KNIGHT
MATERIAL TECHNOLOGIES

CASE STUDY

Modernizing Gold Mining: Knight's Advanced Solutions Improve Yield and Slash Downtime

Situation: Modern Gold Recovery Methods Demand High-Performance Materials

Gold is pulled from the ground at a rate of 3,000 metric tons annually on a global basis. This precious yellow metal does not tarnish, and ornaments and jewelry found in archeological digs gleam as brightly as they were the day they were fashioned. Beyond ornamental reasons, its other properties make gold a useful and indispensable metal in many industrial and aerospace applications as well. Since the 1900s, gold has been commonly extracted in a cyanide process where gold is leached from ore by a cyanide solution. This method is linked to environmental and health concerns, lower production yields and higher energy consumption.

The industry has gradually shifted toward more efficient and environmentally conscious extraction processes, particularly in developed nations. Pressure Oxidation (POX) technology, which emerged in the 1990s in the United States, offers a superior method for processing gold ore. This advanced approach allows for higher extraction efficiency while reducing environmental impact and enabling the processing of lower-grade ores that would otherwise be discarded.

Challenge

In 2016, Guizhou Zijin Mining Co. Ltd., a subsidiary of Zijin Mining Group and a major mining operation in Southwest China, aimed to modernize its gold extraction capabilities by implementing the country's first POX hydrometallurgy system for gold processing. This pioneering installation represented a significant technological leap, transitioning from traditional to state-of-the-art processing methods.

The POX process requires specialized equipment capable of withstanding extreme conditions, including temperatures up to 230°C and 2-3 megapascals (MPa) pressures. These demanding operating parameters, significantly higher than those required for processing other metals, necessitated exceptional material performance and reliability. Additionally, the installation needed to be completed during winter conditions, adding complexity to the construction process.

Challenge (continued)

The scale of a typical POX system for gold processing requires horizontal autoclaves that can average 3.5 meters in diameter and 18-20 meters in length. An article from the University of California, Berkeley notes that it takes 100,000 ounces of ore to yield one ounce of gold. This location processes 600 tons of slurry daily to maintain consistent production levels.

The installation presented numerous technical challenges. The autoclave lining required durable materials that could withstand both thermal and chemical expansion under extreme conditions. In addition, the less maintenance the system requires, the better, since downtime at the gold mine leads to huge daily production and financial losses. A reliable system with low maintenance requirements could help limit these production losses.

Solution

Through a strategic partnership between ENFI, a prominent Chinese engineering institute and local distributor Yehua Company, Knight Materials Technology provided a comprehensive solution for the autoclave's protective lining system. Knight's approach combined advanced materials engineering with expert technical support throughout the design and installation process. The solution centered on three key Knight products:

KNIGHT-WARE® PV33P acid-resistant brick: Engineered to withstand extreme temperatures and chemical exposure in the POX process. Knight acid-resistant brick is:

- Available in standard and custom shapes and sizes
- Corrosion-resistant in high-temperature environments
- Conforms to ASTM 279 specifications

PYROFLEX® acid-resistant membrane: The membrane between the steel vessel and acid-proof brick is a non-porous or impervious thermoplastic barrier that can accommodate thermal expansion differences and absorb stress, just one of the many useful attributes of this product. PYROFLEX is one of the most unique protective lining systems available. In addition, PYROFLEX:

- Completely seals steel or concrete from chemical corrosion
- Directly adheres to metal or concrete without adhesives
- Provides continuous, uniformed lining (no lap joints)
- Is highly resistant to thermal decomposition
- Applies easily with no curing or aging process required

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Solution (continued)

Acid-resistant mortar: Endure acid corrosion and slurry erosion at high operation temperature and pressure. It eases the installation of acid-resistant bricks and provides additional protection for the membrane. Knight offers a line of proprietary mortars of different types and formulations to service the needs of process environments.

Knight's engineering team took a comprehensive approach to the project, beginning with a detailed analysis of the application requirements through completing the engineering design of the brick lining system. Addressing the winter installation challenges, Knight's technical advisors developed procedures for the installation team to follow, including heating the steel vessel to a certain temperature to ensure proper installation of the PYROFLEX membrane. The company maintained a continuous presence during construction, providing on-site technical supervision to train local masons for the installation techniques used for the acid-resistant brick lining and to maintain rigorous quality control throughout the process.

Results and Benefits

Traditional gold extraction methods often rely on harmful chemicals like mercury and cyanide, which pose serious environmental and health risks. The new POX system helps minimize the environmental impact while improving production levels.

Since its installation in 2016, the new production method with the acid-resistant brick lining has demonstrated exceptional performance. The lining system can hold its integrity for seven years before requiring major maintenance repair in the vapor zone, exceeding industry standards for other alternative materials. The customer Zijin Mining is very pleased with the performance of the autoclave brick linings.

Knight's efficient design allows for rapid turnaround times when maintenance is required: one week for routine inspections and minor repairs or two weeks for major replacements, minimizing costly downtime.

POX system implementation delivered multiple operational advantages:

- Higher gold extraction yields from processed ore
- Ability to process lower-grade ore that would be uneconomical with traditional methods, to expand gold recovery and reduce waste
- Reduced environmental impact through the elimination of harmful chemicals like mercury and cyanide
- Improved energy efficiency compared to conventional smelting
- Enhanced operational sustainability due to predictable, short maintenance periods
- Consistent performance in demanding operating conditions at high temperatures

Knight's expertise in material selection and system design, combined with its comprehensive technical support, has established the company as a trusted partner in this groundbreaking project. The success has led to additional POX installations with the same client at different locations and attracted new customers in the metals processing industry in China.

Broader Applications

The technologies and expertise demonstrated in this gold processing application have wide-reaching implications for the broader mining and metallurgy sector. While gold processing represents the most demanding application with its extreme temperature requirements, the same or similar Knight products and solutions are equally effective for POX processing of other metals, including zinc, copper and nickel, which can be successfully processed at lower temperatures. This successful implementation is a benchmark for hundreds of potential installations worldwide as the global mining industry continues its transition toward more efficient and environmentally sustainable processing methods.

The project showcases Knight's ability to deliver reliable solutions for the most challenging industrial applications while supporting customers through complex technological transitions. Its comprehensive approach, combining advanced materials, engineering expertise and dedicated technical support, positions Knight as a leader in providing critical components for modern metallurgical processing systems. This successful installation demonstrates the value of an upfront investment in quality materials, company expertise and professional installation to pay significant long-term dividends through improved efficiencies, reduced downtime and extended service life.