GLENCORE TECHNOLOGY

The Albion Leach Reactor™

ALBION PROCESS

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1. General Albion Process™ Description

The Albion Process™ is a combination of ultrafine grinding and oxidative leaching at atmospheric pressure. The feed to the Albion Process™ is a concentrate containing base or precious metals, and the Albion Process™ is used to oxidise the sulphide minerals in the concentrate and liberate these metals for recovery by conventional means.

The Albion Process™ technology was developed in 1994 by Glencore Technology and is patented worldwide. There are three Albion Process™ plants currently in operation. Two plants treat a zinc sulphide concentrate and are located in Spain (4,000 tpa zinc metal) and Germany (18,000 tpa zinc metal). A third Albion Process™ plant is operating in the Dominican Republic treating a refractory gold/silver concentrate, producing 80,000 ounces of gold annually. A photograph of the Las Lagunas IsaMill™ and oxidative leaching circuit is shown in Figure 1. Glencore Technology is currently completing the design and supply of an Albion Process™ plant for the GPM Gold Project in Armenia. Procurement has begun for this project, with civil works on site advanced. The GPM Gold Project will commission in August, 2013.

Figure 1 – Las Lagunas Albion Plant

The first stage of the Albion Process™ is fine grinding of the concentrate. Most sulphide minerals cannot be leached under normal atmospheric pressure conditions. The process of ultrafine grinding results in a high degree of strain being introduced into the sulphide mineral lattice. As a result, the number of grain boundary fractures and lattice defects in the mineral increases by several orders of magnitude, relative to un-ground minerals. The introduction of strain lowers the activation energy for the oxidation of the sulphides, and enables leaching under atmospheric conditions. The rate of leaching is also enhanced, due to the increased mineral surface area.

Fine grinding also prevents passivation of the leaching mineral by products of the leach reaction. Passivation occurs when leach products, such as iron oxides and elemental sulphur, precipitate on the surface of the leaching mineral. These precipitates passivate the mineral by preventing the access of chemicals to the mineral surface.

Passivation is normally complete once the precipitated layer is 2 – 3 µm thick. Ultrafine grinding of a mineral to a particle size of 80% passing 10 – 12 µm will prevent passivation, as the leaching mineral will disintegrate prior to the precipitate layer becoming thick enough to passivate the mineral. This is illustrated in Figure 2.

After the concentrate has been finely ground, the slurry is then leached in agitated vessels, and oxygen is introduced to the leach slurry to oxidise the sulphide minerals.

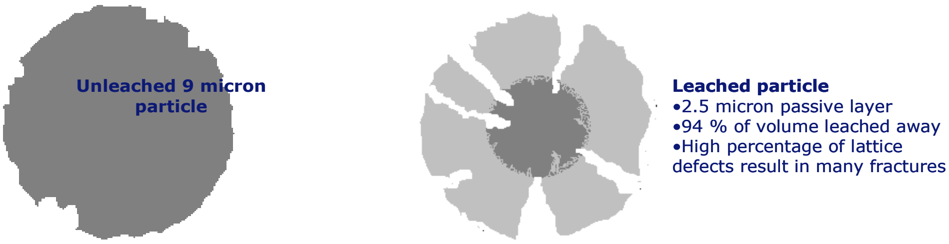

Figure 2 - Mechanism of Passivation of Sulphide Minerals

The agitated leaching vessels are designed by Glencore Technology and are known as the Albion Leach Reactor. The Albion Leach Reactor is agitated using dual hydrofoil impellers and oxygen is introduced to the leach slurry at supersonic velocity to improve mass transfer efficiency and ensure efficient oxidation of the sulphides. The Albion Leach Reactor is designed to operate at close to the boiling point of the slurry, and no cooling is required. Leaching is carried out autothermally, and the temperature of the leach slurry is set by the amount of heat released by the leaching reaction. Heat is not added to the leaching vessel from external sources, and excess heat generated from the oxidation process is removed through humidification of the vessel off gases.

2. Ultrafine Grinding and the IsaMill™ Technology

Ultrafine grinding requires a different milling action than found in a conventional ball mill, due to the fine nature of the grinding media required. In most ultrafine grinding mills, an impeller is used to impart momentum to the media charge. Media is agitated through stirring, and the resulting turbulent mixing overcomes the tendency of fine media to centrifuge. Abrasion is the major breakage mechanism in a stirred mill. The common aspects of a stirred mill are a central shaft and a series of impellers attached to the shaft. These impellers can be pins, spirals, or discs.

In stirred mills, two configurations are common. In the first, the mill shaft and grinding elements are set up vertically within the mill. This type of configuration is limited in size to typically 750 kW of installed power or less. This limitation is brought about by the large break out torque imposed on the impeller located at the base of the media charge, due to the compressive load of media sitting vertically on the impeller.

In the second configuration the mill shaft is aligned horizontally within the mill chamber. This configuration, which is used in Glencore Technology's IsaMill™, is more cost efficient at motor sizes in excess of 500 kW. There is very little break out torque required to begin to agitate the media charge, which limits the motor size to that required for grinding only.

The IsaMill™ is a large-scale energy efficient continuous grinding technology specifically developed for rugged metalliferrous applications. Glencore Technology supplies the IsaMill™ technology to mining operations around the world, with over 100 mills installed in 9 countries worldwide. The IsaMill™ uses a very high energy intensity of 300kW/m3 in the grinding chamber, resulting in a small footprint and simple installation. The IsaMill™ can be scaled up directly from small scale laboratory tests. Glencore Technology's IsaMill™, is installed in more than two-thirds of the world's metalliferrous ultrafine grinding applications. The grinding media size for the IsaMill™ is within the size range 1.5 – 3.5 mm. Media can come from various sources, such as an autogenous media screened from the feed ore, silica sands or ceramic beads.

