COSIA INNOVATION OPPORTUNITY

Mobilizing the world's minds and resources to improve environmental performance.

Innovative Devices which Improve the Performance of Insitu Oil Sands Produced Water Heat Exchangers

SOLUTION DESCRIPTION:	INNOVATION OPPORTUNITY CHAMPION:
COSIA Members are seeking solutions/technologies which improve the performance of Insitu Oil Sands produced water heat exchangers. Steam Assisted Gravity Drainage (SAGD), and Cyclical Steam Stimulation (CSS)	COSIA's Water EPA is championing this Innovation Opportunity. COSIA's Water Environment Priority Area (EPA) aspires to produce Canadian energy without adversely impacting water.
CREATED: MARCH 2024 All project proposals are evaluated and actioned as they are received.	
For more information on this COSIA Innovation Opportunity please visit **www.pathwaysalliance.ca/innovation-hub/**	

SUBMIT YOUR IDEA HERE

Canada's Oil Sands Innovation Alliance (COSIA) is an alliance of oil sands producers, representing more than 90 percent of oil sands production, focused on collaborative action and innovation in oil sands environmental technology. COSIA Challenges are one way we articulate an actionable innovation need, bringing global innovation capacity to bear on environmental challenges and opportunities in Canada's oil sands.

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.
- Device accuracy over the requested measurement range and achievable reporting limits.
- 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).
- Disposal requirement.
- Device outputs (either analog or digital).
- Capital and operating cost estimates if available based on described capacity targets.
- 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 fluctuation.

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

Submit a summary of your solution using COSIA's Environmental Technology Assessment Portal (E-TAP) Process, available at:

ETAP Idea Submission Form

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.

DETAILED CHALLENGE DESCRIPTION

The COSIA Water Environmental Priority Area Steering Committee, and Inlet Separation and Deoiling Working Group invite proposals to reduce scaling and fouling of heat exchangers in Produced Water Cooling service.

These heat exchangers are typically shell-and-tube, spiral, or air-cooled design. Total produced water flow for a facility is typically 15,000 – 30,000 m^3/d. Typically, the carbon steel multiple heat exchangers are installed in parallel to provide the total capacity and are usually composed of 500-2,500 tubes. The typical tube diameter in the heat exchangers is 0.75 to 1 in in outside diameter, with wall thickness of 2.7 mm, while the length is approximately 20 ft straight.

The hot produced water is typically 135°C but can be hotter. It must be cooled to 80 – 90°C prior to being treated (at atmospheric pressure) for re-use in the process. The cold side of the exchanger is typically boiler feed water, glycol/water mix, or air.

Fouling and scale build-up inside of the tubes, typically consist of soluble organics (naphthenic acids), insoluble organics (asphaltenes) and inorganics (Ca, Mg, Si, Fe). Fouling and scale increase pressure drop over time, which in turn increase operating costs and reduce throughput.

Fouling and scale also reduce heat transfer, and thus reduce the amount of waste energy recovered from the produced water when the cold side is boiler feed water. Additional natural gas would be required to heat up the boiler feed water to make up for the loss in heat transfer, which in turn would increase greenhouse gas emissions.

Fouling is reduced through the use of chemistry (e.g. anti-foulants) during ongoing operation. Heat exchanger performance is monitored, and exchangers are taken off-line for cleaning based on high pressure drop, low flow rate, or low heat transfer. Typical time between cleanings is measured in days to weeks.

Produced water characteristics:

- TDS 2,000-8,000 mg/L
- TSS 50 (10-100 mg/L)
- pH 7-8
- Alkalinity 400-700 mg/L as $CaCO_3$
- Total hardness 20-200 mg/L as CaCO3
    - SiO_2 100-350 mg/L
    - Ca 5-150 mg/L
    - Mg 5-75 mg/L
- TOC 300-450 mg/L
- TIC 50-150 mg/L
- O&G 500 (200 – 1,500 mg/L0
- Turbidity 150-250 NTU

DESIRED SOLUTION CHARACTERISTICS

COSIA is interested in physical devices. The successful technology will:

- Be compatible with the produced water characteristics.
- Be applicable to a range of heat exchanger sizes and configurations.
- Extend off-line cleaning intervals.
- Have lower lifecycle operating costs (including costs for ongoing anti-foulant injections, chemical / physical cleanings, downstream natural gas savings, etc.) compared to the incumbent antifoulant chemical treatment.
- Have good thermal conductivity ~5-8 W/mK depending on the operating temperature.

The following characteristics are desirable:

- Good performance under thermal cycling. Function at up to 135˚C; 180˚C is desirable.
- Robust performance across a range of concentrations of foulants and scale-forming components.
- Multi-year service life for any hardware components of the solution.
- Able to be mechanically or chemically cleaned if the proposed technology is a physical enhancement or device.
- Easy to retrofit in existing facilities.

For the technology proposal, COSIA would like to know:

- Applicability to produced water heat exchangers.
- Limitations regarding heat exchanger configurations and sizes.
- Mode of action.
- Advantages and disadvantages compared to other alternatives.
- Estimated operational and capital costs.
- Compatibility with the previously defined produced water characteristics and test results with solutions of similar composition.
- Operational temperature ranges.
- Thermal conductivity.
- Efficiency against fouling and scaling.
- Cleaning mechanism.
- Viability for retrofitting.
- Technology readiness level (TRL).
- Consumables associated with the technology.
- Necessary energy input.
- Specific disposal requirements.

