ALS Metallurgy

High Pressure Acid Leach & Pressure Oxidation

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Introduction

ALS Metallurgy has a purpose built world class Hydrometallurgy Centre at our Balcatta campus in Western Australia. This facility includes unprecedented, state-of-the-art bench and pilot testing equipment for a complete range of hydrometallurgical testwork services.

Supported by Australia's most comprehensive analytical, mineralogical and metallurgical testing facility our Hydrometallurgy testing services cater for all commodities and metals some which are:

Uranium	Nickel	Gold	Copper
Cobalt	Rare earths	Zinc	

High Pressure Acid Leach (HPAL) and Pressure Oxidation (POX) testing services provide a unique opportunity to evaluate and optimise the most economically viable process routes for the recovery of most metals such as nickel from lateritic ores and gold from refractory ores.

HPAL and POX are commercially proven and tested extraction methods for specific ores. As the lithological, mineralogical and metallurgical characteristics of ore types vary from one deposit to the next it is imperative that in depth, detailed testwork is carried out to evaluate and optimise the various pertinent and critical parameters affecting the design and operation of pilot and full scale process plants.

Our team of industry experienced Hyrometallurgists design and conducted HPAL and POX test programs often in close consultation and collaboration with our clients such as mining and process engineering companies to ensure correct plant design and process parameters are derived for bankable feasibility study and definitive feasibility study projects.

Our other ancillary and support services such as sample preparation, comminution testwork, beneficiation, flotation testwork, heavy liquid separation, analytical and mineralogical laboratories, in conjunction with our hydrometallugical testing services, provide a unique blend of services and expertise to ensure the correct understanding of individual ore characteristics and determination of process plant parameters.

High Pressure Acid Leach (HPAL)

HPAL testwork most often comprises initial batch leach tests in bench scale autoclaves to evaluate and optimise the various conditions necessary for pilot scale HPAL campaigns leading to the design, construction and commissioning of full scale process plants.

Bench scale batch autoclave tests are conducted to confirm the ore sample response to operating variables such as acid concentration, dissolution temperature, reaction retention time and liberation particle size.

ALS Metallurgy has several Parr 1 gallon (US) and 5 gallon (US) titanium autoclaves which are used for the evaluation and optimisation of the above process variables The larger 5 gallon autoclave is also used to generate bulk HPAL product slurries for further testing such as solid-liquid separation and generation of pregnant leach solution (PLS) for further metal recovery testing for process options such as ion exchange resin, solvent extraction and precipitation.

The absence of a mechanical seal and the unique magnetic driven slurry agitation mechanism incorporated in the Parr autoclaves allows for very high pressures being applied and tested during HPAL testing.

Our Parr autoclaves are equipped with ancillary equipment allowing for injection of chemicals such as sulphuric acid into the reaction vessel after a specified period of preheating the leach slurry to a set temperature. Specially designed and operated sample canisters allow for the withdrawal of samples from the reaction vessels at pre-determined regular intervals to provide liquor and residue samples for analysis and the evaluation of the dissolution reaction kinetics.

The various process variables tested during bench scale testwork are utilised to determine the configuration of the pilot HPAL circuit. The set up will involve dry bump testing, water testing in sections and continuously to ensure heating equipment is functioning correctly and that material and reagent flows are at set levels. The equipment is then ready to receive actual slurry.

HPAL pilot campaigns are normally conduced continuously for a number of days. During this period the autoclave is allowed to achieve steady state with respect to feed slurry flow rate, operating temperature, residence time and target acid addition. Often pre neutralisation (iron removal), solid liquid separation (counter current declaration (CCDs)), solution neutralisation and mixed hydroxide precipitation modules of the extraction process are all operated continuously during this period. During this period all process conditions are monitored and recorded in all areas and appropriate sampling regimes are employed.

Pressure Oxidation (POX)

It is well know that sulphide minerals decompose rapidly in acidic media under conditions of elevated pressure and temperature using oxygen as the principal oxidation agent. This so called "chemical liberation" will allow for the liberation of metals encapsulated in the sulphide mineral matrix often as solid-solution which is not amenable to mere physical grinding style liberation. Often the sulphide bearing ores or concentrates being treated contain sufficient sulphide sulphur (typically greater than 4% required) to allow for an autogenously run reaction as the exothermic sulphur oxidation reaction would generate sufficient heat for the oxidation reaction to proceed to completion.

Non-acidic pressure oxidation techniques such as alkaline pressure oxidation use similar conditions of temperature, pressure and oxygen to acidic route but the process is run under alkaline or neutral conditions.

ALS Metallurgy incorporates POX testwork in a variety of metallurgical test program flow sheets in particular those involving semi-refractory and refractory gold ores.

Our metallurgical test programs are designed to evaluate and optimise the following process variables:

Grind liberation particle size	Solution potential
Total and oxygen over pressure	Pulp density
Reaction temperature	Feed sulphide sulphur
Acid concentration	Influence of interfering analytes

An understanding of the above variables is critical to POX process plant design studies. The aqueous oxidation of metal sulphides is characterised by complex chemistry with several reactions being possible, either in series or parallel depending on the physio-chemical conditions of the system. The inherent sulphide sulphur content of ores or their concentrate derivatives can report in several forms, during POX reactions, such as elemental sulphur, sulphate, basic sulphate, acid or jarosite. The metals report as cations associated with sulphates or jarosites or as the oxide. Arsenic (a metalloid) behaves in a similar manner to sulphur forming arsenious acid, arsenic acid, arsenite (III) or arsenate (V). Metallurgical testwork in combination with high level analytical and mineralogical examination is necessary to ensure correct understanding of the chemical reactions and process delineation of the required process chemistry for a full scale plant design, construction, commissioning and operation.

Batch bench scale testwork is conducted using Parr autoclaves; normally a 1 gallon (US) unit is utilised for the evaluation and optimisation of the process variables especially when using flotation concentrates such as gold bearing pyrite and arsenopyrite concentrates generated from processing ores via gravity and/or flotation process routes. The bigger 5 gallon (US) Parr autoclave unit is often used to generate bulk POX slurry product under the optimised conditions. The bulk POX slurry is often used for downstream process testwork such as solid-liquid separation, bulk cyanidation and cyanide detoxification testing.

Ultimately pilot POX campaign similar to that described for HPAL are carried out for final confirmation of the process plant design parameters.

The expertise of our industry experienced metallurgists is available for the benefit of all mining and process engineering companies. We can design and conduct metallurgical test program flowsheets incorporating analytical, mineralogical and metallurgical components to evaluate and optimise HPAL and POX process routes for particular ore types such as nickel laterites and refractory gold ores.

ALS Metallurgy

Australia

Perth

6 MacAdam Place, Balcatta,
Western Australia 6021

T +61 8 9344 2416
F +61 8 9345 4688
E metallurgy@alsglobal.com

North America

Kamloops

2957 Bowers Place,
Kamloops BC V1S 1W5 Canada

T +1 250 828 6157
F +1 250 828 6159
E metallurgy.kamloops@alsglobal.com

Latin America

Santiago Mineral Services Centre

Hermanos Carrera Pinto 159
Parque Industrial Los Libertadores Colina,
Santiago, Chile

T +56 2 2654 6100
F +56 2 2654 6163
E Santiago.MineralServices@alsglobal.com

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www.alsglobal.com