INSTITUTE FOR
OIL SANDS INNOVATION
AT THE UNIVERSITY OF ALBERTA
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Imperial

ALBERTA INNOVATES

Engineering at Alberta

Institute for Oil Sands Innovation (IOSI) at the University of Alberta

Call for Letters of Intent

Bitumen Extraction. *2025 Focus: Aqueous and hybrid extraction.*

Instrumentation. *2025 Focus: Measurements for extraction plant optimization.*

Oil Sands Mining. *2025 Focus: Materials and designs to improve reliability and efficiency in oil sands mining.*

Value-Added Products. *2025 Focus: VAP from TSRU tailings for on-site applications.*

Continuous intake of letters of intent. No deadline.

Challenge Statements: Please refer to the following pages for the challenge statements for each theme.

Project Scope: research at all technology readiness levels is supported, including proof-of-concept. The research must demonstrate a clear line of sight toward short-term technology commercialization in oil sands mining operations.

Application Process:

- The letters of intent (LOI) are a maximum of 2 pages long. The LOI template in Word is available at https://iosi-alberta.ca/forms/. The pdf is attached below. There are no restrictions on the number of LOIs per applicant.
- Please email the LOI in a pdf format to iosi@ualberta.ca.
- The selected terms for participation in IOSI projects are available at https://iosi-alberta.ca/forms/. Other IOSI procedures are at https://iosi-alberta.ca/investigator/.

Questions: Please contact IOSI Director Natalia Semagina semagina@ualberta.ca.

General Information: Oil Sands Mining 101

- Kearl Mine (Imperial Oil) by Oil Sands Magazine: https://www.oilsandsmagazine.com/projects/imperial-oil-kearl-mine and links therein
- Mining for bitumen by Oil Sands Magazine: https://www.oilsandsmagazine.com/technical/mining/
- Bitumen extraction by Oil Sands Magazine: https://www.oilsandsmagazine.com/technical/mining/extraction and links therein (paraffinic froth treatment)

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Challenge Statement

Bitumen Extraction.
2025 Focus: Aqueous and hybrid extraction.

Background

Mined oil sands industry uses a water-based extraction process to separate bitumen from oil sands ore. Here, the mined oil sands - after being crushed - are mixed with hot process water and caustic to form a slurry. The slurry is transferred to separation vessels via hydrotransport lines where ore lumps are mechanically sheared, and bitumen gets aerated. The aerated bitumen is separated in the form of froth in the primary separation cell. The unrecovered bitumen is subjected to air flotation. Kearl Oil Sands uses Paraffin Froth Treatment (PFT) process to separate bitumen from water and solids. Over 90% of bitumen recovery can be achieved in the water-based process depending on the ore grade and the processing conditions.

For more information on the extraction process, including at Imperial Oil, refer to the following links.

- Kearl Mine (Imperial Oil) by Oil Sands Magazine: https://www.oilsandsmagazine.com/projects/imperial-oil-kearl-mine and links therein
- Mining for bitumen by Oil Sands Magazine: https://www.oilsandsmagazine.com/technical/mining/
- Bitumen extraction by Oil Sands Magazine: https://www.oilsandsmagazine.com/technical/mining/extraction and links therein (paraffinic froth treatment).

Technology and Knowledge Gaps

- Methods for decreasing extraction GHG emission.
- Reducing water usage for the extraction process.
- Methods/processes that can further enhance bitumen separation.
- Fundamental understanding of bitumen aeration and de-aeration process and methods to improve both.
- Development of new technologies for de-aeration of bitumen froth.
- Fundamental understanding of hybrid extraction process (solvent/water) to reduce process temperature.
- Using computational methods to develop predictive models (transient and steady-state) for different stages of oil sands processing.
- Alternative chemicals for bitumen processing and fundamental science.
- Fundamental science for producing cleaner froth (i.e., fewer solids) in extraction including hydrodynamics of underwash and overwash systems.
- Methods to reduce fines generated by extraction.

- Relationship between slurry conditioning and bitumen recovery and novel rapid conditioning approaches.
- Development of technologies and processes to enable mobile aqueous extraction units for remote mining locations vs. central extraction processing plant:
    - enhanced separation,
    - short residence time,
    - fewer smaller-scale equipment units,
    - production of dry tailings.

