### New Heat Exchanger Technology

**SOLUTION DESCRIPTION:**
Technology which could replace heat exchanger technology in either new or existing thermal in situ operations.

**CREATED:** October 8, 2014
All projects are evaluated and actioned as they are received.

**CHALLENGE SPONSOR:**
COSIA’s GHG EPA is sponsoring this challenge.
Our aspiration is to **produce our oil with lower greenhouse gas emissions than other sources of oil.**

COSIA has four Environmental Priority Areas (EPAs): Water, Land, Tailings, and Greenhouse Gases (GHGs).

For more information on this COSIA Challenge please visit [www.cosia.ca](http://www.cosia.ca)

Canada’s Oil Sands Innovation Alliance (COSIA) accelerates the pace of environmental performance improvement in Canada’s oil sands through collaborative action and innovation. COSIA Members represent more than 90 per cent of oil sands production. We bring together innovators and leading thinkers from industry, government, academia and the wider public to identify and advance new transformative technologies. Challenges are one way we articulate an actionable innovation need, bringing global innovation capacity to bear on global environmental challenges.
WHAT TO SUBMIT TO COSIA

COSIA requires sufficient non-confidential, non-proprietary information to properly evaluate the technology.

Some items that will be especially important to present in your submission are:

- Concept and basic unit operations
- Technical justification for the approach (e.g. laboratory batch or continuous experiments; pilot or demo plants; process modeling; literature precedent)
- Describe quantities and qualities of utilities and consumables that are required
- Energy inputs – quantity and type(s)
- Capital and operating cost estimates if available based on described capacity targets
- 3rd party verified comparison of your proposed technology against an MEA baseline. 3rd party verifiers should be reputable, independent engineering companies if possible
- Basis of cost estimation, including estimation scope, contingency, etc.
- IP status of your proposed technology
- What operating environment restrictions might your technology face:
  - Explosive atmospheres
  - Severe weather
  - Power fluctuations

FUNDING, FINANCIALS, AND INTELLECTUAL PROPERTY

COSIA Members are committed to identifying emerging technologies and funding the development of the technologies to the point of commercialization, while protecting the Intellectual Property (IP) rights of the owner of the technology.

Successful proposals can receive funding from COSIA members to develop and demonstrate the technology in an oil sands application. Multiple technologies may be funded, at the discretion of the Members.

HOW TO SUBMIT TO COSIA


Please note: ETAP is a staged submission process. The initial submission requires only a brief description and limited technical information. Upon review by COSIA, additional information may be requested. Instructions for submission are provided on the ETAP site.

All information provided is non-confidential. COSIA will respond to all submissions.
#00010: New Heat Exchanger Technology

DETAILED SOLUTION DESCRIPTION

The COSIA Greenhouse Gas Environmental Priority Area Steering Committee has identified New Heat Exchanger as a technology which could improve the environmental performance of the oil sands. New technology is sought which could replace heat exchanger technology in either new or existing thermal in situ operations.

The minimum temperature approach in a heat exchanger network defines the maximum energy recovery opportunity of a plant. While lower temperature approaches allow for better heat recovery and integration, the heat exchanger and piping requirements lead to higher capital and operating costs.

COSIA seeks new heat exchanger technologies and designs that:

- Significantly improve heat transfer characteristics
- Incorporate technology that improves resistance to fouling (including silicates at 300 °C) and are wear and corrosion-resistant (particularly for produced water coolers).

BACKGROUND

Heat transfer equipment used in bitumen production facilities consists primarily of shell and tube heat exchangers, with some spiral and plate and frame exchangers. The service includes cooling and heating bitumen emulsion, diluted bitumen, produced water, boiler feed water, make-up water (fresh or brackish) and other. This is done through either process to process contact as well as through a glycol loop network.

Heat exchangers with a heat transfer duty of less than 100 GJ/h are:

- Emulsion/Boiler Feedwater
- Glycol Air Cooler

Heat exchangers with a heat transfer duty of greater than 100 GJ/h are:

- Process Water:Boiler Feed Water
- Blowdown Glycol Cooler
- Boiler Feedwater Pre-heaters, and

Other, smaller, exchangers include: Produced water and gas glycol coolers, make-up water glycol heater, process water-make up water exchange, diluent heater and sales oil cooler, natural gas heater and air heater.

