

BioteQ Environmental Technologies Inc

The economic and environmental benefits of new wastewater treatment technologies

Metal- and sulphate-contaminated wastewater from mining activity creates a lasting environmental liability that mining firms must manage, sometimes in perpetuity. While wastewater management has typically represented a long-term cost for mining firms, new technology is allowing companies to remove toxins from the environment and turn their wastewater into a profit centre.

Mining activity generates large volumes of wastewater that can become contaminated through process streams or through the natural process of acid mine drainage. Acid mine drainage, which affects an estimated 70% of the world's mine sites, is produced when water and oxygen form a weak acid that reacts with exposed rock containing sulphide minerals. The minerals dissolve in the acidic water, creating a toxic cocktail of metals and water. Because of the impact of this contaminated water on surrounding ecosystems, it is fully regulated in most jurisdictions. Environmental regulators require mining firms to treat the contaminated water, and increasingly, mining companies are being required to post bonds that guarantee long-term environmental remediation costs, as the acidic wastewater can continue to occur long after active mining stops.

Lime treatment technology has been widely used to treat the mining industry's metal-contaminated water,

as it is easily engineered and relatively simple to operate. Lime, in the form of calcium oxide or hydroxide, is added to large stir tanks containing contaminated water. The lime precipitates the metals as solids, which form a sludge that is transferred to a storage pond.

While lime treatment can reduce the concentration of metals in the water, the treatment process has two main disadvantages. First, lime treatment does not always produce water that meets tightening regulations for water quality, which means that secondary treatment processes are sometimes required to produce clean water acceptable to regulators. Second, the lime treatment process simply moves the metal contaminants from one form (water) to another (sludge). Because the sludge contains heavy metals, it must be stored and monitored – often for decades – creating a costly long-term environmental liability for mining firms.

In addition to strict regulations for metal-contaminated water, many jurisdictions around the world are imposing tighter regulations for sulphate discharge, in response to rising concerns about the effect of sulphate on water quality, human health and agriculture. This is driving the need for environmental compliance in industries like mining, metal processing, pulp and paper, sewage treatment, and chemical manufacturing. Sulphate imparts a bitter taste and odour that makes it undesirable for drinking water, and is a concern in process waters as it forms scale on process equipment that can cause equipment failure or reduce production capacity.

Prevailing technologies to treat sulphate include reverse osmosis, processes based on ettringite for-

Left: In response to the growing need for alternative technology solutions for mining wastewater, Canadian-based BioteQ Environmental Technologies has developed a suite of technologies that remove metals and sulphate from industrial wastewater, replacing traditional water treatment processes like lime and reverse osmosis.



mation (e.g. SAVMIN and CESR), biological sulphate reduction, and precipitation with barium. Typically these technologies are either not able to treat contaminated water to a level which complies with new regulations and standards that are being imposed on industry, or suffer one or more technical or economic disadvantages. Reverse osmosis, for example, has high capital and operating costs, consumes large quantities of power, and produces a residual product that requires special handling and disposal.

Alternative solutions

In response to the growing need for alternative technology solutions for mining wastewater, Canadian-based BioteQ Environmental Technologies has developed a suite of technologies that remove metals and sulphate from industrial wastewater, replacing traditional water treatment processes like lime and reverse osmosis. The processes produce clean water that can be safely discharged to the environment, as well as saleable by-products that can offset the cost of water treatment. Customers include leading mining firms, utility operators, and regulators, including Freeport McMoRan, Xstrata, Jiangxi Copper Company, Aditya Birla, Molymet, EPCOR, and the US Environmental Protection Agency.

The company was founded in 1997 to develop and commercialise sulphide technologies for metal recovery, and has since expanded its technology to include an ion-exchange process to remove sulphate. The processes are patent-protected, and BioteQ invests in

ongoing research and development to bring new water treatment solutions to market.

BioteQ's core technology, the BioSulphide® process, uses hydrogen sulphide gas generated biologically at the treatment site to remove and recover metals from contaminated water. It has also developed a chemical sulphide process, called ChemSulphide™, for use when biological sulphide is not warranted. In both cases, the sulphide reagent is introduced to a contactor tank that contains the contaminated water to be treated. The solution chemistry in the tank is adjusted to selectively precipitate metals as pure metal sulphides. The precipitated metals and treated water are pumped to a clarifier tank where the clean water is separated from the metal solids and either discharged to the local environment or recycled. The metal solids are then filtered to remove excess water, producing a high grade metal product suitable for refining. To recover multiple types of metals, separate contactor and clarifier tanks are set up in series.

The outputs of the process are saleable metal products and clean water that can be discharged to the environment. Metals that can be recovered include copper, nickel, zinc and cobalt metals that are typically sold to offset the cost of water treatment. Other toxic metals such as arsenic, antimony, cadmium, lead, molybdenum and manganese can also be removed from the water.

New technology for sulphate removal

Complementing its growing portfolio of metal recovery plants, BioteQ has recently introduced new technology for the removal of sulphate from water. The Sulf-IX™ ion exchange process removes sulphate and produces clean water that meets tightening regulations for sulphate discharge, as well as a saleable gypsum by-product that can be used in fertiliser manufacturing and building products. With relatively low capital and operating costs, and no residual product that requires special disposal, this new ion-exchange process provides an attractive alternative to reverse osmosis and other conventional technologies.

