Procemin 2016 | 12th International Mineral Processing Conference

Jameson Cell Project Evaluation in the Cleaner Circuit at Codelco Andina

Eduardo Morin[1] and Virginia Lawson[2]

1. *Andina Division, Codelco Chile*
2. *Glencore Technology, Australia*

ABSTRACT

The Process Engineering Superintendent, visualizing the opportunity for improvement in the recovery of Molybdenum in the stage of column flotation carried out during 2015 an experimental campaign on a pilot scale, using flotation technology Jameson Cell in the concentrator plant Division Andina.

It has been experimentally found that the columns tend to deconcentrate molybdenite, so Mo recoveries at this stage are <25%. This phenomenon occurs by high Mo recoveries in step Scavenger (> 90%). However, this stage is not able to recover more Mo, so is lost in the final tailings plant.

The purpose of these tests was to confirm the advantages of the technology on Jameson technology currently used in the final cleaning stage flotation circuit.

The results show that the Jameson cell is capable of producing concentrates quality similar to that generated in columns cells in terms of copper (27-29%) and 60-90% recoveries, but a clear difference was obtained between the recovery of molybdenum obtained in columns (10-25%) compared with the recoveries obtained in the Jameson (40-80%) cell. Regarding the law of molybdenum concentrate obtained cell column values 0.6-1.0% compared to the Jameson cell with laws 1.0-3.0%

The main difference between the two technologies is the bubble size and intensity of mixing of the particles, allowing smaller particles may adhere to bubbles and be collected as concentrate, which does not occur in cells columns, where mixing intensity is lower and larger diameter bubbles are difficult collection molybdenum particles in the bubbles.

In the quest to be regarding national level in the production and recovery of molybdenum Division Andina economically evaluate the option of including the Jameson cell in the process.

INTRODUCTION

In the bulk copper molybdenum flotation plant at Codelco Andina Division it has been experimentally found that the columns tend to "deconcentrate" molybdenite, so Mo recoveries at this stage are <25%. This phenomenon is mitigated by some degree by high Mo recoveries in the Scavenger (> 90%) however, this stage is not able to recover more Mo, so is lost in the final tailings plant.