POSSIBLE APPROACHES

Possible approaches might include, but are not limited to:

- Spiral
- Plate and Frame
- Double Pipe

APPROACHES NOT OF INTEREST

ADDITIONAL INFORMATION
### Water Balance

<table>
<thead>
<tr>
<th>Source</th>
<th>Dressed Water</th>
<th>Produced Gas</th>
<th>Produced Water</th>
<th>Condensate Water</th>
<th>Water Lost to Production</th>
<th>Blowdown to Disposal</th>
<th>Blowdown to WLS</th>
<th>Waste to Disposal</th>
<th>Blowdown to RISF</th>
<th>Blowdown to Fuel Gas</th>
<th>Blowdown to Preflash</th>
<th>Blowdown to Utilities</th>
<th>Blowdown to Reservoir</th>
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</thead>
<tbody>
<tr>
<td>Make-up Water</td>
<td>14,500 kg/d</td>
<td>1,480 kg/d</td>
<td>175 kg/d</td>
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<tr>
<td>De-oiled Water</td>
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<tr>
<td>Chemicals</td>
<td>2,500 kg/d</td>
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<td>14 kg/d</td>
<td>14 kg/d</td>
<td>14 kg/d</td>
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<tr>
<td>Service Water (WF)</td>
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<tr>
<td>WLS Afterfilters</td>
<td>1,680 kg/d</td>
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<tr>
<td>Blowdown to Header</td>
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<td>175 kg/d</td>
<td>30 kg/d</td>
<td>30 kg/d</td>
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### WATER TREATMENT

<table>
<thead>
<tr>
<th>Flowrate (kg/h)</th>
<th>Quality Parameters</th>
<th>Method 1</th>
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<tbody>
<tr>
<td>1,492</td>
<td>g/GJ</td>
<td>10.0 %</td>
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<tr>
<td>204</td>
<td>ppm</td>
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<td>6,062</td>
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<td>14,234</td>
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<td>149,027</td>
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<td>149,027 ppm</td>
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<tr>
<td>65,522</td>
<td>g/GJ</td>
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<tr>
<td>85,905</td>
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### EMISSIONS SUMMARY

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<tr>
<th>Source</th>
<th>Sulfur (metric t/d)</th>
<th>NOx (metric t/d)</th>
<th>CO2 (metric t/d)</th>
<th>SO2 (metric t/d)</th>
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<tbody>
<tr>
<td>Waste to Disposal</td>
<td>0.3 ppm</td>
<td>0.3 ppm</td>
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<tr>
<td>Blowdown to RISF</td>
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<tr>
<td>Blowdown to Preflash</td>
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<tr>
<td>Blowdown to Utilities</td>
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<tr>
<td>Blowdown to Reservoir</td>
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### make-up Water

<table>
<thead>
<tr>
<th>Source</th>
<th>TDS (ppm)</th>
<th>Hardness (ppm)</th>
<th>TOC (ppm)</th>
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<tbody>
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<td>Make-up Water</td>
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<td>De-oiled Water</td>
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<tr>
<td>Chemicals</td>
<td>1,492</td>
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<tr>
<td>Service Water</td>
<td>1,576</td>
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<tr>
<td>WLS Afterfilters</td>
<td>1,576</td>
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<td>3</td>
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<tr>
<td>Blowdown to Header</td>
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### Stream Summary Table

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<tr>
<th>Source</th>
<th>Water to Gas</th>
<th>Water to LAC</th>
<th>Water to Reservoir</th>
<th>Water to Dilbit</th>
<th>Water to Preflash</th>
<th>Water to Utilities</th>
<th>Water to Reservoir</th>
</tr>
</thead>
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<tr>
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<td>30 kg/d</td>
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</tbody>
</table>

### Stream Composition

<table>
<thead>
<tr>
<th>Stream</th>
<th>Composition (Dry Basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produced Water</td>
<td>Water lost to Dilbit</td>
</tr>
<tr>
<td></td>
<td>Water lost to Reservoir</td>
</tr>
<tr>
<td></td>
<td>Water lost to Production</td>
</tr>
<tr>
<td></td>
<td>Blowdown to Disposal</td>
</tr>
<tr>
<td></td>
<td>Blowdown to WLS</td>
</tr>
</tbody>
</table>

### Process Diagram

- **Wells:** Produced Gas (PG) to Header (1,492 kg/d)
- **Water Treatment:** Make-up Water (14,500 kg/d) to De-oiled Water (589,600 kg/d)
- **Emissions:** NOx (0.38 metric t/d), SO2 (0.06 metric t/d)

### Key Terms

- **COSIA SAGD TEMPLATE**
- **Base Case:** Mechanical Lift - 2300 mPA
- **Water Line Softening - OTSG**
- **Nitrogen Gas:** 300 g/mole
- **Natural Gas:** 204 g/GJ
- **Air Blower:** 10 kW
- **Flue Gas:** 462 kW
- **OTSG Flue Gas:** 2,191 metric t/d
- **WLS Feed:** 65,522 kg/h
- **WLS Afterfilters:** 1,492 g/GJ
- **Chemicals:** 1,576 ppm
- **Make-up Water:** 20,576 g/mole
- **De-oiled Water:** 1,492 ppm
- **Service Water:** 1,576 ppm

