INSTITUTE FOR
OIL SANDS INNOVATION
AT THE UNIVERSITY OF ALBERTA
Energy | Environment | Research | Technologies

Imperial ALBERTA INNOVATES Engineering at Alberta

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

Call for Letters of Intent

Bitumen Extraction. *2024 Focus: Aqueous extraction optimization.*

Online Instrumentation. *2024 Focus: Measurements for extraction plant optimization.*

Value-Added Products. *2024 Focus: VAP from TSRU tailings for construction. Carbon separation from TSRU tailings.*

Deadline: January 31, 2024

Challenge Statements: Please refer to pages 2-7 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 provided below (page 8). There are no restrictions on the number of LOIs per applicant.
- Please email the LOI in a pdf format to iosi@ualberta.ca by January 31, 2024, 23:59 MST.
- 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

- A high-level view of oil sands mining, by the Canadian Association of Petroleum Producers: https://www.youtube.com/watch?v=cxiA40XHF0I
- Virtual tour of Kearl Oil Sands (Imperial Oil): https://www.youtube.com/watch?v=y-pLI86QSMA
- 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.
2024 Focus: Aqueous extraction 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.

Another strategic direction of this theme is to enable Satellite Pit Froth Production. As the mine site expands, new, mobile extraction systems need to be developed and installed at satellite locations from the central processing facility to avoid hauling mined oil sands dozens of kilometres for processing.

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

- Virtual tour of Kearl Oil Sands (Imperial Oil): https://www.youtube.com/watch?v=y-pLI86QSMA
- 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 Satellite Pit Froth Production (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 Satellite Pit Froth Production.
- Low GHG emission, non-solvent approaches.
- Processing to minimize waste rejection.

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Challenge Statement

Online Instrumentation.

2024 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:

- Virtual tour of Kearl Oil Sands (Imperial Oil): https://www.youtube.com/watch?v=y-pLI86QSMA
- 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.
- Online viscosity measurement for PSC middlings layer.
- A clay analyzer (potentially in place of a fines analyzer).
- Online slurry rheology.
- 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.

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Challenge Statement

Value-Added Products (VAP).
2024 Focus:
VAP from TSRU tailings for construction.
Carbon separation from TSRU tailings.

Background
Alberta's oil sands offer a unique opportunity to diversify products of their exploitation beyond fuel to innovative materials with commercialization potential.

The rejected stream of interest in this IOSI Call is TSRU tailings. 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 valuable products. Two research priorities were identified as: VAP for construction, and carbon separation.

VAP for construction
Background: earlier IOSI projects addressed proof-of-concept studies on the potential use of TSRU tailings in pavement construction and as additives for cement-based construction materials. Further research is required to advance TRL and address the challenges.
Challenges:

- Advanced methods to use TSRU tailings for construction (such as buildings, road pavement, etc.) with minimal processing and competitive quality of final products.
- Assessment of environmental fate (e.g., leaching, volatilization, microbial degradation) of residual constituents of concern in construction materials using TSRU and potential methods to reduce the environmental impact.

Carbon separation from TSRU tailings
Background: carbonaceous material in TSRU tailings may be converted to carbon VAP via thermal and/or catalytic processes. However, the dry TSRU tailings consist mostly of minerals, which negatively impacts the energy requirement for conversion and final product quality.
Challenges:

- Methods to separate carbonaceous material from TSRU tailings.
- Methods to separate solid carbon from minerals after high-temperature treatment of TSRU tailings.

These methods should present a viable pathway to a commercial process with low energy intensity, low GHG emissions, low waste production (ideally, solvent-free methods), with a low footprint and potential 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.

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(Maximum 2 pages)

LETTER OF INTENT (LOI)

ENTER PROJECT TITLE

Submission month, year:
Research theme: Extraction, Online Instrumentation, or Value-Added Products *(delete two 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 by the deadline for the current call for LOI to iosi@ualberta.ca