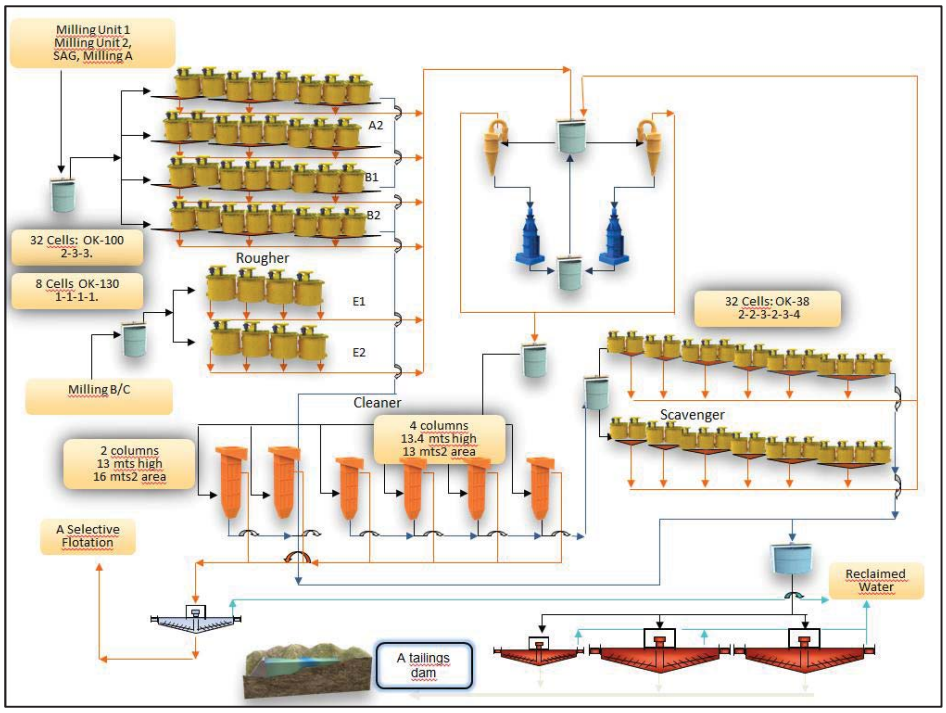

Figure 1 Plant flotation circuit layout

The flotation circuit at Andina Division is comprised of three lines of rougher flotation (lines A, B and E). The rougher concentrate is sent to a regrinding step in vertical mills.

Subsequently reground concentrate is sent to 6 columns cells (1 stand by) producing the final concentrate. Tailings from the column cells are sent to a scavenger stage. The scavenger concentrate is sent to regrinding in vertical mills (in combination with the rougher concentrate) while the tailing of scavenger stage is sent to final tailings thickeners, together with the tailings from the roughers (lines A, B and E).

The superintendent of process engineering, visualizing the opportunity for improvement in the recovery of Molybdenum in the final cleaner stage, contacted Glencore Technology (formerly Xstrata Technology), to analyse whether its flotation technology, the Jameson Cell, could be a solution to improve the recovery of molybdenum in the cleaning step as an alternative to the columns cells.

During 2013, Andina Division of Codelco, performed laboratory dilution tests (used to represent the operation of the Jameson cell using conventional cells at laboratory scale), to determine whether the

Jameson Cell flotation technology may obtain improvements in performance compared to the columns cells.

The results of these tests showed that the Jameson Cell could consistently recover both copper and molybdenum, up to 85%, which in the case of molybdenum, was a significant improvement over the base case where the plant columns were only recovering 15% of molybdenum. These results led Andina Division to consider conducting a pilot plant on site using the Jameson Cell during 2015, in order to validate the laboratory dilution test results with a plant based pilot.

Currently the concentrator achieves the following overall plant performance:

Table 1 Overall plant performance

	Cu (%)	Mo (%)
Feed	0,8	0,032
Final Concentrate	28,5	0,6-0,9
Recovery	88,5	71,5

As for column flotation cell, the stage recovery range corresponds to:

Table 2 Range of recovery of column cells

	Cu (%)	Mo (%)
Recovery	50-80	10-25

METHODOLOGY

In order to carry out the test plan industrially, the Jameson Cell pilot model L500 / 1 was installed, as shown in Figure 2. The L500 / 1 unit was mounted on the floor of the flotation section D. The tests were performed using a bleed of the slurry feed flow to the column cells taken from the pump box feeding the Andina Division columns via a bredel pump. Segregation at the feed sample point resulted in a coarser feed to the Jameson cell. The location was later moved to enable a better sized sample however the feed grade was lower.

The pilot tests were conducted at the Andina Division concentrator plant in two stages: the first between May and July 2015 where a range of different operating conditions of the Jameson cell were tested in order to determine the grade vs recovery curve (Cu and Mo) for different operating conditions.

The second stage was conducted between August-November 2015, in order to validate the best operating conditions obtained during the first phase of testing.

