INTERNATIONAL MINERALS INNOVATION INSTITUTE

DEMOday 2024 Technology Needs

2024 Identified Technology Needs

Advanced Chemicals

- Caking or clumping is a significant concern in dry fertilizer production, storage, transport, and application. IMII is seeking advanced/new anti-caking and/or dedusting chemicals that are not petroleum based and are neutral to environment and health that could be developed for and deployed in the potash (potassium chloride product) and/or uranium sectors (ammonium sulphate product).

Biological Solutions

- Copper sulfate is an inorganic compound that has a wide variety of industrial and agricultural uses. Although it is not toxic at low concentrations, high doses may be harmful. IMII is seeking cost-effective alternative anti-microbial agents to copper sulphate (commonly used in starch solutions). Consideration of industry-ready chemical and biocide additives commonly deployed in the petroleum industry to limit bacterial influences in operations (fluids degradation, souring, corrosion, etc.) and could be adapted for use in the minerals industry are of particular interest.

Carbon Capture, Utilization and Storage (CCUS)

- Carbon capture is a technology that the minerals industry is considering deploying to help achieve carbon emissions reduction targets. IMII is looking for innovative sequestration (e.g., land sinks, engineered sinks) or novel utilization technologies (e.g., construction materials, polymers, new materials, or commodity chemicals) that don't rely on indefinite ongoing monitoring to ensure there is no release of captured carbon.
- IMII and its members are also open to being able to understand how to effectively handle commercial or industrial scale volumes of carbon waste streams from emitter to full storage concept.

Corrosion Mitigation/Prevention

- Mining and mineral processing and extractive are concerned with a wide range of corrosive media. Mining equipment, installations and plants are subjected to high rates of corrosion due to harsh operating and environmental conditions and corrosive chemicals. Corrosion can lead to structural failure or loss of containment, costly repairs, lost or contaminated products, environmental damage, risk to personnel, and loss of public confidence. IMII is looking for innovation solutions which may allow the industry to improve upon metal-metal exchange corrosion mitigation, better understand impacts of sacrificial metals and alloys in the mining industry, identify and adopt cathodic protection developments and enhancements, or evaluations of newer alloys and substitute metals for mining environments.

Electrification or Battery Applications

- While electric equipment is already in use in Saskatchewan's minerals industry, further electrification can help reduce emissions from fossil fuel use and improve air quality underground. However, equipment powered by batteries may also present new safety challenges. To help address these challenges, IMII is looking for safer battery technologies that could be deployed in Saskatchewan's potash operations (which need different application than hard rock due to the salt effect on batteries in underground potash and salt operations), or better protective equipment for battery technology (e.g., to address thermal overload situations). IMII's members are also open to utilizing newer battery technologies for industrial EV use in mining environments, which is currently under development but not fully understood.
- The industry is also looking for technologies with salt bridging battery potential from potash processing waste (i.e., tailings). Research has shown that electricity may be obtainable from water with a high salt concentration, and a path to industrial scale could be of interest.

Emissions Control

- The minerals industry is actively looking for ways to reduce its environmental impact, including the potential for releases into the air. One of the most effective ways to achieve this goal is through the measurement of emissions and the implementation of efficient control measures. To this end, the IMII is looking for new air emissions control technologies, be they abatement, scrubbers, etc., particularly if they offer more efficient processes. The industry is also looking for passive monitoring in real time of stack emissions, and technologies which may provide for mine vehicle exhaust capture.

Energy Efficiency

- The minerals industry is actively seeking to adopt new technologies which extract and process those metal and minerals in more energy efficient and sustainable ways, alongside increasing the use of renewable power. There is, therefore, a standing interest in technologies which may support more efficient energy usage, including means such as reduced water use or electricity consumption, or through energy conservation in existing processes or equipment.
- The industry is also open to resource conservation technologies, e.g., use less of or substitute in something better for things like chemicals, water, etc., as a means to improve energy efficiencies.

Geological Mapping

- The minerals industry has benefited from the development of tools such as seismic land streamers capable of undertaking multichannel analysis of surface waves, refraction, reflection and surface-way surveys above ground. It would like to equally benefit from the development of similar technologies which could be deployed easily underground at a low cost to provide geotechnical and seismic data without compromising data quality. To this end, IMII is looking for the use of newer techniques and methods to be able to effectively map out new developments with AI and advanced platforms, or programs which consider the use of fixed remote sensing and monitoring systems to aid in development mapping and for planning purposes.

