigate the benefits to the Goonyella coal preparation plant of some novel, high intensity flotation technologies, namely:

- Jameson Cell, (MIM Holdings Ltd)
- Microcel, (Bulk Materials Coal Handling) and
- Centrifloat High Rate Cell (Century Oils).

The Jameson Cell, is a pneumatic flotation cell which has no moving parts and no requirement for compressed air or sparging mechanisms. A technical description of this flotation device is given elsewhere, (Evans *et al*, 1995).

## TEST DETAILS

### Pilot test work

Pilot scale models of the Jameson Cell, Microcel and Centrifloat High Rate cells were trialed in open circuit, with the following feed streams taken directly from the preparation plant:

- full flotation feed, 0.5 millimetre wedge wire x 0 coal (see Table 1),
- slimes flotation feed, 75 micron x 0 (minus 200 mesh) coal, and
- tailings thickener underflow.

**Table 1 - Flotation feed characteristics**

<b>Size Fraction Mesh No. (nom. aperture size)</b>	<b>Mass (%)</b>	<b>Ash (%a.d.)</b>
+16 mesh (+1mm)	0.5	19.0
-16 +30 mesh (-1 +0.5mm)	12.1	14.0
-30 +60 mesh (-0.5 +0.25mm)	21.1	14.0
-60 +100 mesh (-0.25 +0.15mm)	13.7	15.2
-100 +250 mesh (-0.15 +0.063mm)	13.2	18.2
-250 mesh (-0.063mm)	39.4	39.0

The flotation feed stream typically has an ash content in the range of 18 to 25%.

A mobile Jameson Cell pilot plant was used for the on-site test work at Goonyella. The pilot plant included two model JC500/1 Jameson Cells, which have a diameter of 500 mm (1.6'), fitted with one 100 mm (4") downcomer. The cells had an individual cell capacity of 7.5 m<sup>3</sup>/h (33 USGPM), and could be operated as single stage, two stage, or single stage with partial tailing recycle. The various Jameson Cell configurations are illustrated in Figure 1.

### Demonstration scale Jameson Cells

Jameson Cell flotation tests were performed using demonstration scale Jameson Cells to confirm that full scale 300 mm (12") diameter downcomers rated at 60 m<sup>3</sup>/h (264 USGPM) could replicate the results of the pilot scale equipment. The demonstration scale Jameson Cell had a diameter of 1.25 m (4.1'), and had a section of the circumferential cell lip blanked off to ensure that the product mass rate per unit of lip length would be the same as for the full scale Jameson Cells which were proposed for installation at Goonyella. Two cells were skid mounted, with the intention of operating in a two-stage configuration.

Due to reagent conditioning constraints, the two-stage Jameson Cell configuration was difficult to operate. As a result, the demonstration scale trials were performed with one cell only operated in partial tailing recycle mode. The pilot scale test work

showed that operating one cell in partial tailing recycle mode approximated the performance of two-stage operation.

The four-day demonstration cell test work campaign was undertaken at a time when the feed to the plant was described by site personnel as oxidised coal, and consequently, plant flotation performance was adversely affected. The feed coal was suspected to have been heat affected. Additionally, the flotation feed solids content was higher than usual (14 to 18%, compared to 10 to 12%).

