GEKKO SYSTEMS

NEW DEVELOPMENTS WITH THE INLINE PRESSURE JIG AND INLINE LEACH REACTOR SYSTEMS

By

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CONTENTS

1. INTRODUCTION

New developments with the Gekko systems InLine Pressure Jig (IPJ) and InLine Leach Reactor (ILR) have allowed the technologies to prosper and provide positive outcomes for customers globally.

A strong focus is placed on continuous product improvement at Gekko Systems and this is particularly so with the IPJ and ILR. Design improvements through past learnings from both a physical design perspective and increased levels of operability through increased automation, have ensured these products provide customers with what they require.

The paper highlights these key areas of product development and how they have contributed to the on going success of the respective technologies.

2. IPJ DEVELOPMENT

2.1. INLINE PRESSURE JIG (IPJ)

The InLine Pressure Jig (IPJ) is unique in its design and use of jigging concepts. The unit is fully encapsulated and pressurised and combines a circular bed with a moveable sieve action. The encapsulation allows the IPJ to be completely filled with slurry and water. As a result, slurry velocity is slowed and water surface tension eliminated which leads to increased recovery potential.

The design allows a wide range of operating conditions to be employed, each specifically targeted to maximise the gravity separation of components in a given feed material.

The screen is pulsed vertically by a hydraulically driven shaft. Length of stroke and speed of up and down stroke can be varied to maximise the gravity separation of components in a given feed material. Screen aperture and ragging dimension and material can also be altered for the application.

Separation of mineral, gem and ore particles occurs based on relative density as well as particle size and shape. High specific gravity particles are drawn into the concentrate hutch during the suction stroke of the bed and are continuously discharged. The lighter gangue is discharged over the tailboard to the outer cone. Both concentrates and tailings are discharged under pressure.

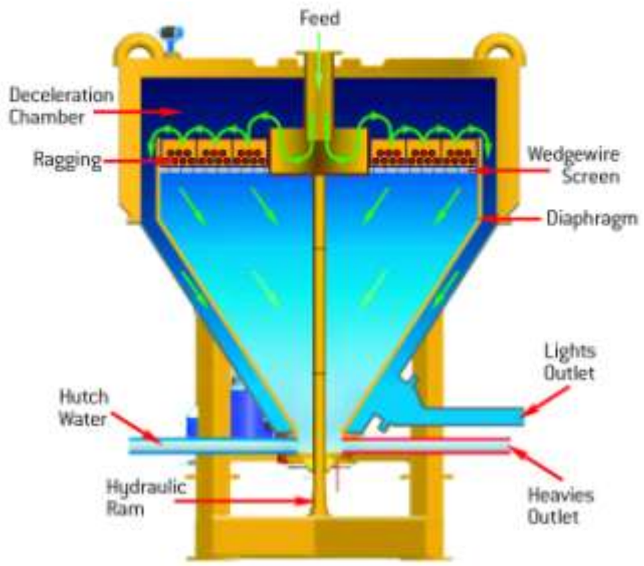

Figure 1: IPJ cross sectional view.

2.2. IPJ DEVELOPMENTS

CFD Modelling

The CSIRO has recently developed a two-dimensional single phase mode of the IPJ to investigate its performance. It was found that slurry recirculates within the deceleration chamber, spreading solid material more evenly across the screens and increasing residence time of the recirculating solid material within the chamber. In the future the model could also be used to investigate the effects of parameters such as bed pulse rate and wave pattern, feed rate, feed properties and ragging makeup, and has currently proved to be a useful tool in the understanding and design of the InLine Pressure Jig.

