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. *2023 Focus: Aqueous extraction optimization.*

Oil Sands Mining. *2023 Focus: Materials and designs to improve reliability and efficiency in oil sands mining.*

Value-added products. *2023 Focus: Value-added products from TSRU tailings.*

No deadline. Letters of intent are accepted year-round.

Challenge Statements: Please refer to pages 2-4 for the challenge statements for each theme.

Project Scope: Both fundamental and applied research will be supported, including proof-of-concept. The research must demonstrate a clear line of sight toward 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 5). 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

- 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
- Materials and Reliability in Oil Sands (MARIOS): https://innotechalberta.ca/services/materials-and-reliability-in-oil-sands-program/
- 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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Institute for Oil Sands Innovation (IOSI) at the University of Alberta

Challenge Statement

Bitumen Extraction. *2023 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 must 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 links provided on p. 1.

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.
- Development of methods and techniques for quick slurry composition measurements – both in-situ and ex-situ.
- Fundamental understanding of bitumen aeration and de-aeration process and methods to improve both.
- Fundamental understanding of processing ore in the presence of coal.
- 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.
- Methods to reduce fines generated by extraction.
- Relationship between slurry conditioning and bitumen recovery and novel conditioning approaches.
- In-situ and continuous measurement of froth quality (e.g., imaging or other properties).
- Development of technologies and processes to enable Satellite Pit Froth Production.

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

Oil Sands Mining. *2023 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 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 performance compared to current weld overlay, casted wear materials etc.
- Improved attachment method/designs for wear-resistant materials to base supporting metals.
- Repairing technology on polymer materials to provide comparable wear resistance as base polymer (polymer lined piping).
- 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. *2023 Focus: Value-added products from TSRU tailings*

Background

Alberta's oil sands offer a unique opportunity to diversify products of their exploitation beyond fuel to innovative carbonaceous materials, as well as minerals and organo-mineral composites with added value. It is desired to identify value-added products and processes for their production from rejected streams of upstream oil sands mining operations.

One of the examples of rejected streams of interest 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% water, 20% minerals, 4% asphaltenes, 1% maltenes, <0.1% paraffinic solvent. There must be economic and environmental benefits to converting TSRU tailings into valuable products.

Challenges

- Innovative methods to produce solid carbon materials from TSRU tailings, including but not limited to activated carbon, graphitic carbon and carbon fibre.
- Methods to separate solid carbon from minerals after high-temperature treatment of TSRU tailings.
- Viable pathway to a commercial process, i.e., large-scale demonstration.
- Valuable carbon-mineral composites.
- Construction materials, process additives.
- Light hydrocarbons.
- Silica materials (colloidal silica, sodium silicate, etc.); clay (kaolinite); soil-like materials. Excluded products of interest are titanium, zirconium, and rare earth elements.
- The preferred feedstock is wet TSRU tailings.
- The preferred technologies are those with low energy intensity, low GHG emissions and non-solvent approaches, with a low footprint and potential pilot or small commercial demonstration within 5 years.

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(Maximum 2 pages)

LETTER OF INTENT (LOI)

ENTER PROJECT TITLE

Submission month, year:
Research theme: Extraction, Oil Sands Mining, or Value-Added Products *(delete two irrelevant)*
Name, affiliation and email of principal investigator:
Names, affiliations and emails of co-investigators: *(if applicable, 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