Heat Recovery

- Some areas involved in the mining or milling of minerals are sources of heat. Is there efficient area (as compared to point source) heat recovery technologies under development? Heat may be generated from pumping systems or process areas.
- Drying potash is a vital aspect of processing the ore into a usable form for the fertilizer production process, as well as in finishing product coming from the fertilizer production line. Is there technology that can be retrofitted to existing process dryers to promote better energy efficiency while still achieving the desired the moisture content (typically below 0.5%)?
- The dryers used to dry and glaze potash generate a large amount of heat, and some of this heat makes its way into the finished product. This waste heat may be a resource and is also a safety concern. Separate from the process (dryer), is there a technology to cost effectively recover heat from finished product (which can range in temperature from 80 to 180 degrees C)?
- Are there technologies which offer opportunities for low grade heat capture without a large heat differential?
- Are there technologies with the potential for heat recovery from “dirty” sources (e.g., calciner or dryer stacks which may contain dust or other particulates)?

Machine Learning

- The application of machine learning in the mineral industry has important benefits in terms of increasing the predictability and controllability of the processes, optimizing their performance, and improving maintenance. However, this application has significant implementation challenges. Among the main identified challenges are data scarcity and the difficulty in characterizing abnormal events/conditions as well as modeling processes, which require the creative use of different learning paradigms as well as incorporating phenomenological models in the data analysis process, which can make the learning process more efficient. Other challenges are related to the need of developing reliable in-line sensors, adopting interoperability data models and tools, and implementing the continuous measurement of critical variables. To help overcome such challenges, the IMII is looking for solution pathways which may make machine learning more accessible to minerals subject matter experts, so they can apply it in their work rather than having to rely on data analytic experts that don't know the applications.
- IMII is also open to ways to consider having companies set up their machine learning systems and protocols to be able to map and analyze their own data sets in real time, the identification of direct applications and uses for this concept in the mining industry (analytics, spatial mapping, monitoring, engineering, etc.), and to address the impacts of AI coming into the mining industry and which uses can offset any risks or improve on current methods.

Mobile Equipment

- The minerals industry deploys mobile equipment underground and on surface to move people and supplies, and this needs to be done safely. We would welcome navigation assist terrain detection technologies able to provide warning/guidance for evading large bumps or voids while operating mobile equipment and minimize the potential for harm to employees operating such equipment (technologies could be deployed on equipment or personnel).

- While many assets associated with the minerals industry are deployed within mine and mills, some are deployed remotely. The industry is looking for technologies which could monitor the location and status of such assets when the communication infrastructure associated with the mine/mill is not readily available.
- Consider the power possibilities using newer EV concepts on larger equipment. Can enough horsepower be generated to be able to be an effective substitute for heavy duty applications?

Process solutions

- Are there any improved and cost effective and safe methods for recovering radioactive isotopes (Specifically Ra226) from uranium ore leach solutions? While there are historical processes used to recover radium from uranium ores, these involved repetitive chemical separations that are complicated and capital intensive to implement with adequate safety procedures.
- Are there any potentially reliable and cost-effective processes to remove chemical substances of concern (COCs), such as As, Mo, Se etc. (typically contained in sulphide minerals), from uranium ores via a pre-leaching? It is imperative that such a process should not affect the dissolution of uranium containing minerals to ensure that it does not affect the efficiency of the subsequent uranium recovery process.
- Are there any new or proven (in other sectors) chemical or mechanical processes to selectively extract/leach uranium from mixed sulphide ore? These could be either a chemical leaching process that selectively dissolve uranium minerals or a grinding process that selectively grinds the uranium minerals allowing subsequent separation via a separation process based on particle sizes.
- Are there any new or proven (in other sectors) technologies that can be used for gravity concentration and recovery of uranium minerals that can be processed directly to a uranium ore concentrate. The focus here is on the possibility of replacing much of the chemical leach and purification processes using physical separations.

Production Efficiency

- One way the minerals industry is looking to further reduce its environmental footprint is by gathering information on mined ore before it reaches the mill. Are there technologies which could fully automate conveyor belt and/or mine face sampling of potash or uranium ores, or at other potential points early in the milling process (e.g., grinding)?
- Underground conveyor lines are just one piece of a complex system for transporting extracted rock and minerals. Their construction requires a great deal of effort and comes with a need for the highest possible safety and reliability. IMII's minerals members are looking for an underground conveyor structure builder/jib with the ability to reduce heavy lifting required when constructing on site the 100+ conveyors anticipated to be installed by the potash industry in the near-term.

