JV Article: Dundee's novel processing techs address cyanide and arsenic risks

Members of the Dundee Sustainable Technologies team responsible for the development of the CLEVR and GLASSLOCK processes. Credit: Dundee Sustainable Technologies

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Two innovative metallurgical processes designed to alleviate environmental risks are beginning to attract the attention of mining companies eager to improve their ESG credentials. Dundee Sustainable Technologies' CLEVR process is a cleaner, efficient and cost-effective alternative to cyanide for the extraction of gold, while its GLASSLOCK process removes and stabilizes arsenic associated with precious and base metal deposits.

A Canadian-based subsidiary of Dundee Corporation, DST has offices, a technical center, and an industrial demonstration facility in Thetford Mines, Que., 105 km south of Quebec City where its industrial size circuits can process up to 15 tonnes of concentrate per day.

The company began working on its CLEVR gold extraction process in 2008. A series of successful development programs then led to the construction and operation of its

industrial demonstration facility in 2015 and, in 2020 it sold its first licence for CLEVR to a major gold company.

Dundee Sustainable Technologies' GLASSLOCK industrial demonstration plant at an operating copper smelter in Namibia stabilizes arsenic within a glass matrix for permanent sequestration. Credit: Dundee Sustainable Technologies

DST has also successfully demonstrated its GLASSLOCK arsenic stabilization process at an operating copper smelter in Namibia and is now finalizing the detailed engineering for a GLASSLOCK circuit to stabilize legacy arsenic trioxide at an operating gold mine in Ghana.

"Cyanide has been widely used to extract gold for decades and it works well," said DST president and CEO Jean-Philippe Mai. "However, there's growing opposition to the use of cyanide. Some jurisdictions have banned or restricted its use, so the industry is in need of an alternative process.

"Our objective," he added, "is to provide an innovative, alternative process that not only does away with the use of cyanide but also improves gold extraction, shortens contact time and reduces infrastructure footprint."

The CLEVR process, said Mai, is an ideal solution for developing gold projects in jurisdictions that are sensitive to the use of cyanide and for projects faced with complex ore bodies where cyanide is inefficient due to the presence of accessory base metals or the refractory nature of the ore.

Instead of cyanide, the process uses sodium hypochlorite with a catalytic amount of sodium hypobromite in acidic conditions at ambient temperature and pressure.

“The process allows us to rapidly put the gold into solution as a gold chloride compound,” explained Mai. “The gold is deposited into silica and recovered as a gold doré, then the depleted brine is fully recycled using an electrolysis cell, which allows us to operate in a fully closed loop.”

Typically, the process requires one or two hours of contact time, compared with 36 to 48 hours with the use of cyanide. “That’s a huge benefit in terms of process efficiency,” said Mai.

“CLEVR also provides additional chemical grinding of the ore’s host matrix which translates into higher gold yields than cyanide on most tested samples.”

The process also operates in a closed loop with the recovery and recycling of all reagents, so there’s no liquid effluent. Additionally, the tailings that are generated are sulphide depleted and non-acid generating because if there’s significant sulphide content in the ore, such as in flotation concentrates, it would first go through an oxidation pre-treatment step. Any residual sulphide would be oxidized to sulphate as the CLEVR process operates in an oxidizing environment.

“This allows us to have inert and barren solid tailings for disposal, so there’s no need for a tailings pond,” Mai said. “The generation of barren solid tailings can benefit the mine site layout and footprint because when you have inert solid tails, you have options. You can co-mingle it with waste rock or stack it with reduced containment measures.”

The CLEVR process isn’t the only alternative to cyanide, Mai acknowledges. “However, it’s really advanced in terms of maturity. We’ve been developing it for close to 15 years. We’ve gone through numerous piloting stages. We’ve gone through industrial demonstration campaigns. We have industrial size facilities and operation data to support its efficiency and capacity, so as an alternative, CLEVR is definitely one of the few mature alternatives which can be considered by developers and miners for their recovery circuits.”

The process has received ISO 14034:2016 certification through the Canadian Environmental Technology Verification Program, providing independent certification of its performance as a cyanide-free gold extraction process. Under the program, 170 tonnes of gold bearing refractory pyrite concentrate were processed at DST’s demonstration plant with all solid residues meeting or exceeding environmental performance norms.

The CLEVR circuit delivered gold recoveries which were up to 10 percentage points higher on average than cyanide yields on the same samples.

Cyanide isn't the only toxic material that's a cause of concern in the mining industry, so following its work on the CLEVR process, DST turned its attention to arsenic removal and stabilization.

"We weren't satisfied with what the industry was doing in terms of long-term arsenic sequestration. That motivated us to develop the GLASSLOCK process," said Mai. "There's a growing association of arsenic minerals with precious and base metal ores. Because more clean oxide metal deposits are depleting, there's an increase in the arsenic sulphide content and the number of complex metal deposits being developed."

The disposal of arsenic depends on its concentrations, but if it's going through a flotation circuit, it ends up being smelted and recovered as arsenic trioxide, calcium arsenate or ferric arsenate, all of which are either highly hazardous or semi-stable products in terms of long-term stability.

"The issue with arsenic is that it volatilizes at low temperatures, so it has been difficult historically to use a pyrometallurgical approach to process or stabilize it," explained Mai. "So, with GLASSLOCK, we produce an intermediate compound that's stable at the melting temperature of glass. That allows us to incorporate high amounts of arsenic within a vitrified silica mixture. We produce a glass product that is 15 to 20% arsenic. The glass is a single-phase amorphous structure that is very stable over time."

The process complies with standard environmental leaching protocols (EPA & EN) and can work with a variety of arsenic feed sources, including arsenic trioxide, ferric arsenate, calcium arsenate, sodium arsenate, or arsenic in solution.

"It offers a permanent sequestration solution for arsenic, removing and reducing the need for long-term hazardous waste disposal facilities and site liabilities. It's also very cost efficient in terms of the dollar per tonne of arsenic stabilized," said Mai. "If you're producing arsenic, we can bolt on a GLASSLOCK circuit to an existing plant."

The disposal of the glass product is project specific, but it can be used as an aggregate in cement or concrete. It could also be used as an aggregate for a mine's backfill paste plant.

A Clean Mineral Processing Technology Survey conducted earlier this year by the Northern Miner Group demonstrated some of the challenges and opportunities associated with the introduction of new metallurgical processes. For example, 76% of

respondents said they spend either no time or less than they should assessing new process technologies. However, on the plus side, 98% said they would be interested in further investigating a metallurgical process that could eliminate the use of toxic chemicals and 85% said they would either consider the GLASSLOCK process or be interested in learning more about it.

Mai advises mining companies to consider their processing options at resource development and PEA stages when the increased gold extraction, the generation of dry stack tailings, smaller footprint and the proper handling of arsenic offered by the CLEVR and GLASSLOCK processes can be reflected in the overall mine plan and project cost. “If they’re already at the feasibility stage, so much effort and money has already been invested in a particular design that it’s very difficult to go back and start making changes.

“We want to be viewed as a means for miners to improve operational efficiency and their ESG credentials,” concluded Mai. “We’ve done the heavy lifting. We’ve invested more than $40 million in the development of CLEVR and GLASSLOCK. We’ve demonstrated them at industrial scale. Now it’s up to mining companies and their technical groups to work with us in assessing the impact of our processes on their operations and on the environment.”

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