IPJ CASE STUDY:

Recovering tin at the Alphamin Resources – Bisie Tin project

Alphamin RESOURCES

Alphamin Resources is a low-cost tin concentrate producer from its high-grade deposit at Mpama North and an additional 5 exploration licenses covering a total of 1,270km² in the North Kivu Province of the Democratic Republic of Congo (DRC).

Alphamin is headquartered in Mauritius and listed on the TSX Venture Exchange (TSXV: AFM) and the Johannesburg Stock Exchange AltX (JSE AltX: APH).

Alphamin are aiming to increase annual tin output and life of mine through incremental production from Mpama South and by adding more mines in close proximity to the current production and from within their licensed footprint.

Background

The Bisie Tin underground project is located in Walikale District, North Kivu Province of the Democratic Republic of Congo (DRC). Bisie is one of the world's biggest tin deposits.

Alphamin Resources holds 80.75% stake in the project through its subsidiary Alphamin Bisie Mining (ABM), while the DRC Government and Industrial Development Corporation of South Africa hold 5% and 14.25%, respectively.

Construction was started in 2018 and completed in the first quarter of 2019.

The Bisie Tin project is being developed in three phases. The first phase focuses on developing the Mpama North region. Mpama North is producing approximately 10,000 tonnes contained tin per annum. Its life of mine is currently 12.5 years.

The second phase is underway with the IPJ forming part of the new plant.

Circuit configuration

The original IPJ circuit design was to pre-concentrate the tin at a metal recovery of >90%. The circuit included the IPJ 2400 (Rougher Jig) and IPJ 1500 (Cleaner Jig) fed at -10mm from the 3-stage crushing circuit.

The tailings of the Jigging plant is dewatered on a dewatering screen and discharge onto a tailings stockpile from which it is removed to the tailings dump. The -1mm fraction that follows the water from the dewatering screen is fed to the low-grade circuit.

The Jig concentrate is also dewatered at -1mm as well and the screen underflow is discharged into the underpan with the tailings -1mm material. This forms part of the material fed to the low-grade circuit.

The IPJ concentrate is conveyed from the screen overflow to the high-grade bin.

The low-grade section consists of a dewatering cyclone, ball mill and several stages of spirals to produce a concentrate that is added to the high-grade section concentrate.

The high-grade section consists of a ball mill and fewer stages of spirals to produce a concentrate that together with the concentrate of the low grade section is tabled to produce a final concentrate.

The final concentrate passes through flotation and a High Intensity Magnetic separator (HIMS) to remove sulphides and metallics. This concentrate is then dewatered through a belt filter, dried and bagged for export.

Figure 1. IPJ1500 Cleaner jig

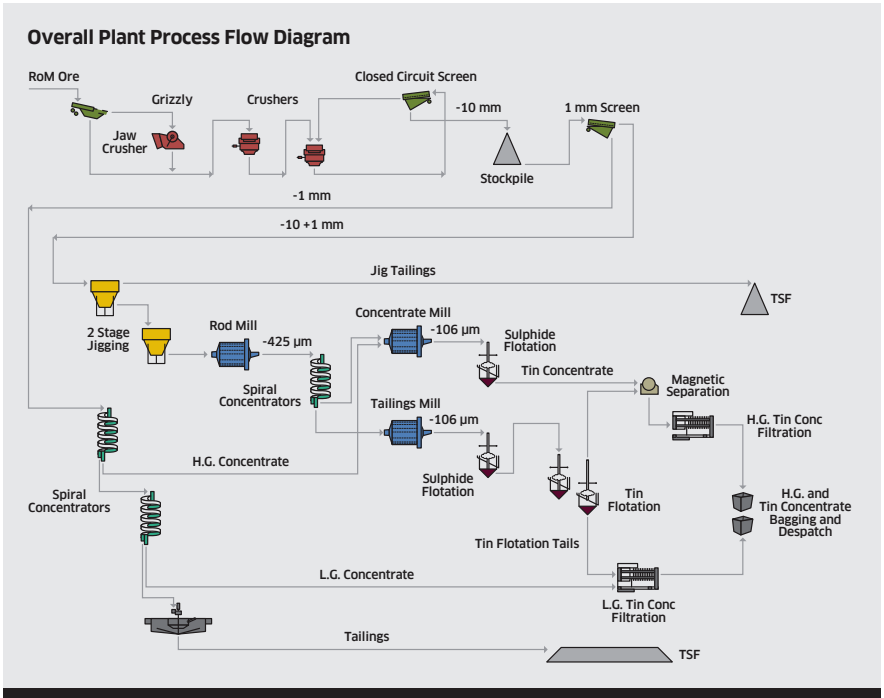
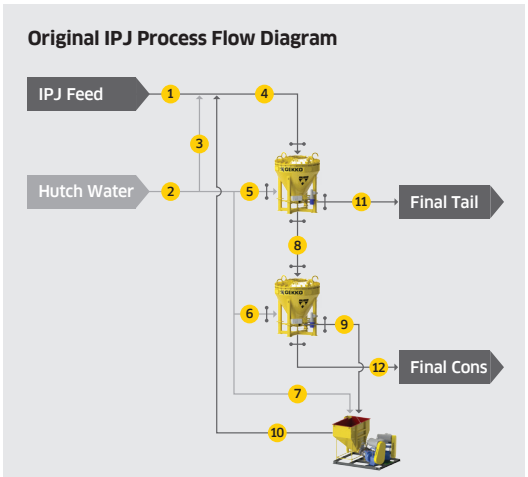