Remote Sensing

- Rock mechanics instrumentation is deployed throughout many underground operations to gather information on the behaviour of rock in response to the stresses and strains of mining activities. Much of this instrumentation is becoming "smarter" when tied into underground communications

networks. However, operations are constantly changing, creating a need for technologies for gathering information from such instrumentation even when they may not be tied into an LTE/Wi-Fi network all the time.

- Drifts in underground mines in Saskatchewan are often built using tunneling technology. Can such technology be adapted to provide rock mechanics data and/or geophysical information of the roof or walls of such openings? Technologies built on multi channel analysis of surface waves may be of particular interest.
- Mine shafts are often lined with concrete or steel to provide for ground support and the safe travel of personnel, equipment, other supplies, and ore to and from underground operations. IMII is looking for technologies (digital or otherwise) that could be developed and deployed to routinely gather data on the integrity of shafts and shaft lining in a safe and efficient way to minimize the manual collection of such data and the time dedicated to data collection.
- Mine shafts rely on steel ropes and other attachments to safely move personnel, equipment and supplies, and ore to/from underground operations. These ropes and attachments must be maintained to a high standard. IMII is looking for technologies (digital or otherwise) that could be developed and/or deployed to improve on the gathering of information as to the condition of such ropes and attachments.

Safety Solutions

- Safety is a paramount concern in the minerals industry, and this extends to all types of equipment deployed. The industry is looking for technologies for the detection and suppression (e.g., passive isolating heat from fuel) of potential mobile equipment fires – be they diesel or battery powered. A variety of technologies are of interest - shields, paint, sensors, or detectors providing warning for example (and not to limit innovation).
- Drifts are horizontal tunnels in rock that allow access to and from ore bodies and other underground mine workings. IMII is looking for technologies or techniques which could be deployed to detect when a potash mine sidewall in a drift needs to be addressed or scaled. The technology or technique should deploy non-destructive testing and could piggyback on technologies already deployed in the industry for other purposes (such as roadbed resonance, thermal imaging, etc.).
- The saturation line is a dam, dike or containment berm is a key safety factor in ensuring the stability of such structures. IMII is open to the consideration of in-line saturation monitoring systems which can be deployed in such structures, ideally to provide real-time and accurate information on stability. Technologies that could be adapted from other sectors (e.g., oil and gas and water inflows into reservoirs) are also of interest.

Tailings management (potash and uranium)

- Are there any novel processes to convert chemical substances of concern (including As, Mo and Se) to stable forms prior to the placement in tailings facilities to ensure long term stability of these elements without leaching into groundwater sources? A successful solution would be one offering a significant simplification of the designing and maintaining of the tailings facilities leading to capital and operational cost savings.

- Are there any new or proven (in other sectors) cost effective and reliable technologies to remove gypsum (CaSO4.xH2O) from gypsum saturated effluent produced during lime treatment of mine/mill effluents? Potential solutions which identify as environmentally safe and cost-effective technologies to significantly reduce the dissolved gypsum levels so the final product can be safely released under cold weather conditions typical of Saskatchewan's north.
- Despite technological advances in mineral processing, mining companies can still face challenges in how to best manage tailings materials. For IMII, the current challenge of interest is limiting the size of or growth in tailings management areas. Are there alternative technologies that will promote a smaller footprint and reduce potential environmental impacts?
- Tailings, often in the form of a slurry, are transported to tailings management areas by pipeline and this carries with it the potential for spills. IMII is seeking technologies which may assist in reducing this potential, for example through new ways to test and/or monitor the integrity of pipelines and their couplings.
- The long-term operation of some tailings management areas may result in brine plumes from seepage of salt-bearing waters. Are there new technologies that may better address such plumes rather than pump back wells (e.g., in-situ treatment options)?

Water Solutions

- The minerals industry seeks to be a wise user of water and is looking for smart industrial-scale water management solutions to help it responsibly manage the consumption and release of water from its operations.
- Concentration involves the separation of valuable minerals from the other raw materials received from the grinding mill. In large-scale operations this is accomplished by taking advantage of the different properties of the minerals to be separated. There is a need however to dewater the concentrates afterward. Is there a technology that could produce higher grade concentrates at similar recoveries reducing the need for leach water?
- In addition to looking for innovations to reduce energy use and greenhouse gas emissions, the minerals industry is open to technologies that may allow it to reduce its consumption of fresh water. In this case, the industry would like to see if there is a technology that could use less fresh water for dryer exhaust particulate removal?