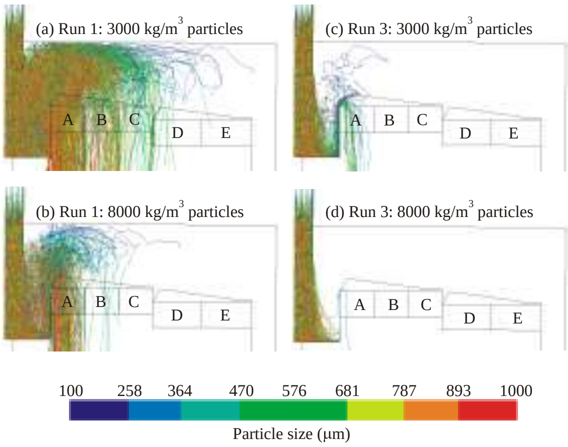

Figure 2: CFD modelling output example – particle tracking

IPJ Internal Scalping Screen

The installation of jigs in the circulating load of a milling circuits, allows the continuous removal of heavy valuable minerals from the circuit, however the presence of circulating steel often requires additional screening equipment ahead of the gravity device to remove coase steel fragments. In order to reduce the complexity of the circuit and the capital required, Gekkos have developed an internal scalping screen that allows the larger steel fragments to bypass the jigging bed.

As shown in figure 3, the scalping screens consist of wedge wire segments that form a sloping screen around the circumference of the bed. The aperature of the screen is typically set at 4 mm which prevents the majority of particles above 2 mm from entering the jigging bed. Maintenance of the screen is faciliated by the ease of removal with just three screws required to be removed to remove all the screen panels.

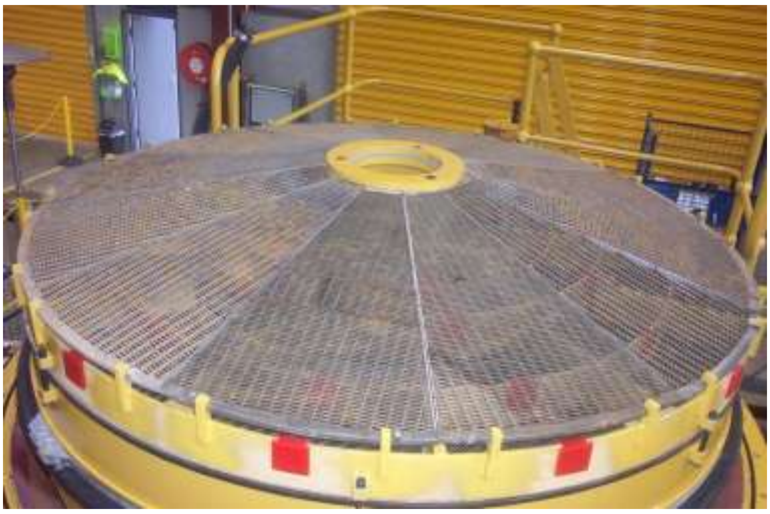

Figure 3: IPJ Scalping Screens

IPJ Automation

Since the development of the IPJ, Gekkos has steadily added more supporting equipment to the client packages, in order to improve its operability. Some of the improvements include:

- Flowmeters on all inputs and output streams. This ensures that flows can be monitored and/or controlled, to ensure that the flow velocities are maintained at design levels, reducing the risk of pipeline blockages.
- Pressure transmitters for internal IPJ pressure. This allows for corrective action to be taken if pressures go outside the normally operating range.
- Automatic dump valves on tails and concentrate lines. This allows a control system to quickly clear blockages and facilitates start and stop sequences.
- Sequence start. A one button start to flush the jig, and restart feed, tails and concentrate lines.
- Sequence stop to fully flush unit of accumulated solids, which allows for a smoother restart.

Figure 4: View of IPJ controls and instrumentation

Multiple IPJ systems

Multiple IPJ systems have been developed to allow for applications that require dry solids throughputs greater than 100 tonne per hour, with concepts up to 400 tonnes per hour developed. The fully automated operating system applied to multiple jigging systems, controls the even distribution of feed to each primary jig, and allows for easy start-up and shutdown procedures.