Preferred Processes and Methods

- New process concepts or enhancement of the current practice that could be integrated into the existing process at the central facility or enable remote mining locations.
- Low GHG emission, non-solvent approaches.
- Processing to minimize waste rejection.

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Challenge Statement

Instrumentation.

2025 Focus: Measurements for extraction plant optimization.

Background

Mined oil sands industry uses a water-based extraction process to separate bitumen from oil sands ore. Here the mined oil sands - after being crushed - are mixed with hot process water and caustic to form a slurry. The slurry is transferred to separation vessels via hydrotransport lines where ore lumps are mechanically sheared, and bitumen gets aerated. The aerated bitumen is separated in the form of froth in the primary separation cell. The unrecovered bitumen is subjected to air flotation. Kearl Oil Sands uses Paraffin Froth Treatment (PFT) process to separate bitumen from water and solids. Over 90% of bitumen recovery can be achieved in the water-based process depending on the ore grade and the processing conditions.

The extraction plant operation relies on the accurate measurements of components of interest in the process streams. Online instrumentation, as well as fast ex-situ measurements, minimize response time, which translates into a stable plant performance with improved bitumen yield, reduced GHG emissions, water consumption and volume of rejected tailings.

For more information on the extraction process, including at Imperial Oil, refer to the links below:

- Kearl Mine (Imperial Oil) by Oil Sands Magazine: https://www.oilsandsmagazine.com/projects/imperial-oil-kearl-mine and links therein
- Mining for bitumen by Oil Sands Magazine: https://www.oilsandsmagazine.com/technical/mining/
- Bitumen extraction by Oil Sands Magazine: https://www.oilsandsmagazine.com/technical/mining/extraction and links therein (paraffinic froth treatment)

Technology and Knowledge Gaps

- Measurement tool for the size distribution of solids / lumps downstream of the secondary / tertiary crushers and lump measurements in hydrotransport close to the primary separation cell (PSC) inlet to understand ablation.
- Tailings flocculation performance instrumentation.
- Detection of residual solvent in slurries containing bitumen, solids and water.
- Identify alternative sensing technologies and lab data-based models to meet the needs of industrial online measurements.

Preferred Processes and Methods

- Online measurement techniques and equipment that could be integrated into the existing process.
- Accurate ex situ measurements with a faster response time than Dean-Stark analysis.
- When considering a new online measurement technique, sensor surface fouling or abrasion plugging of slip streams due to a combination of bitumen and sand must be kept in mind.
- **Excluded** from the Call are:
    - AI- and machine-learning approaches based on the commercial data,
    - use of NMR for crushed ore, cores slurries characterization,
    - use of NIR for crushed ore characterization,
    - use of Hyperspectral Analyzer for crushed ore or cores characterization,
    - use of microwave sensing for metal or lump detection.

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Institute for Oil Sands Innovation (IOSI) at the University of Alberta

Challenge Statement

Oil Sands Mining. *2025 Focus: Materials and designs to improve reliability and efficiency in oil sands mining*

Background

Due to the handling of abrasive oil sands materials, equipment used in the oil sands mining industry experiences a much shorter service life than other mining industries. Equipment covers from front mining moving equipment 7495 shovels or equivalent models, 797F haul trucks, dozers, graders, to plant, ore preparation plant crushers, conveyer, apron feeder chain, vibrating screen, slurry pipeline and pumps etc. The damage mechanisms depend on service conditions: dry abrasion (high, low stress or combined), impact, erosion, corrosion or erosion-corrosion or fatigue crackings.

For more general information on the mining process and related material challenges, including at Imperial Oil, refer to the links provided below:

- Kearl Mine (Imperial Oil) by Oil Sands Magazine: https://www.oilsandsmagazine.com/projects/imperial-oil-kearl-mine and links therein
- Materials and Reliability in Oil Sands (MARIOS): https://innotechalberta.ca/services/materials-and-reliability-in-oil-sands-program/

Technology and Knowledge Gaps

- Current attachment methods of wear materials to base support metals suffer spalling off or cracking due to cyclic loading in operation. Very good wear-resistant materials cannot survive high-impact or high-stress abrasion conditions.
- 3D printing of hybrid materials or large components or repair is still not fully developed in the industry.
- Large equipment welding and designs suffer from cyclic loading fatigue service, how to improve its fatigue life is not fully optimized in industry, and the equipment experiences premature failures.

