



LOW-COST, SUSTAINABLE BIOX[®] PROCESS AT RUNRUNO GOLD MINE, PHILIPPINES

BIOX[®] is a robust, easy to operate and sustainable technology for the treatment of refractory gold concentrates. The process has been in commercial operation for 30 years. The BIOX[®] process can operate over a wide range of feedstock characteristics, can be customized to fit specific project requirements and is especially suitable to remote locations.

BIOX[®] plant design offers a low capital cost solution, reliable process performance and the application of robust, energy efficient equipment. Value-adding features are the HiTeCC and ASTER[™] enabling technologies and full range of service offering and knowledge transfer.

CHALLENGES

- Low yielding gold recovery on direct cyanidation
- High levels of sulphide oxidation required to achieve acceptable recovery
- Environmentally sensitive environment

SOLUTION

- Robust, environmentally friendly BIOX[®] process
- Development and implementation of project by experienced experts

BENEFITS

- Improved gold recovery rate
- Reduced operating and capital costs
- Robust technology suited to remote locations
- Environmentally friendly

About the customer

FCF Minerals Corporation (FCF), a wholly owned subsidiary of Metals Exploration Plc (Metals Exploration), is a Philippine based resources company and the owner of the Runruno gold project.

The work done by FCF Minerals Corporation at the Runruno Gold-Molybdenum Project has attracted series of awards and recognition both internationally and nationally.

International Awards

- Mining Journal Outstanding Achievement Award
- Best Community Development Initiative Award (Asia Mining Congress – Singapore)

National Awards

- Presidential Mineral Industry Environmental Award (PMIEA)
- Safest Mines Award - Exploration Category
- Mining Forest Award
- Platinum Award
- The Kabalikat Award

About the project

The Runruno Gold Project is located on the island of Luzon, approximately 200 miles north of Manila in the Philippines, in the mineral rich province of Nueva Viscaya. The area has been known to contain gold and other precious metals since the early 1960s and has enjoyed a varied exploration history.

One of the key objectives for FCF Minerals was to optimise the capex and opex efficiency of the Runruno project. This was achieved by leveraging new technologies, critically reviewing all design aspects and making use of local contractors as far as possible. A high regard for the environment and the local people is paramount for FCF and was another key reason why the BIOX technology was chosen for the Runruno project.

The mine is an open cut operation and uses the proven BIOX® process for the pretreatment of refractory concentrate ahead of a conventional carbon-in-leach (CIL) processes to recover gold and the ASTER™ process for the detoxification of the CIL residue prior to discharge to the Residue Storage Impoundment (RSI).

Construction of the Runruno gold project commenced during 2011 with commercial production achieved in November 2016 on the BIOX® section of the plant. The Runruno project was also the first implementation of the Generation III BIOX® design principles with the focus on delivering an improved process robustness and ease of operation.

Work to date has defined a mineral resource of 1.39 million ounces (Moz) of gold, and the operation will produce 96 700 oz of gold per annum over a mine life of 10.4 years. The BIOX® circuit is designed to treat 140 000 t/y of concentrate with a design capacity of 404 t/d of concentrate at a design sulfide sulfur grade of 17% S₂.

Background

Metals Exploration commenced drilling at the Runruno project in 2005 followed by the announcement of an inferred resource of 2.0 million ounces of gold in 2006. Development of the project continued with the completion of a scoping study in 2008. BIOX was selected as the preferred technology based on the lower capital and operating cost of the process combined with the ASTER process for treatment of the CIL residue prior to discharge to the TSF. BIOX and ASTER commissioning was completed in 2016 with the first BIOX product pumped to the CIL section.

Outotec BIOX® Process

The Outotec BIOX process was developed for the pre-treatment of refractory ores and concentrates ahead



First implementation of the Generation III BIOX® circuit designed to treat 140,000 tpa of concentrate

of conventional cyanide leach for gold recovery. The gold in these ores is encapsulated in sulphide minerals such as pyrite, arsenopyrite and pyrrhotite, thus preventing the gold from being leached by cyanide. The BIOX process destroys the sulphide minerals and exposes the gold for subsequent cyanidation, thereby increasing the overall achievable gold recovery.