As shown in Figure 5, the Jigs are positioned in a light weight modular frame, which is pre-assembled in the factory prior to packing, which significantly reduces the construction time required on-site. The factory assembly also allows for pre-commissioning work to be carried out before shipment, which reduces the commisisoning time required on-site.

Potential applications of the large jigging systems:

- Pre-concentration of either coarse or finely crushed ore to reduce the size and hence capital and operating cost of downstream processing equipment
- Installed in the circulating load of a large grinding circuit, the jigs can be used to remove coarse free gold and sulphide, which can then be treated separately to increase the overall gold recovery of a circuit. Ideally a dedicated pump at the grinding mill discharge, would feed the gravity module, which reduces the complexity of operations by allowing it to run independently of the cyclone feed pump. The concentrate can be either upgraded in batch centrifugal concentrators such as the InLine Spinner, leached directly in a large InLine Leach Reactor or reground to obtain higher recoveries downstream .
- For ores that have a high coarse gold/sulphide content, the large jigging circuit can act as the primary recovery unit, in the circulating load of a fine crushing circuit.

Figure 5: Modular pre-concentration plant

<u>Python IPJ System</u>

The plant, called "the Python Processing Plant" (Gekko, 2007), was the result of a four year research and development program part-funded by the Australian Government and built on Gekko's 10+ years of experience with high mass pull gravity concentration. This experience included the development of laboratory procedures to characterise orebodies, engineering know how to ensure the gravity circuit operated at its optimum and improvements in the design and control of the key gravity recovery component, the InLine Pressure Jig (IPJ).

The design of the Python is based (Hughes and Cormack, 2008) on two key factors:

1. Concentrate the ore as soon as it is liberated.
2. Combining continuous high mass pull gravity (the InLine Pressure Jig) with flotation to recover both the fine and coarse particles as soon as possible.

The Python relies on the use of coarse and fine crushing, wet screening, continuous gravity concentration, flash flotation and water recycling (refer to Figure 6) to concentrate greater than 90% of the gold into a high mass pull concentrate of 10 to 40% of the mass.