Figure 2. Plant Process Flow Diagram



Flow	TPH	Sn%
1 – IPJ Feed	57	4.3
12 – IPJ Final Cons	9	25-30

Figure 3. IPJ Process Mass Balance

Figure 4. IPJ Gravity Box

INLINE PRESSURE JIG

Circuit configuration – optimised

During the latter stages of commissioning, it was found that the actual rougher jig performance (on its own) was exceeding the design performance of the rougher-cleaner circuit, this was due to the fine-tuning ability of the IPJ – hydraulic jig that allows for the motion of the bed to be set up controlling:

- Cycles per minute
- Height and speed of the upstroke
- Speed of the downstroke

The ragging density was also optimised as an extra dimension that allows for a sharp cut point.

Combined, these parameters allowed Bisie Tin to pick the exact cut-point that it required to optimise the feed to the Gravity plant (although the Jig is also a gravity device it was seen as a separate Jigging plant). The Gravity plant requires a stable exact feed for optimal performance. The IPJ could take a variable feed (3 to 7%Sn) and turn it into a stable known concentrate that the site selected. This makes it possible to set up the spirals and shaking tables with minimal changes required (stability).

Results

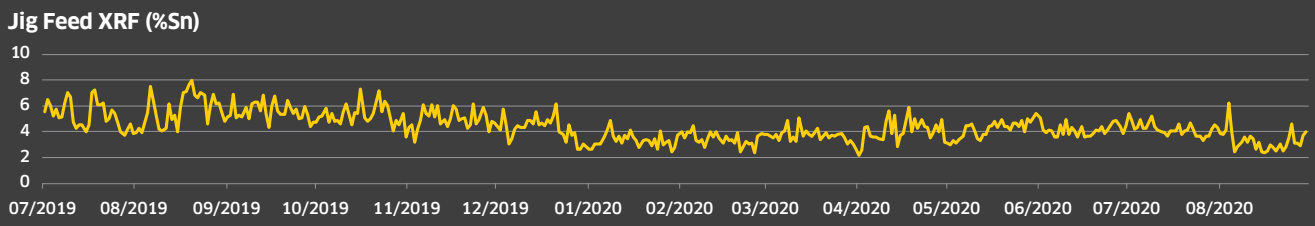


Figure 5. Sn Feed grades measured in % Sn
Sn feed grades range between 3 and 7%. These fluctuations require a robust processing solution that has the capability to absorb the highs without metal losses above target. They also require a solution that can maintain concentrate grade output's when the feed grade is at the lower end of the range. The IPJ provides this.