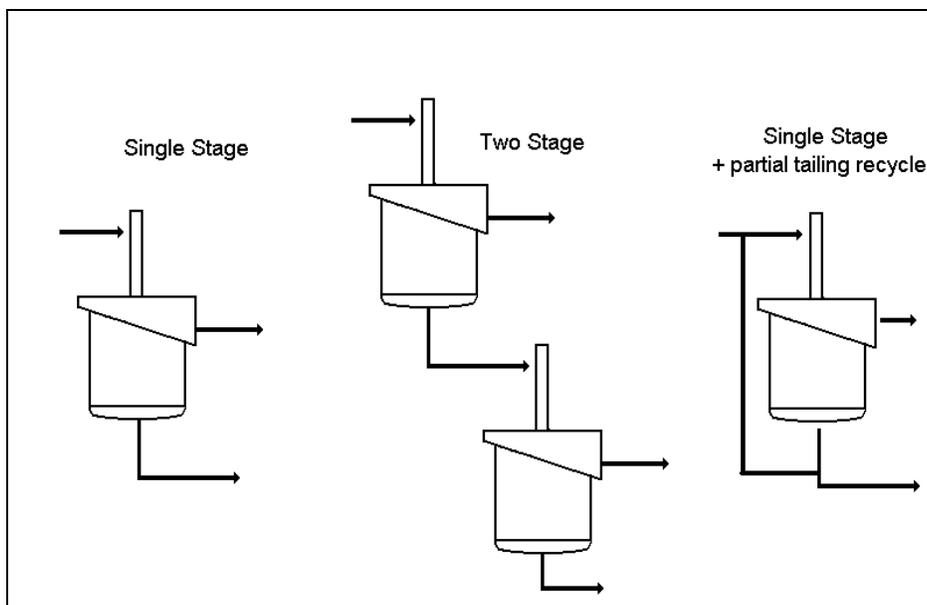
### **Full scale Jameson Cells**

Eight model 5000/16 Jameson Cells (16.5' diameter with 16 off 12" downcomers per cell) were installed in two-stage configuration, (four primary cells followed by four secondary cells) as shown in Figure 2. The specified flotation feed was 3800 m<sup>3</sup>/h (16,700 USGPM) slurry containing 9.2% solids by weight.

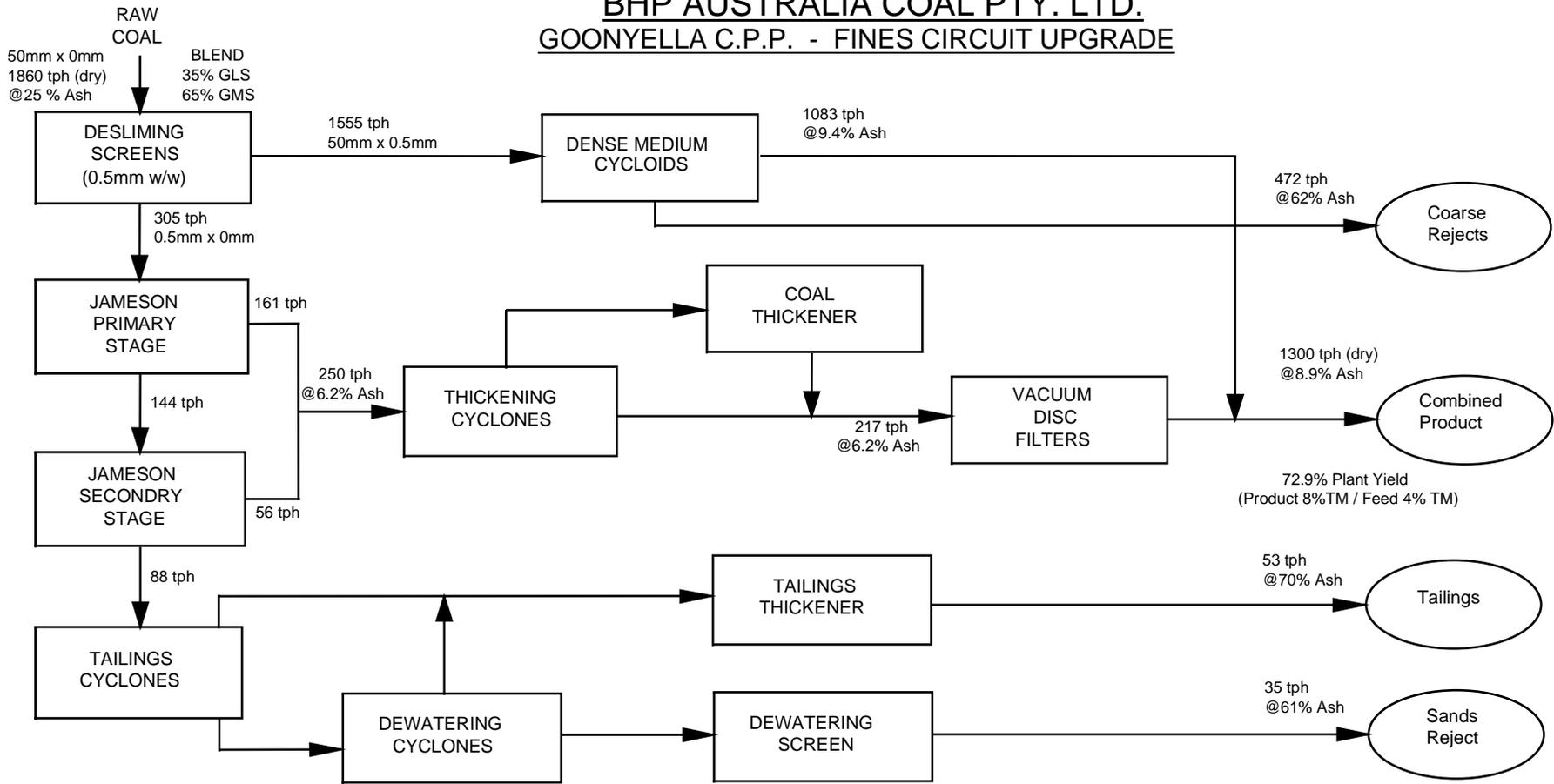
Jameson Cell scale-up is performed using simple algorithms and the values of key parameters determined during test work. The model 5000/16 Jameson Cell was designed directly using optimised parameters from the pilot scale test work. The operating strategies and reagent usage were also determined during the pilot scale test work. Operating variables such as air flow rate, froth depth and wash water addition can be adjusted to achieve performance targets.