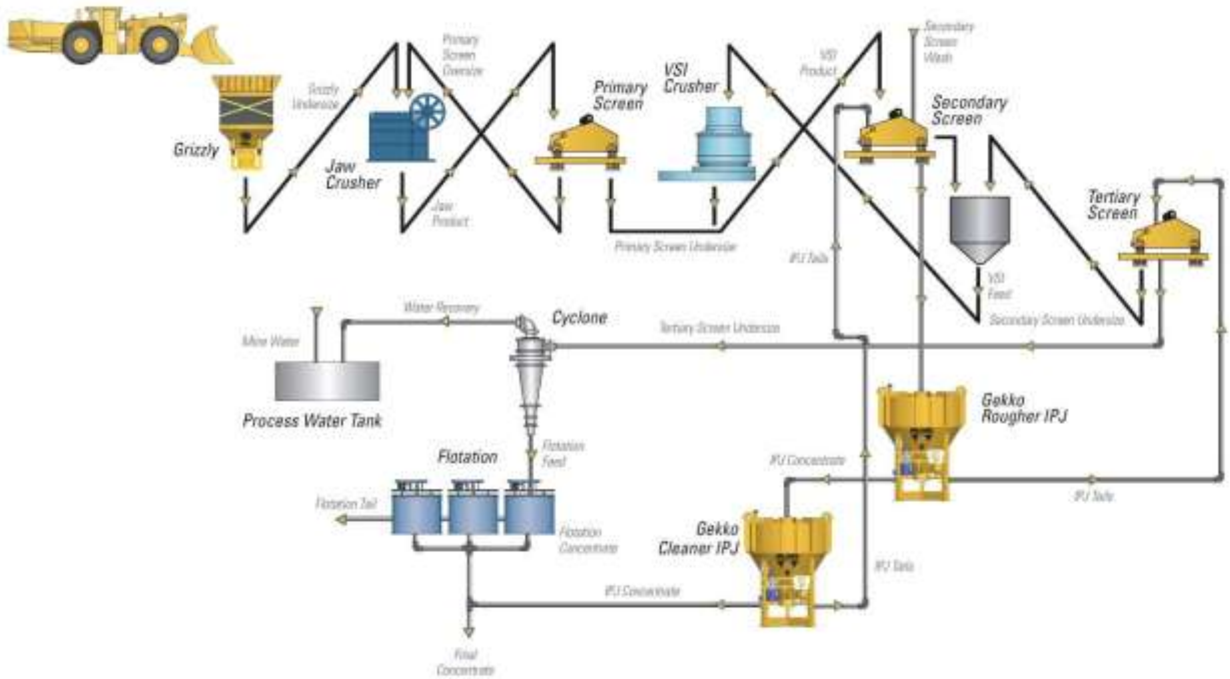

Figure 6: Python Flowsheet

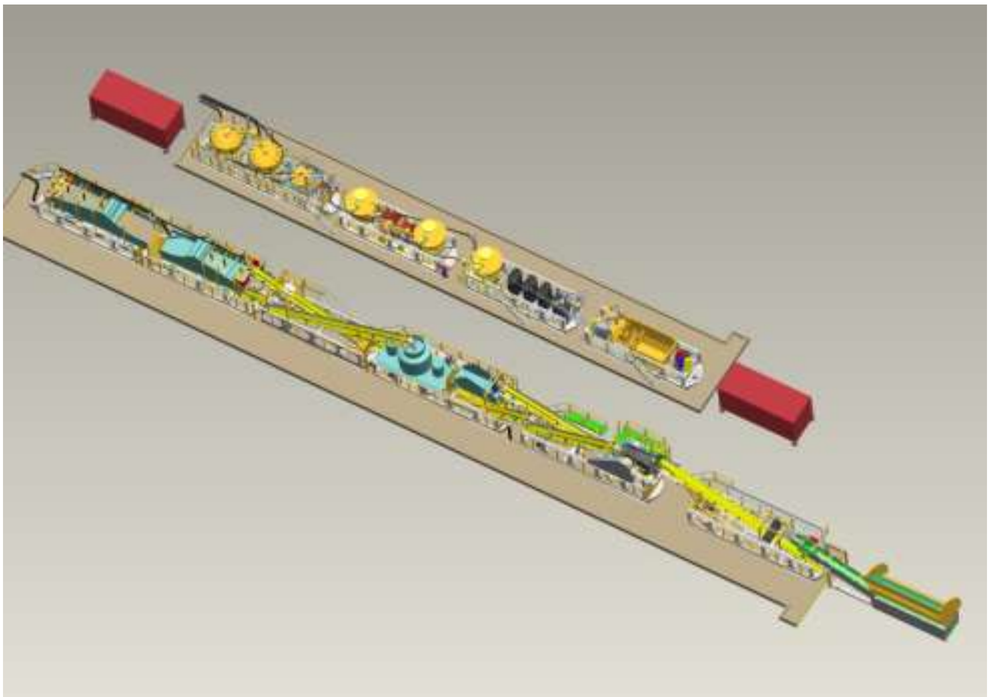

Figure 7: Python 500 installed on surface in a “U” shape.

Figure 8: Python 500 Gravity Skid

3. ILR DEVELOPMENTS

The Gekko InLine Leach Reactor (ILR) is a modular, skid mounted intensive cyanidation reactor. The unit can be used to leach gold and/or silver from medium to high grade gravity and flotation concentrates. The design is based on the same principles as the laboratory bottle roller. In its batch form (ILR-BA), the units available can process between 0.9 to 24 tonnes per batch. While in its continuous form, the largest unit currently available can process up to 1.9 t/hr (based on a residence time of 6 hours).

