



# METAL & MINING INDUSTRY

## Sustainable metal recovery and water treatment

The Metal and Mining industry is increasingly aware of the opportunities to recover valuable resources from process and bleed streams. This combines creating revenues with environmental sustainability.



# Sustainable Metal Recovery and Water Treatment

Paques offers proven biobased technologies for recovery of valuable metals, toxic metal immobilisation, water reuse, zero discharge and water discharge for process, ground or wastewater.

Sulphate and dissolved metals are traditionally removed by neutralisation processes generating large quantities of gypsum and trapped metal hydroxides.

Paques **THIOTEQ™Metal** process recovers valuable metals in the form of high purity metal sulphides. The required sulphide for the **THIOTEQ™Metal** process is generated safely on-site in a bioreactor from a low cost sulphur source.

Removal of sulphate and simultaneous metal recovery is achieved by the **SULFATEQ™** process for the treatment of brines, acid wash water, bleeds, water from tailings dams, acid mine drainage, acid rock drainage and downstream lime treatment. Arsenic removal and immobilisation is achieved by the **THIOTEQ™Scorodite** process.

This is a new process for safe arsenic immobilisation through the biological formation of highly stable scorodite crystals ( $\text{FeAsO}_4 \cdot 2\text{H}_2\text{O}$ ).

**BIOMETEQ™** is a process for the biological polishing of metal containing effluent (ppm to ppb range), using proven moving bed reactor technology.

#### Applications

- Recovery of valuable metals upstream of lime treatment
- Sulphate removal downstream of lime treatment
- Brines, bleeds, blow down streams from pyro- and hydrometallurgical operations
- Treatment of acid mine drainage resulting from mining operations and tailing dams

- Polishing of waste-, process- and cooling water from metal refineries, scrap metal recyclers and galvanising industries
- Arsenic removal as orpiment or scorodite for safe disposal
- Hydrogen sulphide production for e.g. flotation of metals

*Paques offers (pre-)feasibility, lab- and pilot- studies to evaluate the applicability of Paques technologies and customise the solution for a specific case. Our engineers can design, build and commission the plant, or provide a technology package consisting of basic process engineering, proprietary equipment including engineering, micro-organisms for start-up services either directly or through an authorised licensor.*



## SULFATEQ™

- With SULFATEQ™ lower sulphate concentrations are achieved compared to conventional treatment with lime.
- Effluent quality is appropriate for water re-use or discharge
- A minor fraction of solid waste production compared to lime treatment
- Sulphide production for the recovery of valuable metals by selective metal precipitation
- Anaerobic BIOPAQ®/UASBplus reactor for three phase separation for optimal biomass retention and solid separation



## THIOTEQ™Metal

- Cost-effective sulphide source compared to chemical sulphide precipitation
- Revenue from high grade metal sulphides: very attractive ROI at metal concentrations as of ~ 0.1 g/l (depending on flow)
- Good settling and dewatering characteristics of the metal sulphides formed
- Flexible process: production naturally adjusts to demand
- No corrosion due to HDPE and/or FRP construction
- Anaerobic THIOTEQ™ gaslift reactor for optimal mixing and H<sub>2</sub>S stripping



## THIOTEQ™Scorodite

- Use of plain air as an oxidant
- Operating at low temperature (<70°C)
- A low arsenic leaching rate, well below authorities' requirements
- Uniform and large crystals are produced
- Less iron dosing, less solid waste than other precipitation methods
- Aerobic CIRCOX® reactors with small footprint and low OPEX



## BIOMETE™

- Precipitation of a wide range of toxic metals such as Se, Cr, U
- Reliable proven reactor concept with minimum maintenance
- No backwash required
- Effluent is ready to discharge or re-use
- ASTRASAND® continuous moving bed sand filter as proven technique for biomass retention and solid separation



### Recovering copper

At a goldmine in the Caribbean, THIOTEQ™Metal is used to recover copper sulphide from an acidic process water stream. Without Paques process, the copper would end up in the pile of gypsum that is formed during neutralization of the water. More than 10,000 tonnes of copper per year can be recovered using Paques technology.

### Biosulphur recovery

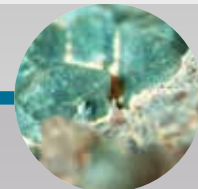
In the SULFATEQ™ reactor, hydrogensulphide is biologically transformed into elemental sulphur with the help of bacteria. The elemental sulphur from the SULFATEQ™ installations can be reused for example for sulphuric acid production.



### Recovering zinc

At the Nyrstar zinc refinery in the Netherlands, Paques SULFATEQ™ technology recovers zinc from acid wash water and groundwater.

Besides zinc, the groundwater is polluted with other metals and sulphate. After neutralisation, bacteria convert sulphate into sulphide. This sulphide reacts with the metals and produces metal sulphides, which are reused in the zinc process. By this treatment the discharge of chemical waste is prevented. Annually, around 300 tons of zinc are recovered.



### Immobilising arsenic

The THIOTEQ™Scorodite process removes arsenic from acid bleeds and crystallises it into scorodite.

Bioscorodite crystals are large in size (>50 microns) having a high arsenic content (30 wt%). These crystals have low free water content and have exceptional stability properties based on arsenic leaching values in TCLP tests. These properties enable disposal of the crystals immediately after being harvested.



## Paques: leading in biological wastewater and gas treatment

Paques has over 30 years experience in helping industries and municipalities to reduce their water and carbon footprints and reclaim valuable resources. The cost-effective effluent purification systems produce energy from wastewater, whilst purifying the water and facilitating water reuse. Since 1980, Paques realised more than 1800

references worldwide. Besides the headquarters in The Netherlands, Paques has subsidiaries and/or production locations in China, Brazil, United States of America, India and Malaysia. In many other countries, the company is represented by licensed partners. This ensures local presence and the best service for clients worldwide.

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