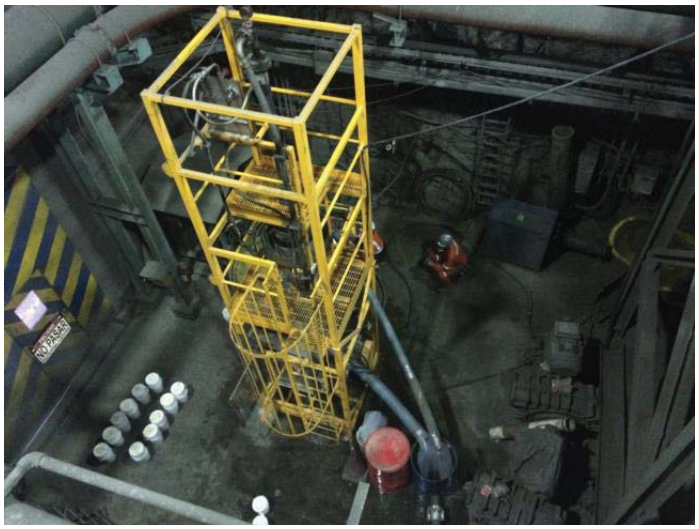

Figure 2 Jameson Cell concentrator plant installation

During the pilot with the Jameson Cell the following operational variables of the cell were varied: froth depth, wash water flow and air flow, so as to generate different recovery conditions vs grade, and get as many conditions operational possible for the cell. This intentional variation of parameters produces results over a range of conditions to enable analysis of cause and effect. The tests were designed to operate along the grade recovery curve over different days and conditions.

To improve selectivity the following operating conditions was used:

- Increased froth depth
- With water wash (on)
- Low airflow.

However, when operating conditions aimed at a greater recovery was explored the following were used:

- Low froth depth
- No washwater (off)
- High airflow

This demonstrates the great versatility of Jameson cell technology, which allows it to operate in a wide range of operating points, depending on the requirements that exist from the process.

Table 1 Jameson Cell range of operating parameters

Parameter	Range
Air flow (m3/h)	9-16
Vacuum pressure (kPa)	7-16
Cell level (%)	60-90
Froth Depth (mm)	150-650
Washwater (m3/h)	0-1.7

CURRENT PLANT CIRCUITS

The main results of this experimental campaign are presented, calculated based on the fresh feed for the Jameson Cell:

Testing on Column Feed stream

Upon completion of plant testing the results confirm the benefit of the application of the Jameson cell observed at laboratory scale (dilution test). These results show that the Jameson cell is capable of producing concentrates similar to that generated in the plant columns cells in terms of copper (grade and recovery), but show significant improvement in recoveries and grades of molybdenum compared to what is currently achieved in columns cells. Figure 3 shows the copper grade and recovery obtained for both the Jameson Cell and the plant column cells.