The BIOX design has evolved over the years, incorporating knowledge and experience from every project into the design of the latest BIOX plant. During 2013 BIOMIN launched the Generation III BIOX design philosophy focusing on delivering an improved process robustness and ease of operation.

BIOX advantages

The plant design offers a low capital cost solution, reliable process performance and the application of robust, energy-efficient equipment. The BIOX process operates over a wide range of feedstock characteristics and can be customized to fit specific project requirements. The simplicity of operation and scalability of the technology, using a modular design, means the process is especially suitable for remote locations. Commercial Outotec BIOX plants operate at treatment capacities in the range of 60 to 2,137 tons per day of flotation concentrate, in various climate conditions.

The Outotec BIOX process has been in commercial operation for over 30 years with 13 successful plants commissioned worldwide. To date, over 22 million ounces of gold have been produced through this process.

Runruno process selection

Runruno primary ore is refractory generally exhibiting 50 – 60 % cyanide leach extraction after grinding to a size of P 80 = 45 micron. It requires oxidative pre-treatment to release gold from pyrite and arsenopyrite. The grade and flotation response of the Runruno ore indicated oxidative pre-treatment of a flotation concentrate rather than whole ore, with POX and BIOX technologies being the main options for this pre-treatment.

In addition to estimating capital and operating costs and incremental recovery differential, the Runruno project team visited both POX and BIOX plants to assess operating criteria. The more significant criteria included safety, environmental acceptability, capital and operating cost, technical risk and ease of expansion. Additionally, further criteria included implementation and ramp up time, operability, maintainability and spares holding as well as sensitivity to feed sulphur grade variations and water quality.

Close customer collaboration

We worked in close collaboration with our customer, providing test work, consulting and process engineering services through the development of the project, from first batch tests through to bankable feasibility study. BIOX test work was undertaken on a wide range of flotation concentrate samples and included both batch BIOX amenability tests and a continuous BIOX pilot plant run. Results of early batch test work indicated that the BIOX culture adapted easily to the Runruno concentrate, achieving high sulphide oxidations on a range of variability samples. Final BIOX liquors had soluble iron to arsenic (Fe:As) molar ratios exceeding 3:1 and generated stable basic ferric arsenate precipitates on neutralization. Leach tests on the BIOX residue samples confirmed high cyanide leach gold recoveries can be achieved on the fully oxidized BIOX product samples.

Process design and scope

We were responsible for the process design specifications for the BIOX plant including the BIOX feed section, BIOX reactors, CCD section and neutralisation section. All the associated reagent addition systems and BIOX services were also included in the Outotec scope.

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Primary BIOX® reactor

contractors as far as possible. We collaborated during the process design and detailed engineering to implement the GEN 3 BIOX design principles.

Support services throughout

As part of the standard scope delivered to every BIOX project, we supply full consulting and advisory services during the detailed design of the plant. This service is extended through construction and included construction verification and commissioning planning. Included in the scope, is the supply of the bacterial inoculum for the process. Our team of Outotec process engineers work closely with site personnel and assist during the commissioning of the commercial plant until commercial production.

Results

Runruno is the latest and most advanced BIOX plant, including the BIOX Generation III design as well as the latest BIOX agitator design for improved oxygen transfer efficiency. The BIOX plant was commissioned in 2016, treating primary sulphide concentrate with the oxidised BIOX product fed to the CIL section for gold recovery. The robustness and adaptability of the process ensures performance and is maintained during variations in the feed concentrate characteristics.

Operational results have also confirmed that any arsenic solubilised in the BIOX process can be removed efficiently from solution during neutralisation and fixated as a stable basic ferric-arsenate precipitate that can be safely deposited onto a tailing storage facility.

Conclusion

The BIOX process for refractory gold recovery from the Runruno concentrate was successfully implemented. The process offered technical, economic and environmental advantages over alternative processes. Using our know-how and experience in the testing, design and commissioning of bacterial oxidation plants, we worked closely with our customer during project development from first batch BIOX amenability tests through to commercial production. A bespoke test work program was developed and executed for our customer, generating the required level of confidence for a bankable feasibility while taking into consideration the project specific scheduling and sample availability constraints.