The intensive cyanidation reaction is typically performed at 2% NaCN levels, 8-20ppm O2, 30% solids and requires no exotic chemicals or materials. The oxygen is supplied to the unit as gaseous oxygen or as 25-50%w/w hydrogen peroxide.

In the batch ILR concentrates are leached and pregnant solution is produced and electrowon in discrete batches before being returned to the CIP plant. In the continuous ILR the concentrate is fed, leached and discharged continuously while a recirculating stream of leach solution passes continuously from the reactor to solution recovery – typically electrowinning – and back to the reactor to be reused.

3.1. ILR DEVELOPMENTS

Batch ILR System

The ILRBA has evolved over the course of the past 8 years since the first units were installed at the Target Mine in RSA and Kelian Equitorial Mining in Indonesia. The level of automation has increased and the PLC control sequence has been refined to produce a truely hands free system.

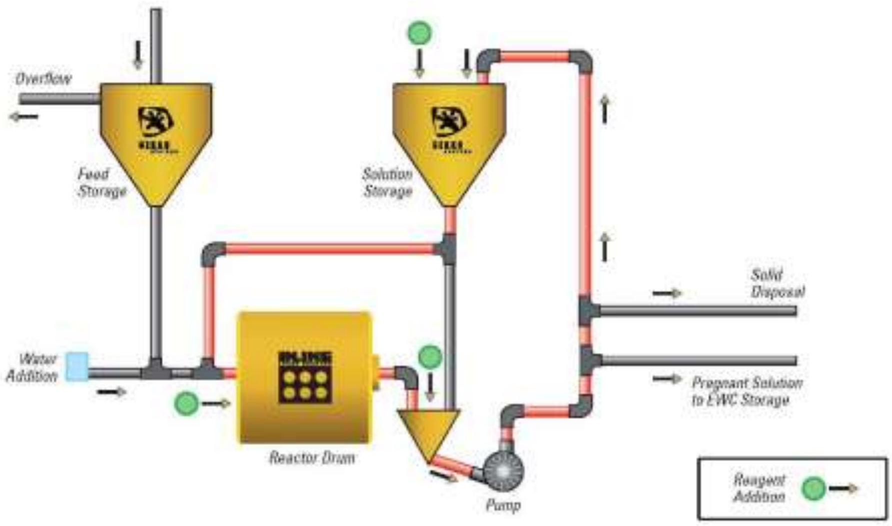

Figure 9: Batch Reactor Flow Diagram

ILRBA - Single Solution Cone

One of major design improvements to take place with the batch automatic unit was the change to a single solution cone design in 2002, which allowed all the solids, including fines, to be efficiently recaptured in the drum during the dedicated clarification stage. Earlier batch manual units ran with a 2 stage solution cone approach which added operational complexity without providing any genuine technical benefit. The single solution cone design and the associated control sequence allows the ILR to prepare, circulate and clarify pregnant solution in the one vessel. It also provides ideal control from a measurement perspective because the solution mass is measured on a single load cell which provides optimum reagent and gold accounting measurements.

Figure 10: Batch ILR within bunded area.

ILRBA-Single Pump System

The new generation batch automatic syetem was also refined into a one pump design in 2002. The design ensures absolute minimum pump maintenance and is made possible by the PLC controlled valve distribution network that directs the product flow depending on which stage the program is in. It is now proven across more than 50 installations and has been a key factor in the batch automatic units continued growth and market dominance.

ILRBA - Custom oxygen sparger

The refined and improved oxygen sparging unit is standard with all ILRBA installations. A major advantage of the ILR's rolling drum technology is it's ability to generate accelerated kinetics as a result of the mechanical agitation within the drum. The reaction zone is supplied with oxygen by sparging gaseous oxygen into the recirculating leach solution as a dispersion of fine bubbles. This is achieved using a spring loaded ceramic tipped sparger. This principal of metallurgical operation has ensured that chemical oxidants are generally not required and the refinement of the sparging unit has further enhanced this. Oxygen is the most common oxidant in use with the BA units globally and recoveries >98% are typical.