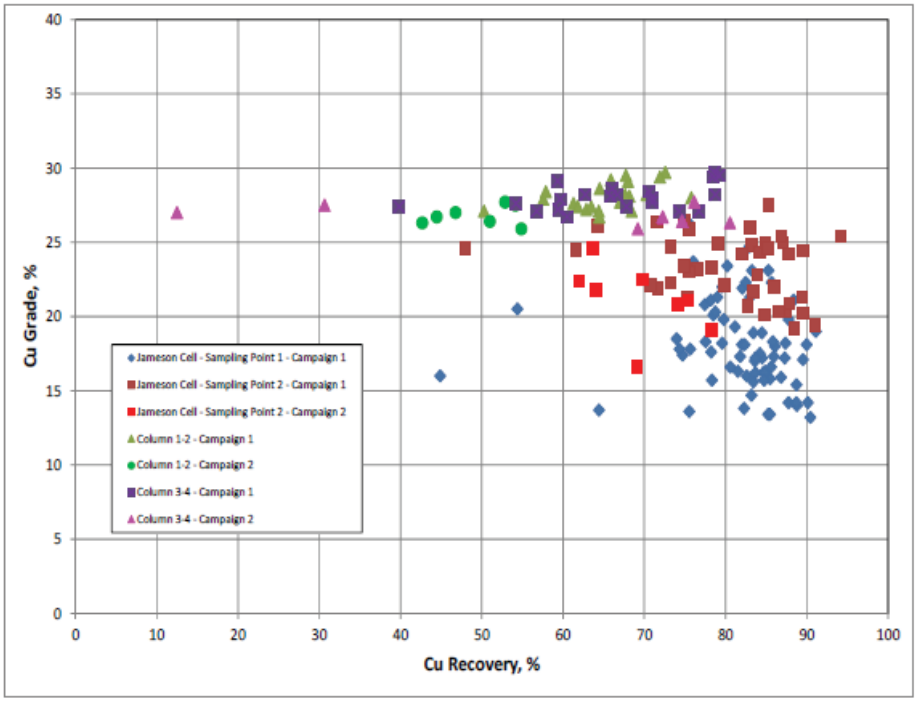

Figure 3 Cu Grade Recovery curve

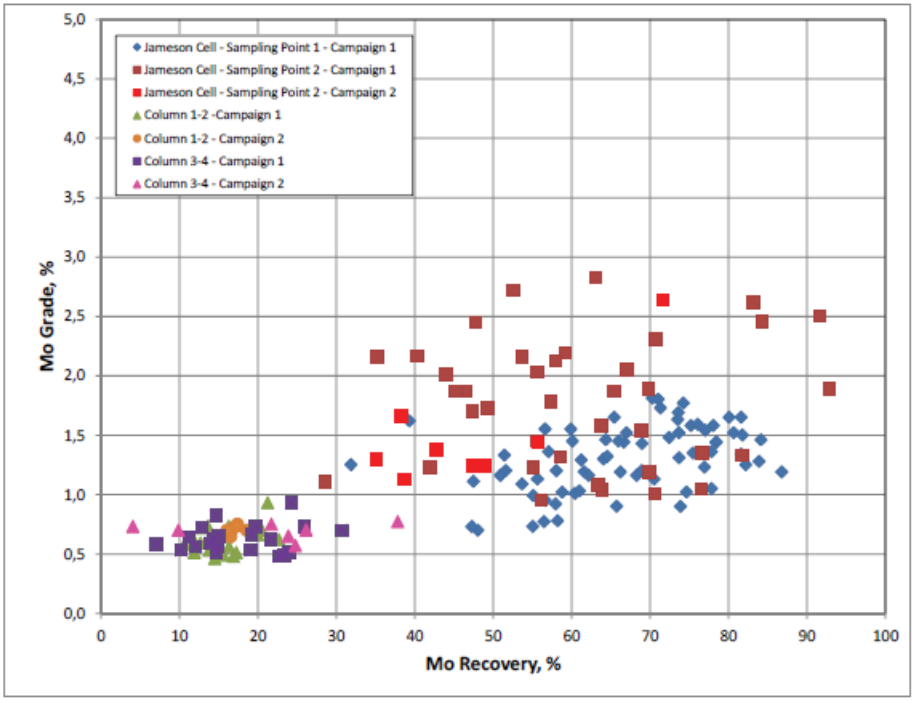

Figure 4 Molybdenum Grade Recovery curve

With respect to molybdenum a clear difference between the results obtained for molybdenum recovery in the columns (10 to 25 %, with a single value around 37.8 %), compared with the recoveries obtained in the Jameson Cell with up to 90% recoveries observed. The main difference between the two technologies is the bubble size and the intensity of mixing for contact of the particles and bubbles. In the column cells, where mixing intensity is much lower and with bubbles of significantly larger diameter molybdenum particles are difficult to recover. Figure 4 shows the recovery comparison for molybdenum (Jameson Cell and plant column cells). Both the grade and recovery are significantly improved.

Figure 5 shows the selectivity curve of copper with molybdenum, for the plant columns cells and for the Jameson Cell. This graph shows a significant difference in the behaviour of both technologies and reinforces that the molybdenum can be floated by true flotation and not only by entrainment, as is often accepted by operations and reported in the literature (Gonzalez, 2015).

The column cell demonstrates more selective flotation behaviour of copper compared to molybdenum. Copper recoveries ranging from 50 to 80%, while for molybdenum ranging from less than 10 % to 25 %. Even at the maximum value of 37.8 % molybdenum recovery (80 % copper) the performance is two thirds that achieved in the Jameson Cell of 60 % molybdenum.