Glencore Technology will provide the IsaMill™ as a packaged Grinding Plant, consisting of the mill, slurry feed and discharge systems, media handling system, all instrumentation and control and all structural steel and platforms. Some of the IsaMill™ Grinding Plant components are shown in Figure 3 and 4. The IsaMill™ Grinding Plant incorporates all of Glencore Technology's operational and design experience gained from over 100 IsaMill™ installations, ensuring a trouble free commissioning.

The IsaMill™ will contain up to eight discs on the shaft, with each disc acting as a separate grinding element. The operating mechanism for the IsaMill™ is shown in Figure 5. This allows the IsaMill™ to be operated in open circuit without the need for cyclones. The IsaMill™ produces a sharp size distribution in open circuit, as the feed must pass through multiple distinct grinding zones in series before reaching the Product Separator. This plug flow action ensures no short circuiting, and efficiently directs energy to the coarser feed particles.

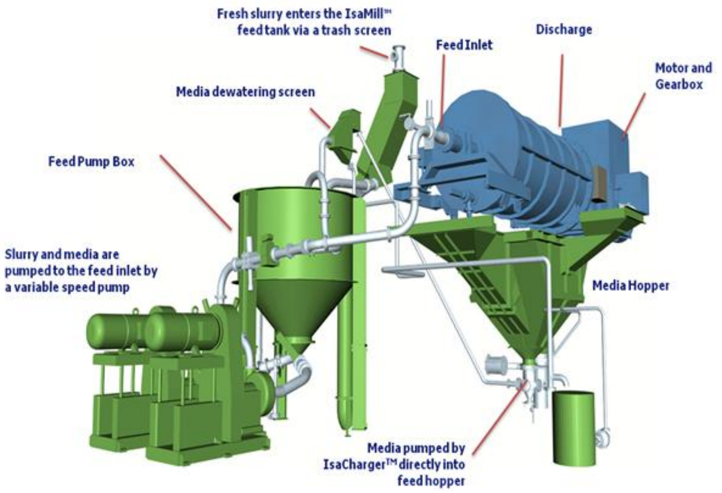

Figure 3 - IsaMill™ Feed and Media System

The Product Separator is a centrifugal separator at the end of the mill shaft that spins at sufficient rpm to generate over 20 "g" forces, and this action is responsible for the sharp classification within the mill. The IsaMill™ can be operated in open circuit at high slurry density, which is a key advantage for the leaching circuit, as the entry of water to the leach is limited, simplifying the water balance.

The IsaMill™ uses inert grinding media that produces clean, polished mineral surfaces resulting in improved leaching kinetics. A steep particle size distribution is produced in the mill. The 98 % passing size in the mill is typically less than 2.5 times the 80 % passing size, and very little coarse material enters the leaching circuit, resulting in very high leach recoveries.

The IsaMill™ is the highest intensity grinding technology available (>300kW/m^3), meaning it is also the most compact, with a small footprint and low profile. The IsaMill™ is oriented horizontally, with the grinding plant accessed by a single platform at an elevation of approximately 3 m. Access to the mill and maintenance is simplified by the low operating aspect of the IsaMill™ and the associated grinding plant. Maintenance of the IsaMill™ is similar to routine maintenance for a slurry pump.

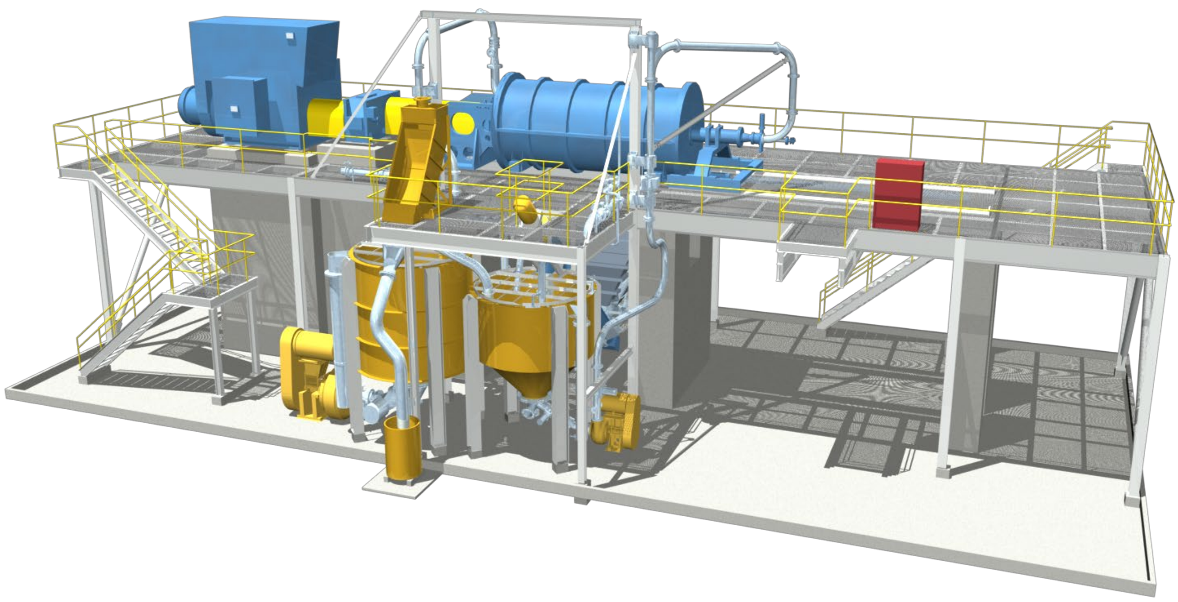

Figure 4 – IsaMill™ Grinding Plant Layout

The internal rotating shaft in the IsaMill™ is counter-levered at the feed inlet end so the discharge end flange and grinding chamber can be simply unbolted and slid off using hydraulic rams. A shut down for inspection and replacement of internal wear parts takes less than 8 hours. Availability of 99% and utilisation of 96% are typical of the IsaMill™.

