Unconventional ways to source critical metals

The mining sector is facing an imperative challenge; how can it provide the metals and materials needed for the energy transition and decarbonisation while simultaneously reducing emissions and implementing environmental safeguards?

By Georgia Williams

Solving the decarbonisation and critical metals conundrum will require outside-the-box thinking
Photo: AlbertPego

Tackling this problem requires innovative solutions for the entire mining value chain, especially mineral processing.

According to the IEA current, "emissions from energy transition mineral production are relatively small, due to their low production volumes. However, these emissions will grow alongside projected growth in demand."

The energy agency noted that future production of critical metals is anticipated to be energy-intensive, pointing to the lithium market's transition from brine-based recovery to production from hard rock as an example.

"Demand is also moving from lithium carbonate towards lithium hydroxide with higher emissions profiles, as the latter is more suitable for batteries with higher nickel cathode chemistries," the IEA wrote.

BUT WHAT IF WE COULD PRODUCE LITHIUM HYDROXIDE FROM OIL BRINES?

Calgary-based Volt Lithium has developed a proprietary Direct Lithium Extraction (DLE) process that recovers valuable lithium from Alberta's oil production waste.

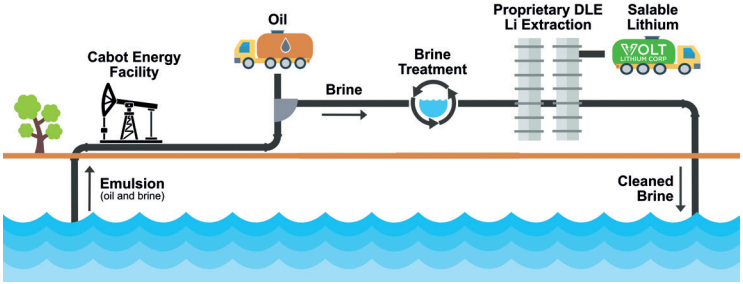
"We really have a two-step process for removing the lithium from the brine," said Alex Wylie, president, chief executive, and director of Volt.

"Our first step is contaminants removal. And that's a critical part of what we're doing; we need to get anything that interferes with the lithium removed from the brine before it goes into our DLE process," said Wylie. "When we get into direct lithium extraction, with our clean brine, we're able to extract up to 90% of our lithium from oilfield brines."

Strategically located in Alberta, Canada's largest oil-producing province- Volt has access to 99 billion barrels of lithium-infused brine with concentrations up to 121 mg/L.

As Wylie explained, not only does Alberta provide the oil brines needed for extraction, but the province has also offered collaborative opportunities for partnership and infrastructure.

"Oil and gas producers produce that brine daily," he said. "We're working in conjunction with the oil companies, for them to bring the brine from the subsurface to the surface where we can do our extraction process, we [then] turn the brine back to the oil company, and then they dispose of it safely afterwards. Our partnership model works very effectively in Alberta."



The proprietary lithium extraction process and flowchart
Photo: Volt

BENEFITS OF REPURPOSING

As Volt extracts lithium from the waste, the oil company also benefits.

"One of the outcomes from our contaminant removal process is we create a very clean brine," said the head of the company.

Wylie continued: "Unfortunately, a reality of oil and gas companies is they're still doing fracking, [but] we can improve that. They don't have to draw water from lakes and rivers. They can recycle the water. We want to create a better solution for the oil company to be more ESG friendly and really preserve what we've got on the surface with our lakes and rivers."

The DLE process can also reduce the amount of waste brine the company has to manage.

"It makes a big difference," he said. "As opposed to storing tailings on the surface and having to do contaminant removal there, we've done that upfront. So they don't have to store big tailings ponds as they move forward."

DLE also has the potential to reduce historical oil sands tailings levels, as the technology can be scaled for use on the massive amounts of oil sands tailings that have already been produced.

"Our number one focus today is on lithium extraction," he said. "But our process works for oil sands tailings as well. So, as we get better and we commercialise, we've got other applications for our technology, and one of them will be for oil sands."