The Jameson Cell installation was part of a major fines circuit upgrade which also included design and construction of a coal thickener, building an annexe on the existing plant to house the Jameson Cells, upgrading the control system and relocating several items of equipment in the plant.

**Figure 1 - Jameson Cell configurations for fine coal flotation**



**Figure 2**  
**BHP AUSTRALIA COAL PTY. LTD.**  
**GOONYELLA C.P.P. - FINES CIRCUIT UPGRADE**



## RESULTS AND DISCUSSION

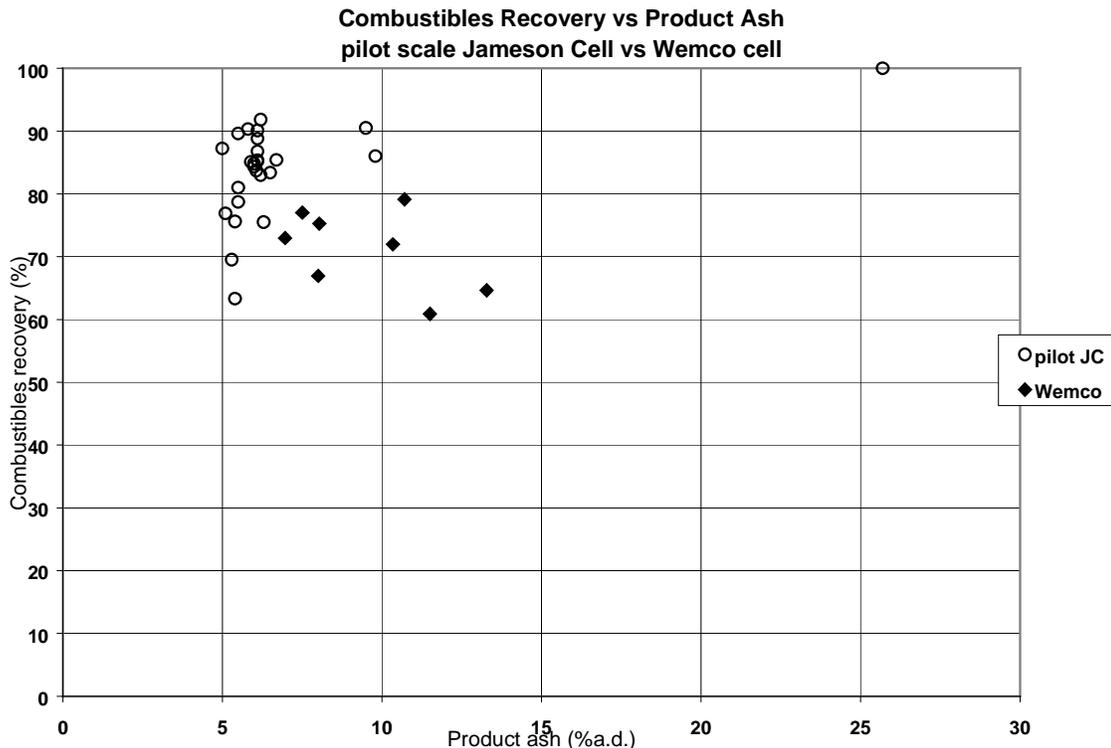
### Pilot scale test work and evaluation