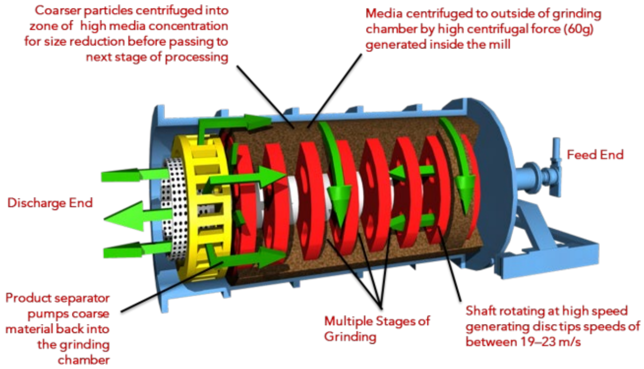

Figure 5 – IsaMill™ Operating Mechanism

Scale-up of the IsaMill™ is straight forward. Laboratory test results are directly scaled to commercial size with 100% accuracy. The IsaMill™ has a proven 1:1 direct scale-up to reduce project risk.

The IsaMill™ is available in the following models:

- M1000 (500 kW), capable of throughputs in the range 10 – 16 tonnes per hour
- M5000 (1200 and 1500 kW), capable of throughputs in the range 20 – 55 tonnes per hour
- M10000 (3000kW), capable of throughputs in the range 60 – 100 tonnes per hour.
-

3. Albion Leach Reactor

After the sulphide concentrate has been finely ground, it is then leached under atmospheric conditions in an oxidative leach. The purpose of the oxidative leach is to oxidise the sulphide mineral lattice to liberated base and precious metals for recovery. The oxidation process involves the injection and dissolution of gaseous oxygen into the slurry.

Oxygen is a poorly soluble gas in mineral slurries, and the process of gas injection and gas dissolution requires specialised equipment to ensure an efficient and cost effective solution. Glencore Technology has designed an atmospheric pressure reactor to achieve the oxygen mass transfer required for oxidation of the sulphide minerals at low capital and operating cost. The reactor is called the Albion Leach Reactor.

The Albion Leach Reactor consists of the following components:

- A corrosion resistant alloy steel tank and base, supported on a ring beam foundation. The reactor aspect ratio is designed to achieve high oxygen transfer rates and capture efficiencies. Glencore Technology has developed fully modular tank shell systems, which can be rapidly installed on site in one third the time of a field welded tank and at much lower costs. The Glencore Technology modular reactor designs require limited site welding.
- An agitation system consisting of a high solidity lower hydrofoil impeller to handle the combined duties of gas dispersion and slurry suspension, coupled with additional lower solidity impellers to ensure adequate mixing within the reactor. Glencore Technology designs the agitator support platform as an integral part of the Albion Leach Reactor to ensure safe and reliable installation and maintenance of the agitation system. Modular baffles are designed as integral components of the Albion Leach Reactor.
- On oxygen delivery and injection system consisting of Glencore Technology's HyperSparge™ technology. Oxygen is injected into the base of the Albion Leach Reactors using Glencore Technology's HyperSparge™ supersonic injection lances. The design of the HyperSparge™ injection system is carried out in conjunction with the design of the agitation system to ensure high oxygen mass transfer rates are achieved in the reactor. The agitator unit power is moderate, and the impeller tip speed is chosen in combination with the HyperSparge™ injection velocity to provide the required mass transfer rates.
- An exhaust gas capture and venting system to safely vent humidified exhaust gases from the reactor to atmosphere.
- Specialised instrumentation and control systems for operation of the Albion Leach Reactor. The primary control loops involve acid or alkali dosing for pH control, process water addition for slurry density control and oxygen addition to control the extent of oxidation across the leach.
- A slurry distribution system consisting of slurry risers within the Albion Leach Reactors, launders and isolation valves to provide slurry flow between the Albion Leach Reactors via gravity and minimise slurry bypassing.

3.1 Modular ZipaTank™ Technology

The Albion Leach Reactor utilises Glencore Technology's ZipaTank™ technology to provide a low cost, modular tank shell and base that can be assembled on site within 1 – 2 weeks, reducing expensive site construction costs.

The entire oxidative leach train is constructed from modular Albion Leach Reactors, inclusive of agitators, modular agitator support platforms and interconnecting launders and reagent piping.

The ZipaTank™ uses a mechanical join to provide water tight sealing of pre-fabricated panels, eliminating the need for welding at heights. All tank ancillaries, such as man doors, nozzles, baffles and overflow system are fabricated into the panels under controlled factory conditions, eliminating site work and improving quality.

The Albion Leach Reactor consists of a base assembly and a series of strakes that are connected in the horizontal plane by a lap plate join. The strakes themselves are made from pre-radiused alloy steel panels that are joined in the vertical plane using a lap plate join.

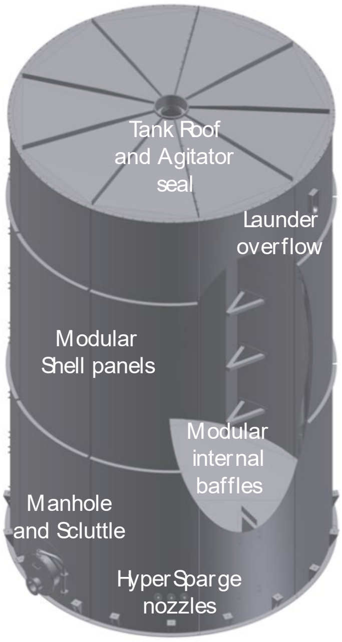

Figure 6 – Albion Leach Reactor

The tank base sections and all strake panels are sized to fit within standard 40 ft open top international shipping containers for transport to site.