The Sulf-IX process employs two different resins to achieve sulphate reduction by removing calcium and sulphate ions (Ca^{2+} and SO_4^{2-}) from water. The complete process cycle includes resin loading, regeneration and rinsing. Feed water is first passed through a series of contactors containing cation exchange resin to remove calcium and magnesium by loading the cations onto the resin, and then through contactors containing anion exchange resin to remove sulphate. The ion exchange resins are regenerated using low-cost reagents, sulphuric acid and calcium hydroxide.

The technology was initially based on the GYP-CIX technology developed in South Africa, which also uses sulphuric acid and calcium hydroxide for resin regeneration. The Sulf-IX process has incorporated some improvements to overcome difficulties of the GYP-CIX process associated with limited process flexibility for varying feed chemistry, mechanical entrainment of gypsum in the regeneration stage, and limitations on

Below: BioteQ operates the plant on behalf of a joint venture between Xstrata and Freeport McMoRan. In 2007, the plant recovered 635t of copper, and processed 2.8Mm3 of water produced by drainage of a low-grade stockpile of waste rock that is estimated to contain 180,000t of copper.



sulphate removal when magnesium is present in significant concentrations in the feed water. The BioteQ process is particularly suited for removal of sulphate from lime plant effluent, but can also be applied to treat any process stream or wastewater high in total dissolved solids (TDS) or hardness caused by calcium or magnesium.

Commercial applications

BioteQ has deployed its metal recovery technology at five sites that include operating as well as closed mine sites, and has several new plants in construction. The first commercial scale plant built in 2001 was at Caribou Mine, a closed mine site in New Brunswick, Canada. Although relatively small compared to the plants that the company is building today, the Caribou operation demonstrated the commercial application of the technology, and led the company to its next two projects with Falconbridge (now Xstrata) at the active Raglan nickel mine site in the Canadian Arctic region of northern Quebec, and with Phelps Dodge (now Freeport McMoRan) at the closed Bisbee mine site in southern Arizona.

The Raglan plant, which operates seasonally because of harsh winter conditions, has completed three successful years of operations. In 2007, the plant processed 920,000m³ of water, and prevented 12,500kg of nickel from entering the pristine Arctic environment. The plant removed nickel to less than 0.2ppm (parts per million), well below the required 0.5ppm set by regulators. BioteQ built the plant for US\$1.8m, and is responsible for all aspects of the on-going plant operations. Xstrata pays BioteQ a water treatment fee, and sells the nickel that is recovered, which helps to offset the water treatment costs.

The Bisbee plant is a 50-50 joint venture with Freeport McMoRan – both companies shared in the initial US\$3.2m capital cost in 2004, and split the on-going operating costs of the plant. BioteQ operates the plant on behalf of the joint venture, and is paid from its share of the high-grade copper product that is recovered. In 2007, the plant recovered 635t of copper, and processed 2.8Mm³ of water. The plant treats water produced by drainage of a low-grade stockpile of waste rock that is estimated to contain 180,000t of copper.

Building on its commercial success at Caribou, Raglan and Bisbee, BioteQ has recently completed construction of two new plants that are now in the final stages of commissioning, and are expected to be fully operational by April 2008. The first new plant is with India's large mining conglomerate Aditya Birla at their Mt Gordon copper mine in Australia. The plant is slated to treat up to 2.2Mm³ of water annually, producing an estimated 635t/year of copper, 63.5t/year of cobalt, and 10.4t/year of nickel.

The second new plant is a 50-50 joint venture with China's largest copper producer, Jiangxi Copper Company, at the Dexing copper mine site in southeastern China. The Dexing mine produces 120,000t/year of

copper concentrate from flotation concentrate and also operates a heap leach using SX-EW to produce copper cathode from low grade stockpiles. The water treatment plant is expected to initially produce 450t/year of copper, increasing in stages to almost 2000t/year depending on the copper grade and volume of water treated.

BioteQ has an active construction pipeline of new projects, including a new plant at the Lluvia de Oro gold mine site in northern Mexico. This plant, which is expected to commence commissioning during the second quarter of 2008, will use a new application of BioteQ's technology. It will recover copper from the cyanide leach solution used to extract gold and then regenerate the cyanide to re-use in the gold extraction process. This technology innovation changes the project economics for what was once considered a marginal gold mine site.

BioteQ is also initiating construction of two new plants that will use the Sulf-IX technology to remove sulphate – one with Freeport McMoRan at their Sierrita

copper mine site in southern Arizona, and one with Molymet at their Nos Refinery near Santiago Chile. In the case of the Molymet plant, the BioteQ's Sulf-IX technology is slated to re-

place a new reverse osmosis system that has proven to be very costly to operate. The companies will share in the cost savings generated by the Sulf-IX process.

BioteQ's water treatment plants provide several economic and environmental benefits. The technology reduces the long-term liability created by alternative treatment processes by eliminating the production of toxic sludge, generates revenue from metals and by-products that can offset water treatment costs, produces high quality water that can be re-used or discharged to the environment, and saves money compared to other treatment processes.

The outsourcing solution

Wastewater management remains a long-term concern for many mining operators. With changing regulations and the rapid evolution of treatment technology, mining companies are increasingly choosing to outsource their water treatment requirements to companies like BioteQ, in order to access water treatment expertise and new technologies that deliver sustainable water treatment solutions that remove toxins from the environment while generating revenue from waste. This approach allows mining companies to focus on their core business, and use specialised expertise to address their water treatment needs.

Global mining firms are interested in enhancing their environmental performance to meet the rising expectations of regulators, communities, investors, and the general public. Water treatment technology is evolving to meet these demands, providing both environmental and economic benefits while mitigating long-term liabilities and costs.



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