The pilot scale flotation test work showed that the Jameson Cell could achieve a significantly lower ash product than the existing Wemco flotation cells, while maintaining or increasing the combustibles recovery. Figure 3 illustrates the performance of the pilot scale Jameson Cell when treating the flotation feed stream, compared to the combined performance of the Wemco sands and slimes flotation cells. The Wemco data was obtained by an independent party performing flotation surveys.

During the pilot scale test work, the results from two stage Jameson Cell flotation were observed to be very similar to the results from tests performed with a single stage with partial tailing recycle. This is a typical result, and can lead to substantial equipment cost savings in full scale installations.

The test results from the three novel flotation cell technologies and operating data from the mechanical flotation cells were included in a comprehensive evaluation process, which examined capital and operating costs, forecast increases in revenue, operability and technical risk.

**Figure 3**



After rigorous analysis, BHP Coal decided to install Jameson Cells to treat the full flotation feed stream. The Jameson Cells were to be configured as two-stage units,

with the tailing from the first stage being treated in the second stage. Although single stage Jameson Cells incorporating partial tailing recycle achieved results comparable to the two-stage cells, the latter configuration was selected, as it had been successfully installed and operated at BHP Coal's Blackwater Mine and MIM Holdings' Newlands operation (Manlapig *et al*, 1993). At that stage, single stage operation with partial tailing recycle had an element of risk, as the Goonyella pilot testing represented the first thorough investigation of this mode of operation, and there were no industrial scale Jameson Cells installed in this configuration. However, this Jameson Cell configuration has subsequently adopted by several coal preparation plants, (Dawson *et al*, 1996 and Le Page *et al*, 1995).

The Jameson Cell technology was selected over the competing technologies because of (Carretta, 1996):

- the lower capital cost for full scale installation,
- lower operating costs (power, reagents) and maintenance costs,
- the scale-up from the pilot rig had been proven at BHP Coal's Blackwater Mine,
- the Jameson Cell having achieved the same combustible recoveries and product ashes as the other technologies, and
- the Jameson Cell test rig was the easiest to operate and was insensitive to feed fluctuations of percent solids and feed rate.

The ability of the Jameson Cell to produce a low ash product meant that the recovery from the coarse circuit could be increased (at a slightly higher ash content), thereby increasing the plant's production rate while meeting the product ash specifications.