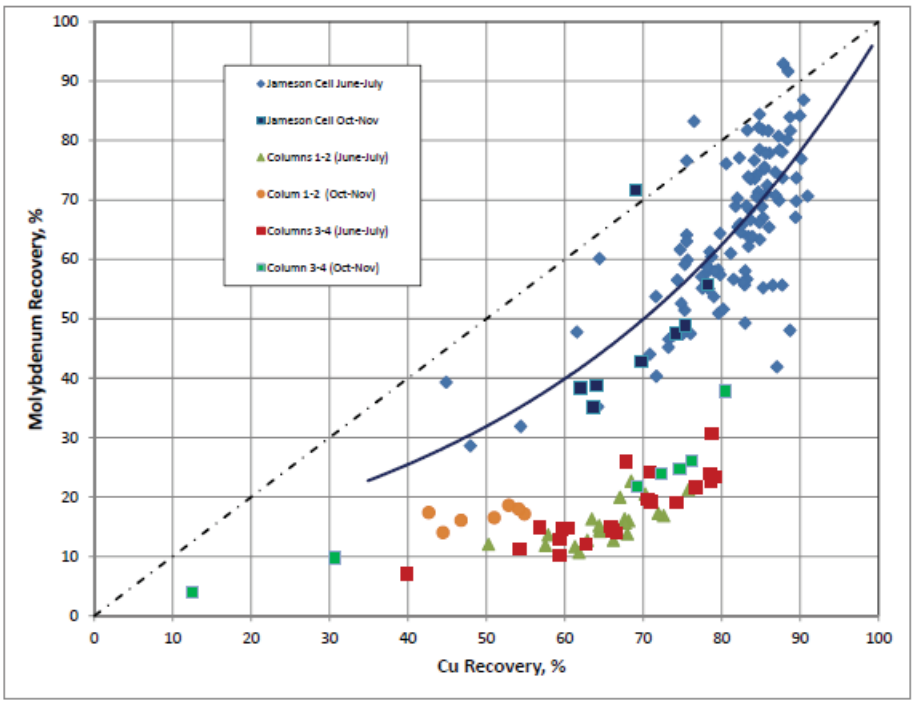

Figure 5 Copper Molybdenum Selectivity curve

Testing on column tails

Exploratory tests were also conducted on the plant column tail to identify if this may be an ideal location for the Jameson Cell. The results show the same behavior on the column tail as was observed on the column feed i.e. copper recoveries of 60% and recoveries of 50% for molybdenum. Molybdenum concentrate grades were excellent. This confirms the floatability of the molybdenum that is lost in the column.

The copper grades on this stream are lower, below 20% copper. This indicated that the copper in the column tails is not liberated and that the Jameson cell is successfully floating composite materials, probably from the coarser fractions with lower grade. This indicates that liberation is limiting the concentrate grade as the Jameson Cell recovers more coarse material.

Figure 6 and Figure 7 illustrate the impact of a single variable, wash water, on the grade recovery curve of copper and molybdenum. In the case of copper, some recovery is lost as particles with lower hydrophobicity are removed and the concentrate grade is improved at a lower recovery. This represents movement on the same grade recovery curve again confirming the presence of composite particles. The molybdenum however shows that its grade is increased with very little change in recovery demonstrating its recovery by true flotation and suggests that the froth stability in a Jameson Cell with wash water is supporting its recovery.