A major advantage of the modular Albion Leach Reactor is that all components are fabricated and painted or lined off site, under controlled conditions to ensure a high quality finish.

The Albion Leach Reactor base is provided as separate fabricated sections inclusive of the base plates, annular ring, first strake panels, manhole flange, all nozzles and tank anchors for joining at site on the tank foundation. The base sections are joined by welding, and this is the only welding required in the fabrication of the tank. Welding is carried out at ground level, without the need for any scaffolding.

The width of each base section is limited to 2200 mm to accommodate transport in standard 40 ft shipping containers. Tank diameters up to 10 metres can be accommodated in full diameter sections with only a single butt weld required to join the sections at site. Larger diameter tank bases would be split into smaller sections. Tank anchor spacing conforms to site seismic requirements.

The Albion Leach Reactor and key components is shown in Figures 6 and Figure 7.

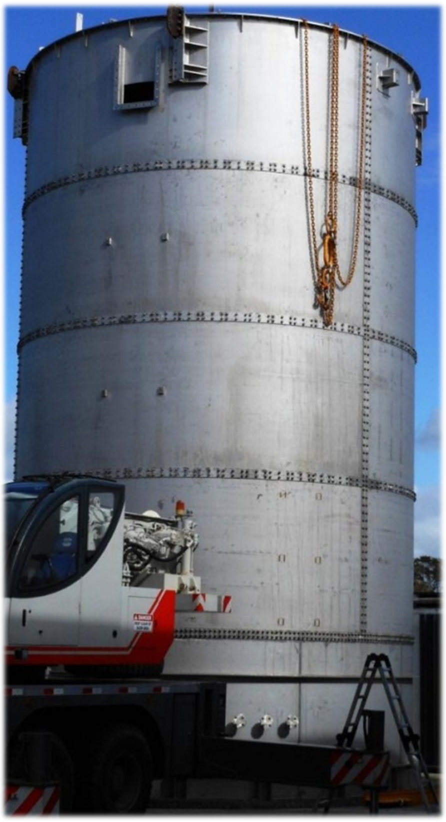

Figure 7 – Assembled Albion Leach Reactor – 250m^3

Figure 8 – Albion leach reactor base assembly

A completed base assembly for a 6.5 m diameter Albion Leach Reactor is shown in Figure 8.

The base will have an approximate height of 2000 - 2200 mm. All tank base sections can be manufactured from a range of materials such as stainless steel or duplex grade alloy steel. Lifting and assembly tools will be provided with the tank panels to assist in the assembly of the Albion Leach Reactor.

Assembly guidelines and drawings will be provided with all Albion Leach Reactors, and Glencore Technology can provide experienced site supervisors during the assembly process if required.

The Albion Leach Reactor shell consists of a series of strakes bolted to the tank base, with an approximate height of 2000 - 2200 mm. The strakes are joined to the tank base using a bolted lap plate join. The strakes consist of individual panels, each joined in the vertical direction by another lap join.

The strake panel joining system consists of lap plates bolted through laser cut perforations in the stake panels. The joins between tank panels are sandwiched between an inner and outer lap plate. An EPDM gasket is fitted between the inner lap plate and the tank shell to provide a seal between the join. Inner lap plates are manufactured by welding studs into the plate with the studs penetrating through the slots in the strake panels.

The outer lap plate is then bolted to the studs from the outside of the tank. A picture of the lap join system is shown in Figure 9.

Figure 9 – Albion Leach Reactor-Lap Join System

The number of panels will depend on the diameter of the Albion Leach Reactor. The panels will be supplied with all attachments, such as flanges for the overflow box and agitator support frame attachment stools already fabricated into the panels. Panels will be pre-radiused to match the required circumference of the tank. An assembled Albion Leach Reactor is shown in Figure 10.

Figure 10 – Assembled Albion Leach Reactor

Panel thicknesses will be designed according to API 650 (11^{th} edition). A 2mm allowance for corrosion will be applied when calculating shell course thickness due to the potentially abrasive nature of the contents of the tank. Lifting and assembly tools will be provided with the tank panels to facilitate assembly of the Albion Leach Reactor.

The individual panels that comprise the Albion Leach Reactor will be provided with all nozzles and penetrations prefabricated into the panels prior to shipment. An example of some nozzle types is shown in Figure 11. A standard DN 750 access door would be provided with all Albion Leach Reactors, along with a DN200 scuttle nozzle and overflow nozzle or weir box. The size of the overflow nozzle or weir box would be determined on consultation with the client.

Individual nozzles to accommodate the HyperSparge™ insertion assemblies would be provided in the base sections.

Additional nozzles for pump suction or process uses can be added to the tank panels as required.

Figure 11 – Albion Leach Reactor Nozzle and Penetrations

The scope of supply for the Albion Leach Reactor will include all detailed tank design according to relevant standards, inclusive of finite element analysis and selective destructive testing where required. Wind and seismic load specific to the plant site will be included in the design.