Continuous ILR System

The continuous ILR was first pioneered by Gekko Systems for the purpose of treating IPJ concentrates, which are typically high mass, medium grade, coarse concentrates. However the majority of early applications were to treat low mass high grade gold concentrates produced by BCCs (Falcons, Knelsons and InLine Spinners) which typically aare low mass, high grade and can contain significant levels of slimes. The new generation batch ILR replaced the original continuous units in these applications from about 2002, however the ILR "continuous" remains a critical unit within Gekko Systems product range and has now found its design target as the treatment of high mass gravity and flotation concentrates becomes more prevalent.

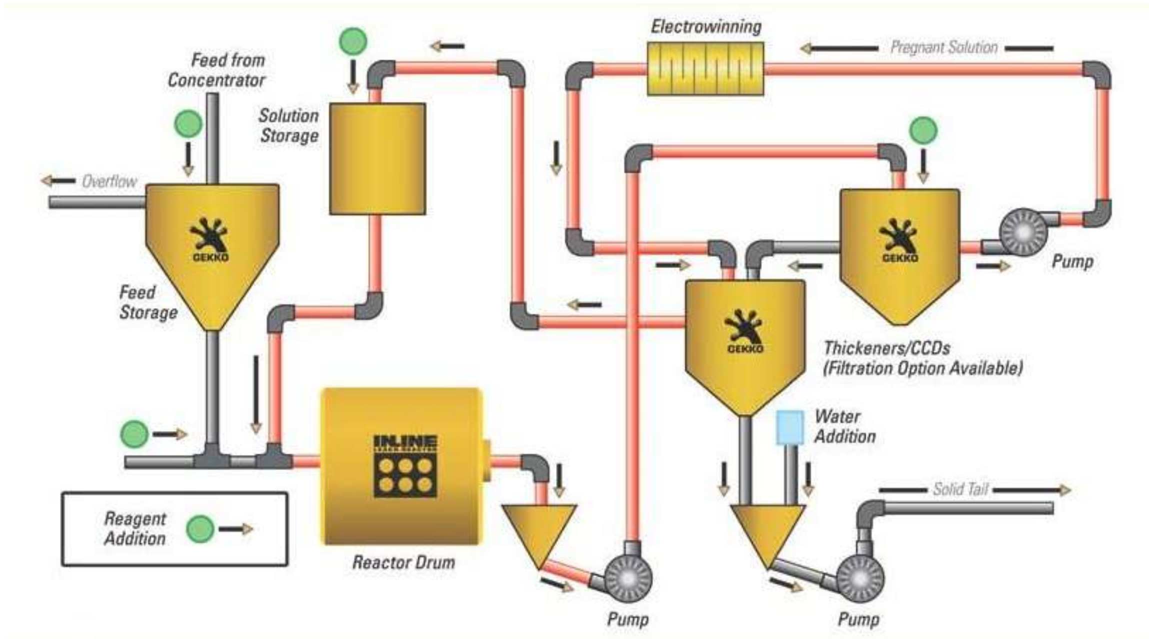

Figure 11: Continuous ILR flowsheet

The new generation continuous ILR's are specifically designed around the treatment of medium to high mass applications and generally treat lower grades than the batch automatic units. They provide the ideal solution for those operations wishing to leach flotation concentrates and or concentrates collected from continuous gravity circuits. The multiple leaching system shown in Figure 12, allows for the treament of up to 20 tonnes per hour of concentrate based on a residence time of 4 hours.