Preferred Processes and Methods

- New materials/technology to provide much-improved wear/fatigue performance compared to current weld overlay, casted wear materials, OEM tires, ropes, etc.
- Improved attachment method/designs for wear-resistant materials to base supporting metals.
- Repairing technology on polymer/cast iron materials to provide comparable wear resistance as base material.
- Advanced inspection technology, like robotics, NDT methods to inspect parts/areas that are hard to reach or cannot be inspected with current NDT methods.
- New engineering design/materials/methods to improve fatigue life on mine mobile equipment.
- New technology that can reduce parts lead time, inventory, improve designs and operating efficiency.

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Challenge Statement

Value-Added Products (VAP).

2025 Focus: VAP from TSRU tailings for on-site applications.

Background

Alberta's oil sands offer a unique opportunity to diversify products of their exploitation beyond fuel to innovative materials which could be used on a mining site.

The rejected stream of interest in this IOSI Call is TSRU tailings. The mined oil sands industry uses Paraffin Froth Treatment (PFT) process to separate bitumen from water and solids: https://www.oilsandsmagazine.com/technical/mining/froth-treatment/paraffinic.

The rejected tailing stream from the tailing solvent recovery unit (TSRU) of PFT contains about 75-80% water, 15-20% minerals, 4% asphaltenes, 1% maltenes, <0.1% paraffinic solvent. There must be economic and environmental benefits to converting TSRU tailings into products to use on a mining site. The process itself should have a minimal environmental impact.

Challenges:

- Low-emission, no-waste technologies with minimal processing or simple additives to transform TSRU tailings into materials that can be used on mining sites, such as adsorbents for treating oil sands process water, materials to accelerate dewatering of fine tailings, substrates to improve land reclamation and mine closure, materials for road pavement, etc.
- Assessment of environmental fate (e.g., leaching, volatilization, toxicity, microbial degradation) of residual constituents of concern in the produced materials and potential methods to reduce the environmental impact.

The suggested methods should present a viable pathway (i.e. economically and logistically feasible) to a potential application on a mine site with low energy intensity, low GHG emissions, low waste production (ideally, solvent-free methods), low environmental footprint and potential for a pilot or small commercial demonstration within 5 years. The preferable feedstock is wet TSRU tailings, before or after separation by gravity.

Excluded challenges for this Call:

- Methods to separate water from TSRU tailings.
- Methods to convert asphaltenes/maltenes into value-added products.
- Methods which use solvents or high temperatures.

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(Maximum 2 pages)

LETTER OF INTENT

ENTER PROJECT TITLE

Submission month, year:
Research theme: Extraction, Instrumentation, Oil Sands Mining or Value-Added Products *(delete three irrelevant)*
Name, affiliation and email of principal investigator:
Names, affiliations and emails of co-investigators: *(do not include trainees or technical personnel)*

Proposed research or process concept:

Expected advantages relative to current commercially available technologies:
If applicable, we recommend including a process flow diagram, if different from the existing one, including regeneration/recycle and waste streams, when applicable. It is recommended to include a quantitative business case (economic/environmental impact).

Applicant's expertise and prior research as related to the proposed project:

Funding, resources, equipment required (Canadian dollars):
(For your convenience, you can use the Excel IOSI budget template but include here only the required information. You do not need to submit the detailed budget at this stage)

Project duration (years):
Annual and total project budget including overhead: (note that the maximum overhead rate covered by IOSI is 25%; for UofA researchers – 0%).
Research staff required (students, post-doctoral fellows, etc.):
New equipment required (the new equipment cost may be covered up to C$50,000. Note that IOSI houses a laboratory with free service and training for IOSI researchers):

Comments (if any):

Prior to the submission, please familiarize yourself with the details of the particular call for LOI, selected terms and conditions for researcher participation in IOSI projects, and other IOSI procedures. The information is available at the IOSI website https://iosi-alberta.ca/ under "Forms" and "Apply"

Submit the 2-page LOI pdf file to iosi@ualberta.ca