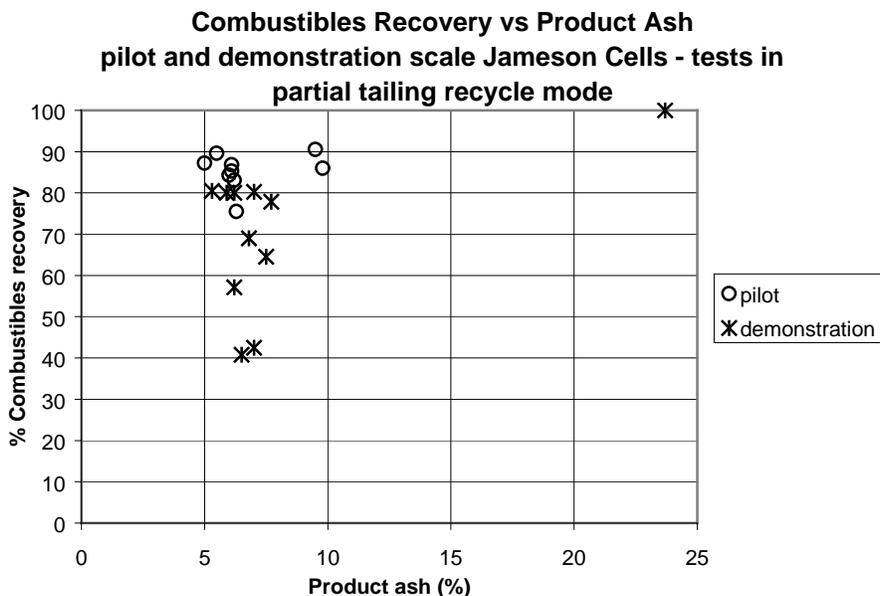
### **Demonstration scale test work**

The combustibles recovery versus product ash results from the demonstration scale flotation tests were generally in line with those of the pilot scale tests, although at reduced combustibles recoveries, (Figure 4). The performance of the plant's Wemco cells when treating the poor quality feed used during the demonstration scale test work was also poorer than usual.

The demonstration cell test program was terminated prematurely when the feed type to the plant changed to a partially oxidised Riversids middle seam.

High feed solids contents are known to adversely affect the performance of the Jameson Cell, particularly when operating near carrying capacity limitations (Espinosa-Gomez *et al*, 1988). Therefore, the abnormally high feed solids content may have caused a limitation in the combustibles recovery. Given the less than ideal conditions under which the demonstration scale test work was performed, the results were viewed as encouraging.

Figure 4



### Full scale

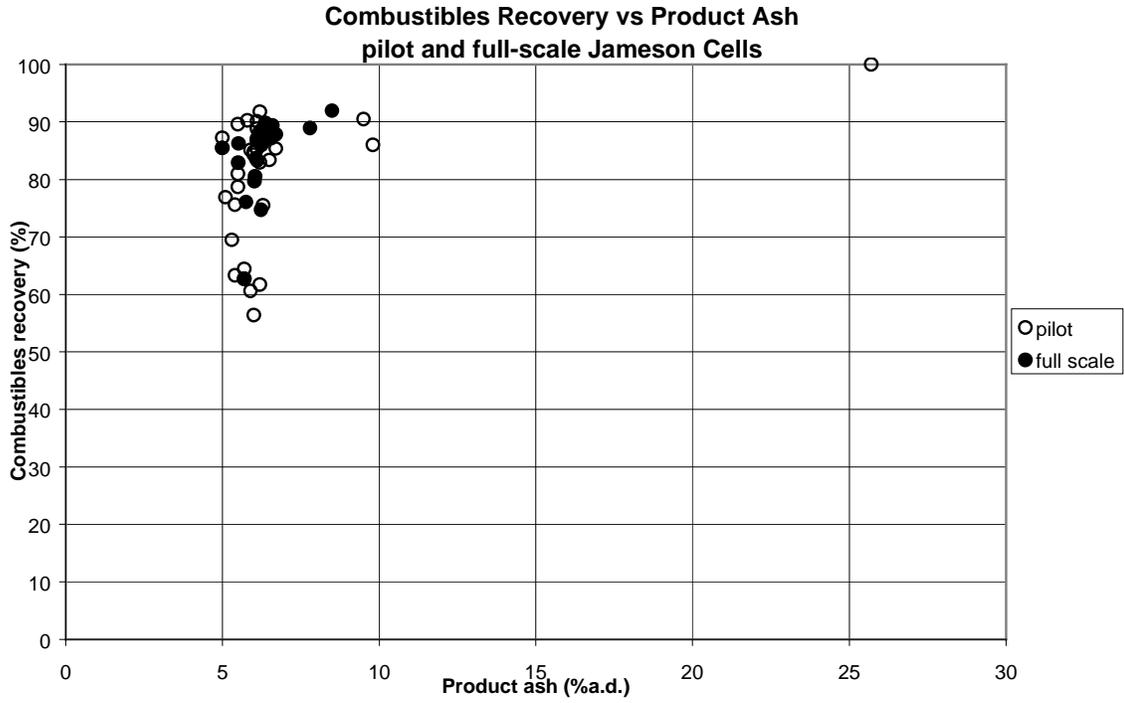
Commissioning of the upgraded fines circuit occurred in December 1995. The commissioning was completed in two weeks, with major difficulties being maintenance short-falls and operational problems with the one metre (3.3') diameter tailing classifying cyclones, the coal thickener, and the new reagent dosing system. The plant was able to operate at its maximum throughput of 2000 t/h (an increase over the pre-upgrade throughput of 1800 t/h) six weeks after re-commissioning the fines circuit.