Beyond lithium, Volt's DLE process could also extract other critical metals from oil tailings and brines later down the road.

"Today, we're focused on lithium, but our process works for any metals," said Wylie. "For any metal that we're going to leverage from an extraction perspective, it's the same process. We've got to deal with contaminants at the beginning, isolate the metals, and then extract it from the oil sands; it's a very efficient process."

With the goal of establishing a Canadian supply chain of lithium hydroxide for EV manufacturers, Volt is moving from pilot scale to commercial. At the commercial stage, Wylie expects to process 1000tpa.

"That's really important because that will allow us to accelerate our ability to get into production,' he said. "Our goal is to be in production by the second half of 2024."

He added: "Once we're in production, we can expand. We can also expand to other oil fields and other reservoirs. But the key is let's get ourselves into commercial production. Then we can grow with the car companies and meet their needs for supply."

> "The DLE process can also reduce the amount of waste brine a company has to manage"

REDUCING ENERGY CONSUMPTION

While Volt focuses on processing waste in the oil sector, Rockburst Technologies is targeting the energy intense comminution space.

Built around a patent-pending transcritical CO2 pulverisation (tCO2) technology, Rockburst believes it can reduce global electricity consumption by 2% using its method.

"The essence of our technology is that we break rock with gas," said Oscar Malpica, founder and chief executive at Rockburst.

"When you break rock with gas, you're breaking the rock from within instead of exerting external forces on the ore," said Malpica. "Rocks are 10 times weaker under tension than compression."

The "waterless" tCO2 method utilises a pressurised vessel to "infuse" the gas into the rock.

"Then we very rapidly decompress that system. And when you decompress a pressurised gas, the gas tries to expand. It is that expansion that causes the rock breakage from within," said the executive.

The straightforward technology is estimated to cut energy consumption in half compared to traditional comminution equipment and requires no grinding media.

"In Canada alone, 17% of electricity consumption goes exclusively into rock breaking," he said. "Rock-breaking processes consume 4% of [all] global electricity, roughly equivalent to the electricity consumption in Germany, for one year."

CARBON NEUTRALITY

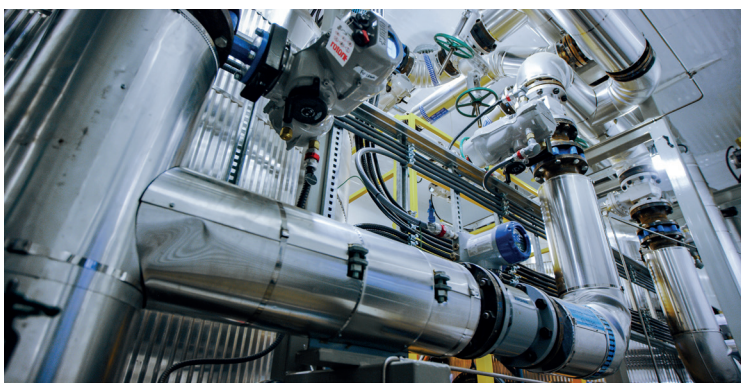
As noted by the IEA, fuel switching, low-carbon electricity, and investment in energy efficiency are some of the most immediate ways the mining sector can reduce carbon emissions output.

This makes technologies like Rockburst's -which provide multiple solutions- exciting.

"Right now, we're at 90% energy savings compared to traditional comminution processes," said Malpica. "And when you're talking about 90%, that could be a very consequential impact in the mining industry."

Aside from driving down energy consumption, Malpica pointed to another newly realised advantage.

"We have some early evidence of carbon sequestration in our system," he said. "Not only are you using



Volt's pilot plant operations. Testing facility equipment utilised to treat Volt's brine before entering the DLE process
Photo: Volt

greenhouse gas as a fuel to our process, but some excess CO2 gets trapped in the tailings in the waste of our process."