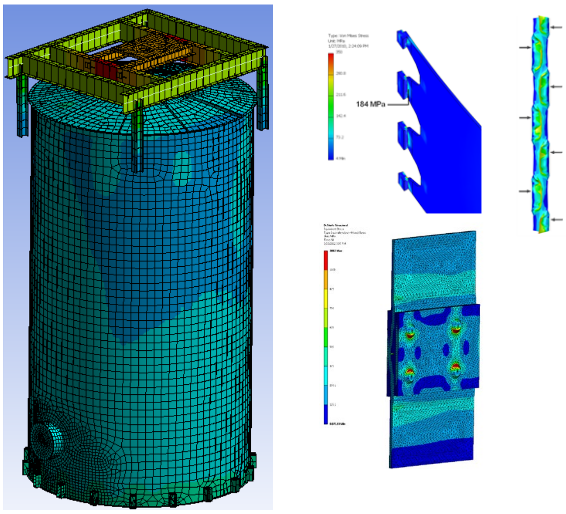

Figure 12 – Albion Leach Reactor Finite Element Design

The Albion Leach Reactor base and shell will typically be designed according to API 650-05 (11th Edition, 2007), with specific design of joining components using finite element analysis.

Structural steel design would be in accordance with the relevant local standards. Other relevant standards used in the design of the Albion Leach Reactor will be:

AWWA-D103, "Factory Coated Bolted Steel Tanks for Water Storage", American Water Works Association

AS3990 –1993 Mechanical Equipment – Steelwork (allowable stress/working stress design code)

All factory welds will be in accordance with AS1554 'GP' Class AS1554.1 – Welding of Steel Structures

All Albion Leach Reactor will be designed to operate in the temperature range – 20 to 105°C.

3.2 Agitation and Oxygen Injection System

The agitation and oxygen injection system in the Albion Leach Reactor consists of a dual hydrofoil impeller coupled with a series of oxygen injection lances located peripherally around the base of the reactor.

The aim of the agitation and oxygen injection system is to disperse and then dissolve oxygen from the gas phase into solution for oxidation of the sulphide minerals. The rate at which oxygen can be dissolved into the solution is:

Rate = $k_L a.\Delta C$

The ΔC term stands for the oxygen solubility gradient in the leach solution, and is a function of both solution chemistry and oxygen partial pressure. The Albion Leach Reactor is designed to maximise oxygen partial pressure through increased reactor aspect ratio and by sealing the reactor to maximise the oxygen content in the gas phase. High aspect ratio reactors have a higher hydrostatic head at the base of the vessel, which increases the oxygen solubility profile across the reactor. The preferred aspect ratio for the Albion Leach Reactor is a function of the cost and complexity of the agitation system and the cost of the reactor shell. Glencore Technology optimises these variables to provide the most cost efficient and effective reactor design.

The k_La term in the rate equation is known as the volumetric oxygen mass transfer coefficient. It is a combination of two terms, k_L the diffusion coefficient for oxygen across the liquid film surrounding the gas, and a which is the interfacial area between the gas and solution phases.

Conventional gas dispersion systems inject oxygen through a low pressure sparge pipe or sparge ring. These systems maximise the k_La value of the reactor by concentrating solely on increasing interfacial area, a. This is achieved by the turbulent breakdown and elongation of oxygen bubbles into smaller bubbles by the action of the agitator. This process is driven by pressure differentials across which the bubble is distorted and broken down. In conventional systems, this pressure differential is supplied by an impeller with differential pressures of 10 – 20 kPa generated across the impeller blade.

The Albion Leach Reactor is unique in that the reactor is designed to maximise both the diffusion coefficient and the gas/liquid interfacial area. This is achieved by combining a traditional impeller system with the HyperSparge™ supersonic oxygen injection lance. A picture of the HyperSparge™ is shown in Figure 13.

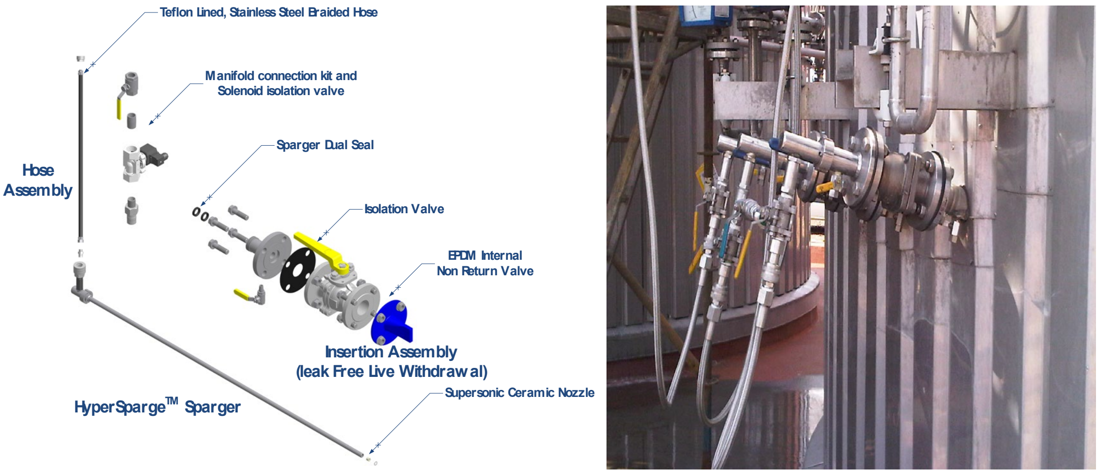

Figure 13 - HyperSparge™

The HyperSparge™ is designed to accelerate oxygen gas to supersonic velocities prior to impinging on the slurry. The accelerated gas forms a continuous gas jet with high shear zones at the interface between the gas phase and the slurry. Mass transfer then occurs primarily at the high speed gas jet interface, providing a much more efficient mass transfer mechanism than a rising gas bubble.

The supersonic gas jet produces very high levels of shear within the process vessel, resulting in excellent mass transfer. The oxygen diffusion coefficient, k_L, is dramatically increased at the interface of the gas jet, due to the supersonic velocities generated in the jet. The gas/liquid interfacial area, a, is also increased by the supersonic jet, as a result of both the high gas velocity and the 200 – 300 kPa pressure drop across the gas jet. The HyperSparge™ Supersonic Oxygen Sparger can generate local energy dissipation rates in excess of 2 - 5 kW.m^{-3} of slurry, compared to agitators, which typically deliver energy dissipation rates of 0.1 – 0.5 kW.m^{-3}.