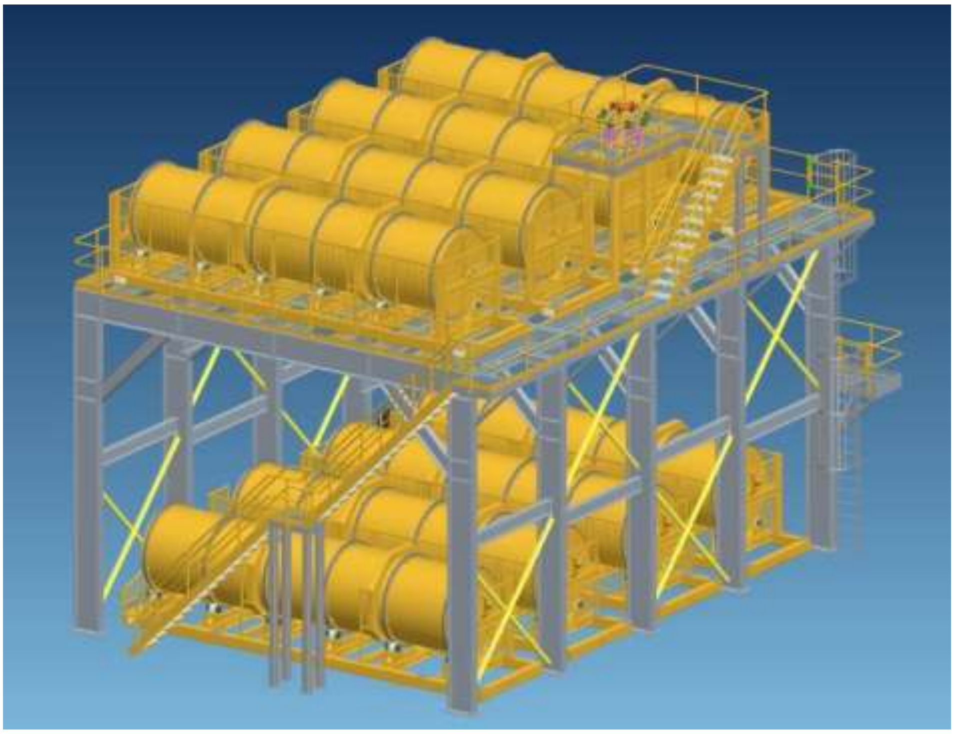

Figure 12: Continuous ILR Leaching System

CCD-Filter circuits

A key development in the ILR"CA" range has been the addition of high efficiency solid/liquid seperation options. The early continuous units that treated predominantly low mass high grade concentrates were not required to obtain high solution recovery since all effluent streams were returned to a CIP plant where residual dissolved gold was recovered. This could be up to 10% of gold dissolved in the ILR. The new continuous ILR's are usually the primary gold leaching operation and therefore soluble gold recovery becomes critical for overall plant recovery. To obtain the necessary high soluble gold recovery continuous ILRs are normally packaged with either:

- A 3 stage counter current decantation process which not only ensures maximum gold solution recovery through multiple wash steps but provides a clear solution for the "in circuit" electrowinning process.
- Automated plate and frame filters, which can produce much higher wash efficiencies than CCD's, resulting in higher soluble gold recovery, however usually at the price of a higher capital cost.

Super ILR

As the continuous ILR has evolved there has been a higher degree of interest in utilising the benefits of the ILR technology for higher and higher mass yields of concentrate. It is for this reason that Gekko have now finalised design of the super ILR technology. It allows for the treatment of far larger mass treatment rates (8 tonnes per hour) whilst reducing the number of individual drums. This ensures that capital costs remain competitive with other options and expands the application of the technology.

Gravity Box

Whether it be a greenfields site designing a gravity circuit from scratch or brownfields opportunity where a customer is looking to optimise or upgrade a curcuit, there is far more to a gravity circuit than may initailly appear. Traditionally the various pieces of the gravity circuit puzzle are purchased independently and designed by a site projects team and/or engineering company. Increasingly in recent times Gekko Systems have engineered complete "gravity box" systems to provide a complete solution for the unit processes required.