As he explained, the closed system, which emits no CO2, could be paired with a direct air capture system to utilise CO2 in the air to fuel the Rockburst process.

"We could connect that into our process plus carbon sequester at the end of our process. Now you're talking about a great potential for a carbon-neutral or carbon-positive process."

Although Rockburst is still in development, the company has already garnered attention from the sector and Canadian Government. In fact, the technology was born from a federal government call for innovative solutions to energy consumption in the mineral processing space.

Making the short list of finalists, Rockburst was the only participant that looked to target tensile strength instead of external force.

This outside-the-box thinking was also a catalyst for the Saskatchewan Resource Council's (SRC) rare earth separation technology. The government of Saskatchewan affiliate has designed and manufactured a commercial-scale solvent extraction cell targeting rare earth elements.

As Mike Crabtree, president and chief executive at SRC, explained, the process took 15 years to develop and exploits minute differences in the chemistry of each rare earth using solubility.

Likening the separation cell to a tree-like structure with branches, Crabtree said the SX (separation technology) can then pinpoint the REE it wants to target.

"What you can actually do is promote the concentration of one and demote the concentration of the others sequentially in almost like a cascading waterfall process," he said. "Until at the ends of the tree, you've got the highly purified individual rare earths."

SRC's development of the SX system is part of a larger goal of completing g a rare earth processing facility, which is currently under construction. The timely build comes when Canada and the US seek to establish REE mining, refinement, and processing outside China.

"The Chinese are dominant in this sector; they control a better part of 90% of the supply chain, right from the actual extraction through to the production of magnets," he said. "Which is one of the reasons why there's that existential drive to develop the technology outside of China to balance that very large market share."

INCORPORATING DIGITAL TWIN

While the SX system utilises a similar process as the Chinese, the SRC's SX technology differs in size, using a larger modular tank containing six cells instead of multiple tanks with one cell each. According to Crabtree, this makes the SRC technology "much more compact."

The single-cell system also requires copious amounts of employees to oversee and adjust valves, while the SRC's SX system is far less demanding.

'We decided to automate the process and create a numerical digital twin of the whole process," said Crabtree.

Artificial intelligence was then placed above the digital twin to learn how to run the system.

"When we've completed the commissioning of the first part of that SX development -which will be later this year- we will then blip the AI from the digital twin onto the real system, and then the AI will operate the SX."

The benefit of using AI, beyond reducing the operations team from 80 to five or six, will be its ability to swiftly and accurately calibrate and stabilise the system, which can take weeks or months when done manually.

Although there are no monocyte mines in Canada, the SRC is banking on explorers and miners to begin targeting these deposits now that the SX has been demonstrated as effective.

"The reason for building this, ultimately, is to develop a mid-stream, rare earth processing hub in Saskatchewan, to handle all of Canada's monocyte minerals," he said.

As AI monitors the fine details at a micro level, on a macro level, the SRC is designing the processing plant through an ESG lens.

"We're also building it to be the most ESG sustainable plant," said Crabtree, who explained that although the process uses "a lot of water and a lot of chemicals, not one single liquid discharges everything [is] recycled and reused. And that's going to be incredibly important."

DUAL ADVANTAGE

Because monocyte deposits contain uranium and thorium, the waste has traditionally been labelled radioactive; however, the SRC plans to leverage these additional metals in its processing.

"One of the advantages of us being in Saskatchewan is that compared to other provinces in Canada, where uranium and thorium would be seen as a highly dangerous waste product, here, it's seen as a highly valuable product for us," said Crabtree.

In fact, Saskatchewan is Canada's leading uranium producer and ranks among the top five countries outputting nuclear fuel.

"What we've done is invest capital in extracting the uranium and thorium from what would otherwise be the tailings," he explained. "So, the tailings can be disposed of as a non-radioactive tailing material."

Through this investment, the SRC has turned what would be a costly waste problem into a revenue-generating stream.

The SX system and plant are expected to be up and running by late 2024 or early 2025.

The SRC's technology on display
Photo: SRC

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