Several HyperSparge™ units are installed around the circumference of the Albion Leach Reactor to provide a continuous high shear zone at the base of the vessel for high mass transfer rates and high utilization of the oxygen gas. The number and location of the HyperSparge™ are designed in combination with the agitation system to optimise oxygen mass transfer.

The HyperSparge™ is mounted externally to the Albion Leach Reactor for easy maintenance, and individual units can be removed live for inspection or maintenance. This significantly reduces reactor downtime, as all maintenance to the oxygen injection system is carried out external to the reactor. The HyperSparge™ system requires low pressure oxygen at 3.5 – 5 atm(g) and a VPSA oxygen plant is suitable for the oxygen supply. The HyperSparge™ has no moving parts and the only maintenance required is replacement of the supersonic ceramic nozzle every few years.

The HyperSparge™ is designed in conjunction with the agitation system for the Albion Leach Reactor. The agitation system consists of dual hydrofoil impellers on a centrally mounted shaft. The impeller size and rotational speed, as well as the agitator drive power are selected by Glencore Technology based on their in house mass transfer correlations. These correlations are based on an extensive data base collated over 20 years of testing and commercial development.

The agitator is mounted in an agitator support platform that is also fully modular in design. The agitator support platform is bolted to the top strake of the Albion Leach Reactor through connection stools. An indicative image of the Albion Leach Reactor roof and agitator support platform is shown in Figure 14.

The agitation system suspends the mineral particles within the Albion Leach Reactor, however this is not an onerous duty due to the finely ground nature of the IsaMill™ product. The agitator also ensures a high level of gas hold up within the Albion Leach Reactor to further improve oxygen mass transfer.

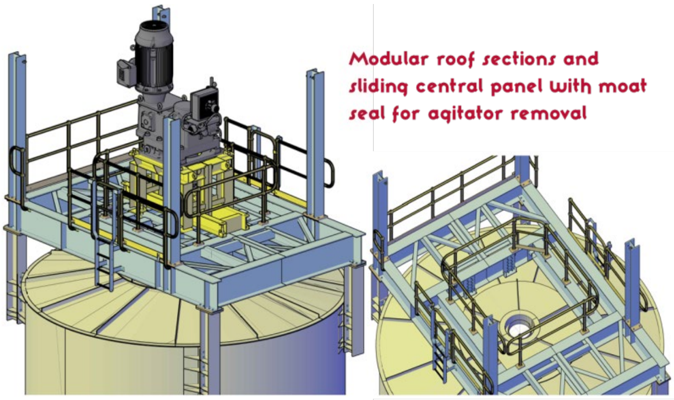

Figure 14 – Reactor Roof And Agitator Support Platform

The agitator support platform can be designed with interconnecting walkways to accommodate access from other structures within the client’s plant. The platform is normally designed with a removable inner section to allow complete removal of the assembled agitator for maintenance, to eliminate the need for scaffolding within the tank to access impeller blades and hubs. Safety lines and fencing are designed into the agitator platform for tank maintenance activities. Bolting patterns to accommodate local electrical panels and other plant items can be incorporated into the design of the platform.

Figure 15 – Albion Leach Reactor Baffle Components

Three or four baffles are provided with each Albion Leach Reactor to assist in slurry mixing and prevent vortexing.

Baffles are modular and designed in conjunction with the agitator to ensure adequate mixing and oxygen gas dispersion within the Albion Leach Reactor.

An example of a baffle sections is shown in Figure 15. Baffle sections would be added to each panel during assembly.

Baffles would be fixed to the tank shell using an anchor cleat welded to the inside of the panel.

3.3 Sealing and Exhaust Gas System

The Albion Leach Reactor does not require any internal cooling or heating equipment, with the reactor temperature controlled autothermally. Heat is supplied to the reactor by the oxidation of the sulphide minerals, with the majority of the excess heat removed from the reactor through humidification of the reactor exhaust gas.

The Albion Leach Reactor is fitted with a modular roof that is bolted to the top flange of the reactor shell. The tank roof consists of a series of interlocking petals and a central moat seal that is designed in combination with the agitation assembly to seal the reactor and direct all off gas to a single exhaust stack. The exhaust stack is fitted to a flange on the reactor roof and exhaust gas is vented to 3 metres above the working height of the agitator support platform.

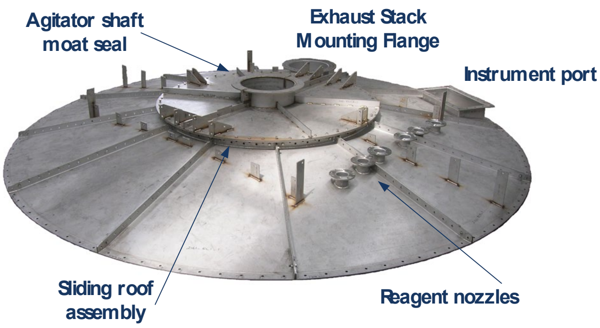

Figure 16 – Albion Leach Reactor Roof With Central Moat Seal

Reagent dosing nozzles are pre-fabricated into the reactor roof and the central component of the roof assembly consists of the moat seal, which is split into two rail mounted sections. These sections can be disconnected and will slide apart to allow installation and removal of the agitator. A picture of a roof section for an Albion Leach Reactor is shown in Figure 16.