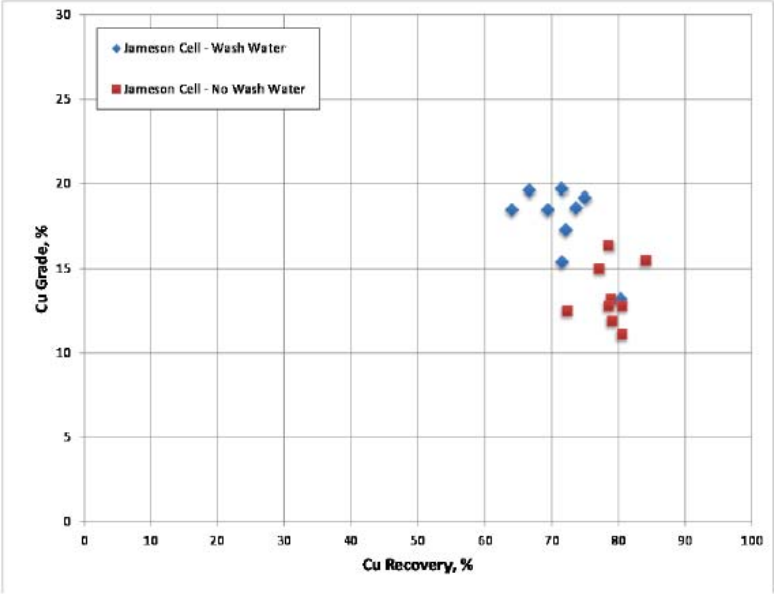

Figure 6 Effect of wash water on copper performance - column tails

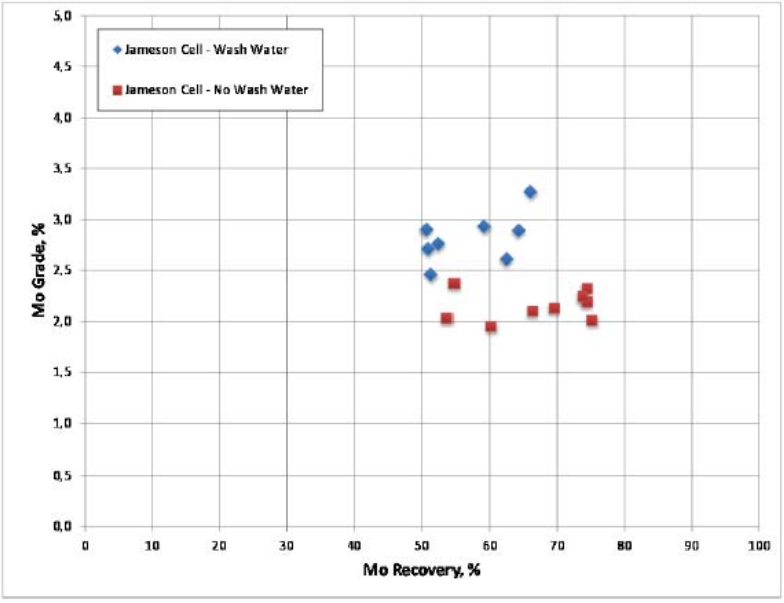

Figure 7 Effect of wash water on molybdenum performance - column tails

CONCLUSIONS

Pilot plant testing confirmed the results, and the benefit, of the application of the Jameson cell observed at a laboratory scale (dilution test). These results show that the Jameson cell is capable of producing concentrate grades similar to that generated in columns cells in terms of copper (grade and recovery), but show significant improvement in recoveries and grades of molybdenum in comparison to what is currently achieved in the plant columns. A summary of the results can be observed the following table:

Table 2 Comparison of Column Cells and Jameson Cells

	Column Cells	Jameson Cell
Recovery Cu %	50-80	60-90
Recovery Mo %	10-25	40-80
Maximum Grade Cu (%)	29.7	28
Maximum Grade Mo (%)	0.9	3.0

Due to the intense mixing and novel bubble generation in the Jameson Cell, it is possible to simultaneously obtain good recoveries of both copper and molybdenum, compared to the columns where copper is recovered in preference to the recovery of molybdenum. This shows that with the Jameson Cell molybdenum is floated by true flotation and not as entrainment, as is often accepted by operations and literature (Gonzalez, 2015).

These results confirm that the Jameson cell is a valid alternative to consider for replacing the column flotation cells currently installed in the circuit, in order to improve the metallurgical performance of the flotation cleaning circuit at Andina Division.

REFERENCES

Gonzalez, C. / Glencore Technology (2015). Pruebas Piloto Celda Jameson L500/1 – División Andina – Codelco Chile.