Figure 5 illustrates the combustibles recovery versus product ash results of the full scale Jameson Cell optimisation trials, which were performed after commissioning, to the pilot scale test work results. The ability of the pilot scale test work to accurately predict the performance of a full scale Jameson Cell is demonstrated here.

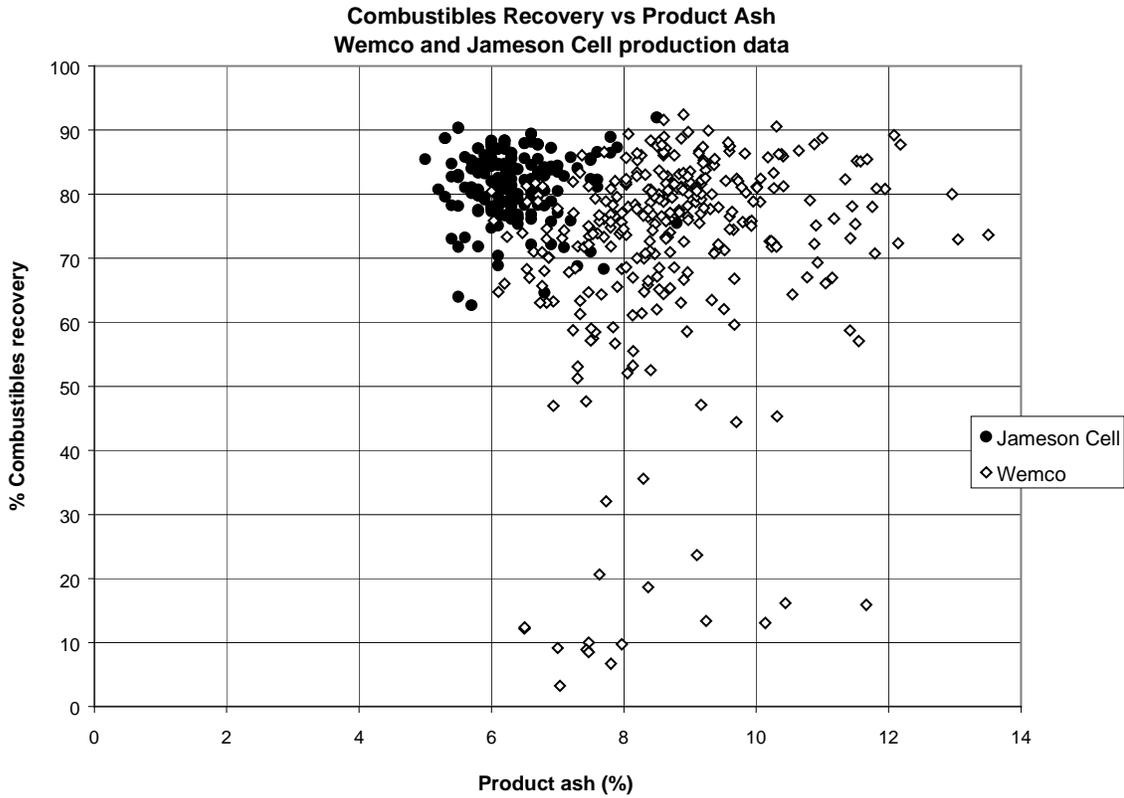
The full-scale Jameson Cell's operating parameters such as reagent addition and froth depth were determined by pilot test work, and directly translated to full-scale operation.