### Notes

- **Water Balance:**
  - Make-up Water: 14,500 kg/d
  - De-oiled Water: 589,600 kg/d
  - Chemicals: 2,500 kg/d
  - Service Water (WF): 1,500 kg/d

- **Emissions Summary:**
  - NOx: 0.38 metric t/d
  - SO2: 0.06 metric t/d

- **Process Diagram Details:**
  - Produced Gas (PG) to Header (1,492 kg/d)
  - Water Treatment: Make-up Water (14,500 kg/d) to De-oiled Water (589,600 kg/d)
  - Emissions: NOx (0.38 metric t/d), SO2 (0.06 metric t/d)
This is a generic and hypothetical mine extraction facility developed by COSIA. While representative, it is not based on any one facility.

Recovery and solvent loss is based on Alberta Energy Regulator requirements.
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Recovery and solvent loss is based on Alberta Energy Regulator requirements.
COSIA Mining & Extraction: High Grade - Naphthenic Froth Treatment - Material Flow

**Ore Preparation: Conditioning, Crushing and Conveying**

- **Mine Face**
  - T/h Crusher
  - Conveyor Feed
  - Rotary Breaker
  - Truck and Shovel
- **1 °C System**
- **50 °C Rejects**

**Primary Extraction 58 °C**

- **12 °C Hot Process Water**
- **80 °C**
- **Gland Cooling Water**
- **T/h**
- **T/h Breaker Rejects**
- **45 °C Warm Dilution Water**
- **T/h T/h T/h**

**Secondary Separation-Froth Treatment**

- **50 °C Primary Extraction**
- **Vent to atmosphere**
- **28 T/h Caustic Stripping Steam**
- **Deaerator 40-50 °C**
- **NaOH Flotation Froth**
- **Deaerated Froth 77 °C Middlings**
- **T/h**
- **Bitumen 58 wt%**
- **Water 32 wt%**
- **Middlings Displacement**
- **Cooling Water T/h T/h T/h**
- **Solids 10 wt%**

**Utilities**

- **38 wt% Water**
- **Bitumen**
- **12 wt% Solids**

**Legend**

- **Steam 70 T/h**
- **NRU Tailing**
- **Fuel Gas**
- **2 wt% Bitumen**
- **Diluent 955 T/h**
- **IPS Centrifuge**
- **Warm Water 19 T/h**
- **59 wt% Bitumen**
- **1.5 wt% Water**
- **Diluent 0 wt%**
- **Solids 1 wt%**
- **48 °C**
- **0.7 wt/wt Diluent : Bitumen**
- **Diluent Loss:Bitumen 0.4 vol./vol.**

**Abbreviations**

- **0.4 wt% Diluent**
- **BFW Boiler Feed Water**
- **Bitumen GTG Gas Turbine Generator**
- **bbl Bitumen**
- **HHV High Heating Value**
- **28 wt% Bitumen**
- **2 wt% Bitumen**
- **Diluent**: **2 wt% Bitumen 69.8 wt% Water**
- **76 wt% Water 21 wt% Solids**
- **22 wt% Solids 7 wt% Diluent**
- **0.4 wt% Diluent BFW Boiler Feed Water**
- **10 °C**
- **85 % Process Water**
- **Reclaimed vol./vol Diluent : Bitumen**
- **Asphaltene in Bitumen**
- **NRU Naphtha Recovery Unit**
- **wt% Solids + Water**
- **PSC Primary Separation Cell**
- **Losses**
- **Bitumen Recovery Summary**
- **201 T/h 470 T/h Recovered MPS Primary Extraction**
- **Water treatment Condensate GTG 100 % Quality Froth Treatment (without rejected asphaltenes)**
- **GJ/h kPag Total Bitumen Recovery**
- **m3/h °C Asphaltenes Rejection**
- **BFW Unit T/h Process Heating**
- **T/h Duct Burner MPS LPS Utility Steam**
- **Water Summary (T/H)**

- **Make-up Water mg/L TDS GJ/h HRSG 2 Unit 90 % Quality Cooling Water**
- **10 °C mg/L Silica**
- **mg/L Hardness Unit °C Reclaimed Water**
- **Make-up Water mg/L TOC GTG Duct Burner HRSG T/h Raw Water**
- **mg/L TDS BFW**
- **mg/L Silica Boiler Blowdown**
- **mg/L Hardness Make-Up Water**
- **mg/L TOC Recovered Condensate 470 T/h Boilers LPS Condensate Return**
- **Fresh Water : Bitumen GJ/h**
- **vol./vol. Natural Gas Required Space Heating m3/h**
- **Project: Static Oil Sands Mine and Extraction Reference Facility**
- **GJ/h Purge Gas to Flare 91.5 % Efficiency Case: Naphthenic - High Grade Revision: V 1.3**

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