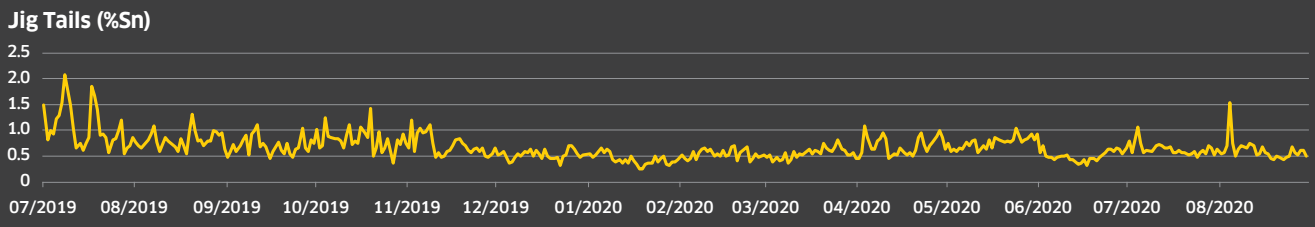


Figure 6. IPJ tailings measured in % Sn
IPJ Tailings typically run at approximately 0.5% Sn. This is a recovery level that provides significant economic benefit and will do across life of mine. The original process design criteria had a new feed rate to gravity of 57tph with just 9tph of this going to downstream processing. This pre-concentration success changed the capital and operating cost by an order of magnitude, delivering higher returns and a faster ROI.

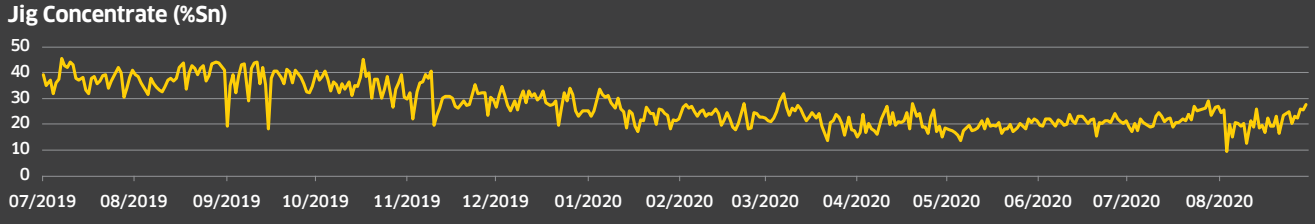


Figure 7. Jig concentrate measured in % Sn
The results show that the mass yields to concentrate were optimised to maintain the final IPJ Sn grades overall recoveries with the target range.

The benefits of the IPJ

Exceptional improvements to mine operating costs, process efficiencies and recoveries are achieved by pre-concentrating deposits using the IPJ. Gangue rejection enriches the valuable mineral product into a smaller volume for efficient downstream processing.

The IPJ uses 20% less power, and consumes 10% of the water, compared to traditional jigs. Saving water and reducing energy helps mine operations lower their environmental impacts and remain profitable.

IPJ pre-concentration of old tailings or low-grade deposits can liberate commercially viable minerals and maximise mine operations.

An innovative and compact design, the IPJ provides superior gravity separation for many different materials. Great flexibility in design allows Gekko's IPJ to be:

- Easy to operate, reducing manual handling and staff costs
- Optimised for performance, to pull 0.5 to 30% of the feed mass as a concentrate
- Transportable and mobile, the IPJ can even be mounted to a ship for marine operations
- Matched to process volume with five IPJ sizes now available
- Adjusted to recover the heaviest 5% or the heaviest 15% total mass, to suit specific downstream operations
- Modified to recover the most mineral value as the deposit changes

Figure 8. IPJ2400 Rougher jig

Summary

With the performance achieved on the first plant Bisie Tin has incorporated the learnings into the design of the second plant at Bisie Tin. This allows savings as follow:

- Only one jig required, no need for cleaner jig and cleaner jig tailings pump.
- Simplified control
- Reduce structural complexity and cost

This will make it far simpler for the operators to operate the plant and for maintenance to maintain the plant.

"The In-Line Pressure Jig (IPJ) made in Ballarat, is a composition of all the better ideas in jigging in the last 30 years .... Principally by the simple idea of using hydraulics to pulse the jig bed rather than expensive pressurized water under the bed, the water consumption is much reduced."

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