3.4 Slurry Distribution System

The Albion Leach Reactors are connected by overflow launders to transport slurry within the oxidative leach train. Each Albion Leach Reactor is fitted with a slurry riser to assist in transport of slurry out of the Albion Leach Reactor and prevent slurry bypassing. Each slurry riser directs slurry into an overflow port that is connected to a launder assembly.

The launder assembly allows slurry to be directed to one of two adjacent reactors, to allow any reactor to be taken off line for maintenance. The launder is provided as a fully modular assembly and includes isolation penstock valves and spades to direct slurry movements. The launder assembly is designed to accommodate foam transport as well as slurry to assist in foam build up within the reactor. A typical slurry riser, launder assembly and isolation valve is shown in Figure 18 and Figure 19.

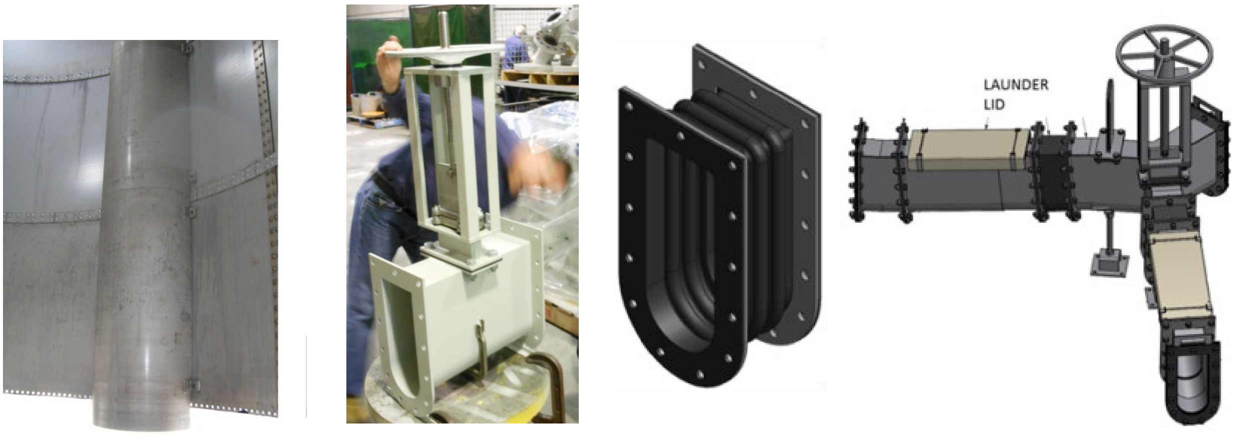

Figure 17 - Slurry Riser and Inter Tank Launders

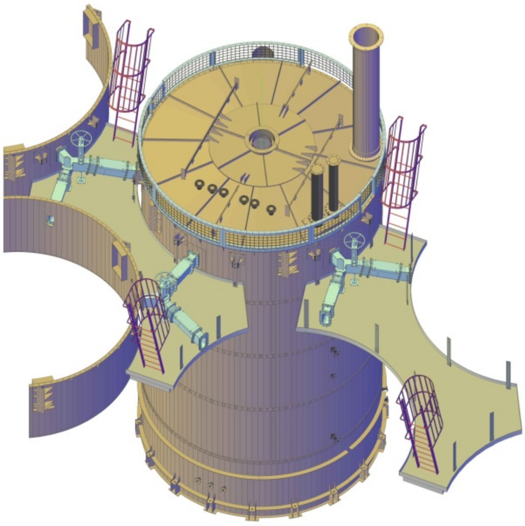

Figure 18 - Albion Leach Reactor and Inter Tank Launder Arrangement

3.5 Instrumentation and Control Systems

Control of the Albion Process Reactor involves three control loops:

- Slurry density control to maintain solution viscosity within acceptable limits for oxygen optimum mass transfer and ensure the appropriate oxidative leach temperature profile
- pH control to maximise leach kinetics and minimise scale formation within the reactor
- Oxygen addition control to ensure high utilisation of oxygen within the reactor and across the oxidative leach train

Glencore Technology designs the entire oxidative leach train to ensure that these process control objectives are met, including supply of the instruments, reagent storage and distribution networks and control systems, inclusive of the central PLC or DCS.

The design of the Albion Leach Reactor allows instrument insertions and attachment cleats at the optimum point for maintenance access and process control. Reagent addition nozzles are fabricated into the reactor roof and panels, including the HyperSparge™ insertion nozzles at the tank base and acid and alkali dosing points in the reactor roof.

The overall oxidative leach train, which consists of a series of modular Albion Leach Reactors as well as modular reagent storage tanks, reagent distribution systems and reagent dosing mains is designed by Glencore Technology to ensure a robust plant that is easy to operate and maintain.

3.6 Instrumentation and Control Systems

The Albion Leach Reactor can be installed for a large vessel inside 1 - 2 weeks, and assembly follows a top down approach, with individual strakes assembled at ground level without the need for scaffolding or special tools.

The assembly sequence for the Albion Leach Reactor is shown in Figures 20 to 22. Assembly requires a completed tank foundation and two temporary support platforms. Each temporary support platform consists of a series of metal or wooden beams fixed to a concrete foundation or compacted gravel base for assembly of consecutive strakes of the tank.

The sections comprising the reactor base are first lifted onto the tank foundation and joined using a butt weld. All sections will be pre-prepared to accommodate the weld. Anchor bolts are pre-tensioned to secure the tank base to the foundation.

The panels comprising the top strake of the reactor are then joined and the roof assembly bolted into place. The agitator support platform is then assembled and bolted to the top strake. The agitator support platform can then be used as a lifting aide to move the strakes. Alternatively, standard lifting beams can be used for assembly.