Gekko utilise our extensive in house gravity expertise to provide not only the equipment package but a fully engineered, designed and constructed package which incorporates steel frames, piping, electrics, automation, installation and commissioning. It is fully engineered, factory pre-assembled, and only requires the connection of reagents and services, power input and product feed. It can be incorporated into a new plant design or simply bolted onto an existing plant structure.

We supply and install the best option according to:

- Gravity Recoverable gold potential test work
- Throughput requirements
- Client preference on technology
- Budget requirements
- Client preferred scope of work (ie, gravity box package or just equipment package supply only)

Current standard "gravity box" screening/gravity concentration/intensive cyanidation options available are:

- 50 tph free Au
- 100 tph free Au
- 200 tph free Au
- 300 tph free Au

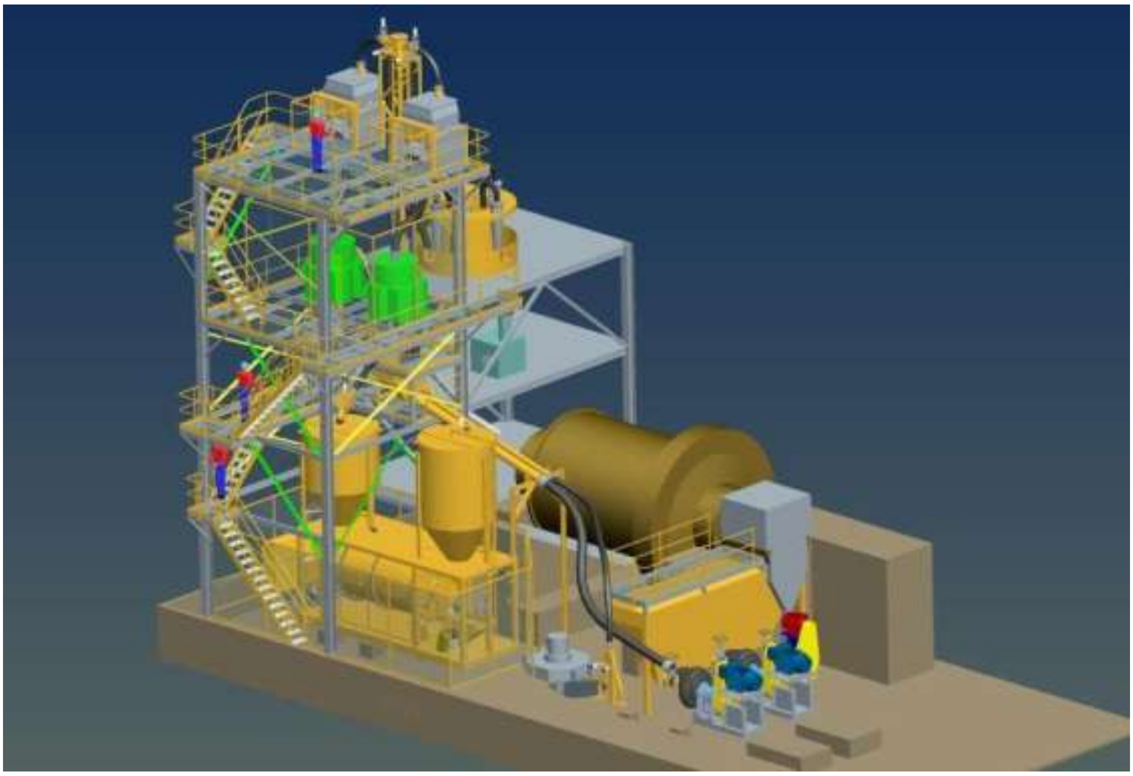

Figure 13: Gravity Box System – Magscreen, BCC, ILR

4. REFERENCES

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2. Solnordal, C., Hughes, T., Gray, S., and Schwarz, P., "CFD Modelling of novel gravity separation device", Seventh International Conference on CFD in the Minerals and Process Industries, CSIRO Melbourne 9-11 Dec 2009.