The consistent performance of the full scale Jameson Cell installation is illustrated by Figure 6, in which one year's Wemco shift data is compared to approximately six months of Jameson Cell shift data. The Jameson Cell is demonstrated to achieve a consistently low ash product in spite of variations in the feed properties.

**Figure 5**

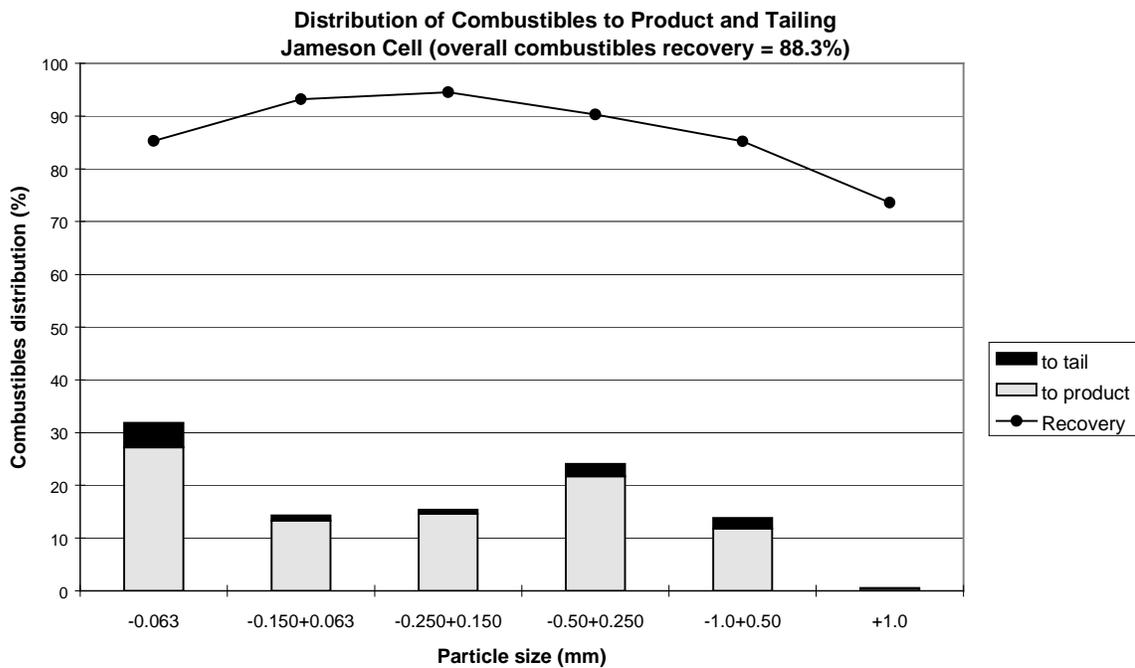


**Figure 6**

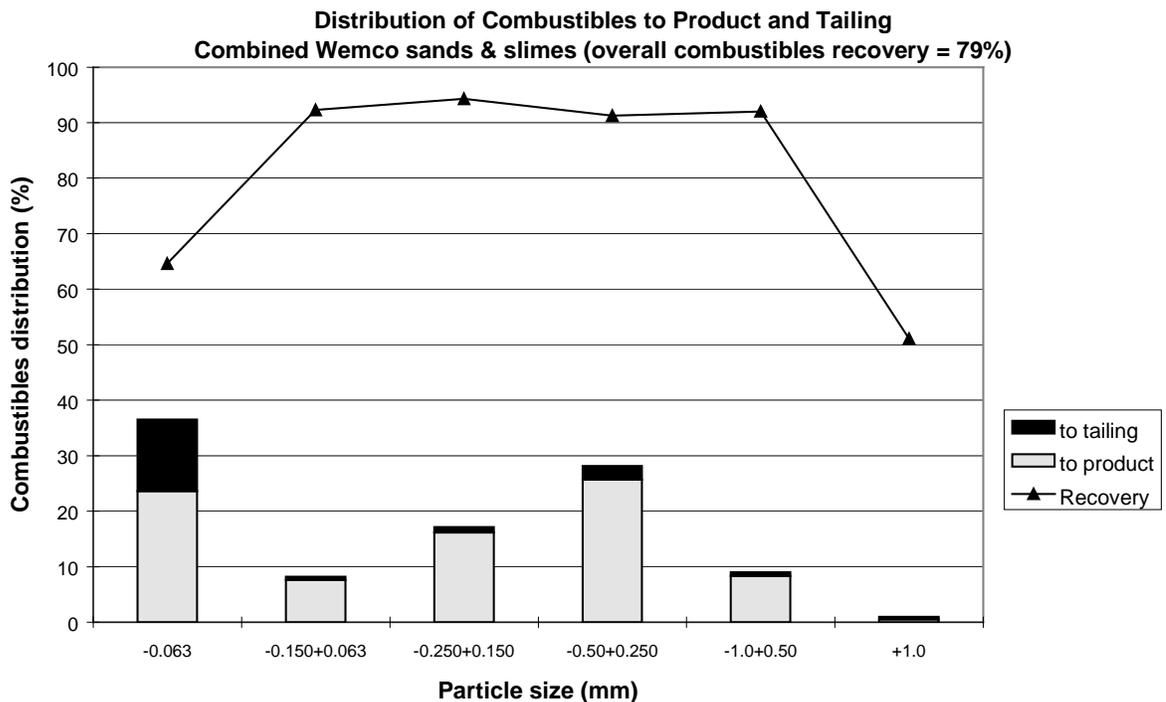


Figures 7 and 8 illustrate the distribution of the combustibles in the feed to the product and tailing when treated by the Jameson Cell and Wemco cells respectively. The Jameson Cell is demonstrated to maintain high combustibles recoveries across the range of particles sizes present in the flotation feed. The mechanical flotation cells reported poorer combustibles recoveries from the finest and coarsest particles, the former being particularly critical to the overall recovery.

**Figure 7**



**Figure 8**



Performance data subsequent to commissioning the Jameson Cells has shown that the overall plant yield has been increased by 3.5%. The realised plant increase was

significantly higher than the predicted yield increase of 2.1%. As a result, the payback for the fines upgrade project was reduced from the predicted 28 months to 17 months.

The success of Jameson Cell installation at the Goonyella coal preparation plant has contributed to the plant's record breaking performances. In March 1996, Goonyella broke the BHP Coal weekly production record by producing 198,645<sup>1</sup> tonnes of coal, overtaking the previous mark set by the nearby Peak Downs Mine. Goonyella has continued its record breaking performances, setting new weekly production highs in May 1996 (200,163 tonnes) and in January 1997 (210,476 tonnes).

## **CONCLUSIONS**

1. Pilot scale Jameson Cell testing proved that this technology was superior to the existing mechanical flotation cells in producing a lower ash product and achieving higher combustibles recoveries.
2. During the demonstration scale Jameson Cell tests, the product ashes observed in the pilot scale test work were reproduced, although the combustibles recoveries fell short of the pilot scale results. The lower combustibles recoveries were most likely caused by the degraded nature of the coal feedstock.
3. The performance of the full scale Jameson Cell installation closely matches the performance of the pilot scale cells. Therefore, pilot scale Jameson Cell test work was able to accurately predict the performance of the full scale cells.
4. The Jameson Cell achieves higher combustibles recoveries from the finest (-0.063 mm) and coarsest (+ 1.0 mm) size fractions, and hence is able to give higher overall combustibles recoveries.
5. The ability of the Jameson Cell to consistently deliver a low ash product at high combustibles recoveries has contributed to an overall plant yield increase of 3.5%. This has led to the setting of new production records.

## **ACKNOWLEDGEMENTS**

The authors would like to thank BHP Coal Pty Ltd and MIM Holdings Ltd for permission to publish the data contained herein.

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<sup>1</sup> All tonnages corrected to a moisture content of 8%, which is standard BHP Coal practice.

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