The next lowest strake is next assembled on the second temporary platform, and the agitator platform and top strake lifted onto this strake by crane. The top strake and next lowest strake are then bolted together. The third lowest strake is then assembled on the first temporary platform, and this process continued until all strakes are joined. Baffles, manholes and overflow pipework are bolted into place as each strake is assembled. A urethane sealant is applied internally to the tank across all mechanical joins to ensure watertight sealing.

The agitator platform and assembled strakes are then lifted onto the tank base and bolted to the base. All anchor bolts are then secured to the appropriate torque levels and the agitator is lifted into place. The agitator support platform is designed with a removable internal section to allow a fully assembled agitator to be lifted into place and bolted to the platform.

The agitator platform in Figure 22 is shown with static line braces to accommodate working around the agitator platform with the centre section removed while the agitator is being installed. The grid mesh flooring and hand railing is not shown on the agitator support platform for clarity.

A major advantage of the modular Albion Leach Reactor is that all components are fabricated off site, under controlled conditions, enabling a high quality product. Assembly requires a crane, plus a team of 3 – 4 workers including a rigger. Glencore Technology will provide a complete set of assembly instructions and drawings with each oxidative leach train and can also provide an experienced site supervisor to assist in the assembly process.

Figure 19 – Albion Leach Reactor Assembly

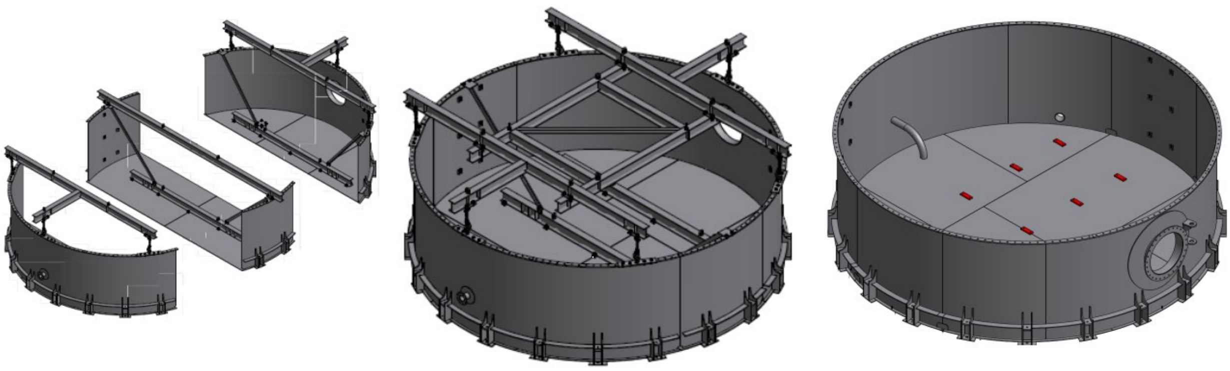

Figure 20 - Albion Leach Reactor Base Assembly Sequence

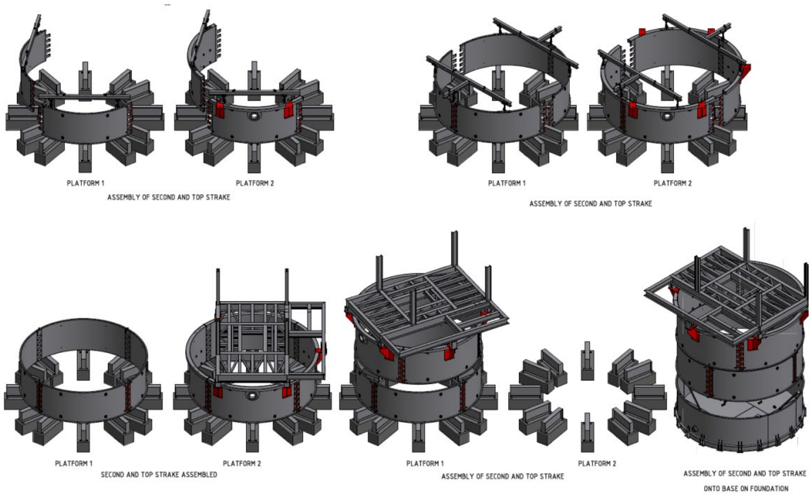

Figure 21 – Albion Leach Reactor Strake Assembly Sequence

4. Engineering and Project Development Services

Glencore Technology is the developer and owner of the Albion Process™ technology and offers the technology to clients worldwide.

Glencore Technology provides lump sum equipment design and supply packages to all Albion Process™ clients. The scope of supply includes the full IsaMill™ grinding plant and the oxidative leaching circuit in modular components with little or no site welding required. All structural steel, piping and launders, platforms, stairways and support structures are supplied by Glencore Technology, along with full civil and foundation design. Construction is supplied by the client, with supervisory labour provided by Glencore Technology.

The Albion Process plant package provided by Glencore Technology is low cost and low risk, and incorporates all of Glencore Technology's knowhow in the 20 year development history of the IsaMill™ and Albion Process™ technologies. Glencore Technology can work with our client's EPCM contractor to ensure that the Albion Process™ plant interfaces with all other plant areas in an efficient manner.

Glencore Technology involvement in a project usually begins at the testwork stage, with a testwork program designed for the client by Glencore Technology and carried out at an approved testing facility. Glencore Technology can then provide a low cost + 35 % Class 4 study on the capital and operating costs of the Albion Process™ plant as one of the outcomes of this initial testwork program. Glencore Technology can also provide Feasibility Study services, ultimately leading to a lump sum equipment design and supply package, which is fully guaranteed by Glencore Technology.

As an introduction to the Albion Process™ technology, Glencore Technology can provide desktop capital and operating cost estimates for an Albion Process™ plant at no cost to our clients, once provided with a concentrate composition and planned throughput.

For more information on the Albion Process™, please refer all enquiries to:

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