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BACKGROUND

The most common recovery process employed for producing oil from deep oil sands reservoirs (geological formations) is known as Steam Assisted Gravity Drainage (SAGD). In this process, steam is generated at a Central Processing Facility (CPF), transported to well pads, and injected into a horizontal well bore within the formation. The heat supplied by the steam warms the heavy oil in the reservoir, allowing it to flow via gravity into a second well bore that captures the oil water mixture and produces it to the surface with the hydrocarbon at temperatures of over 180°C, and high levels of impurities, including salts, metals, silica and organic compounds. Because of the large water requirements, recycling and reusing the produced water recovered are mandatory, both to protect the environment and to minimize costs.

APPROACHES NOT OF INTEREST

The following approaches are not of interest:

- Approaches that have not demonstrated proof of concept.
- Online mechanical cleaning.

ADDITIONAL INFORMATION

COSIA has tools you can use, including sample SAGD Reference Facilities. These tools will help you analyze and quantify the benefits of your technologies prior to submitting them to our Environmental Technology Assessment Portal (ETAP).

To receive the sample SAGD Reference Facilities document by e-mail, please contact ellen.widdup@pathwaysalliance.ca.

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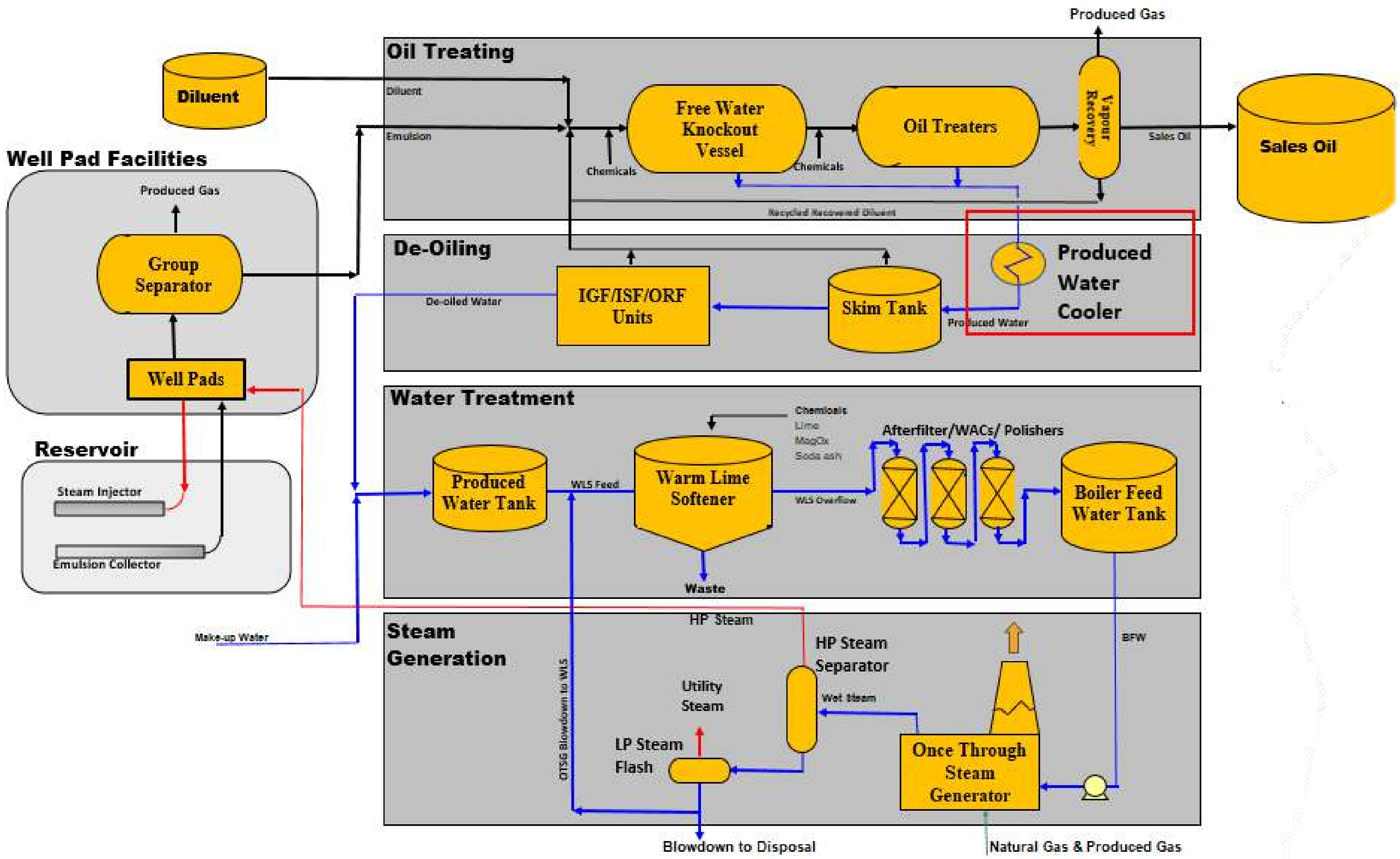
Typical Bitumen Production Process Schematic



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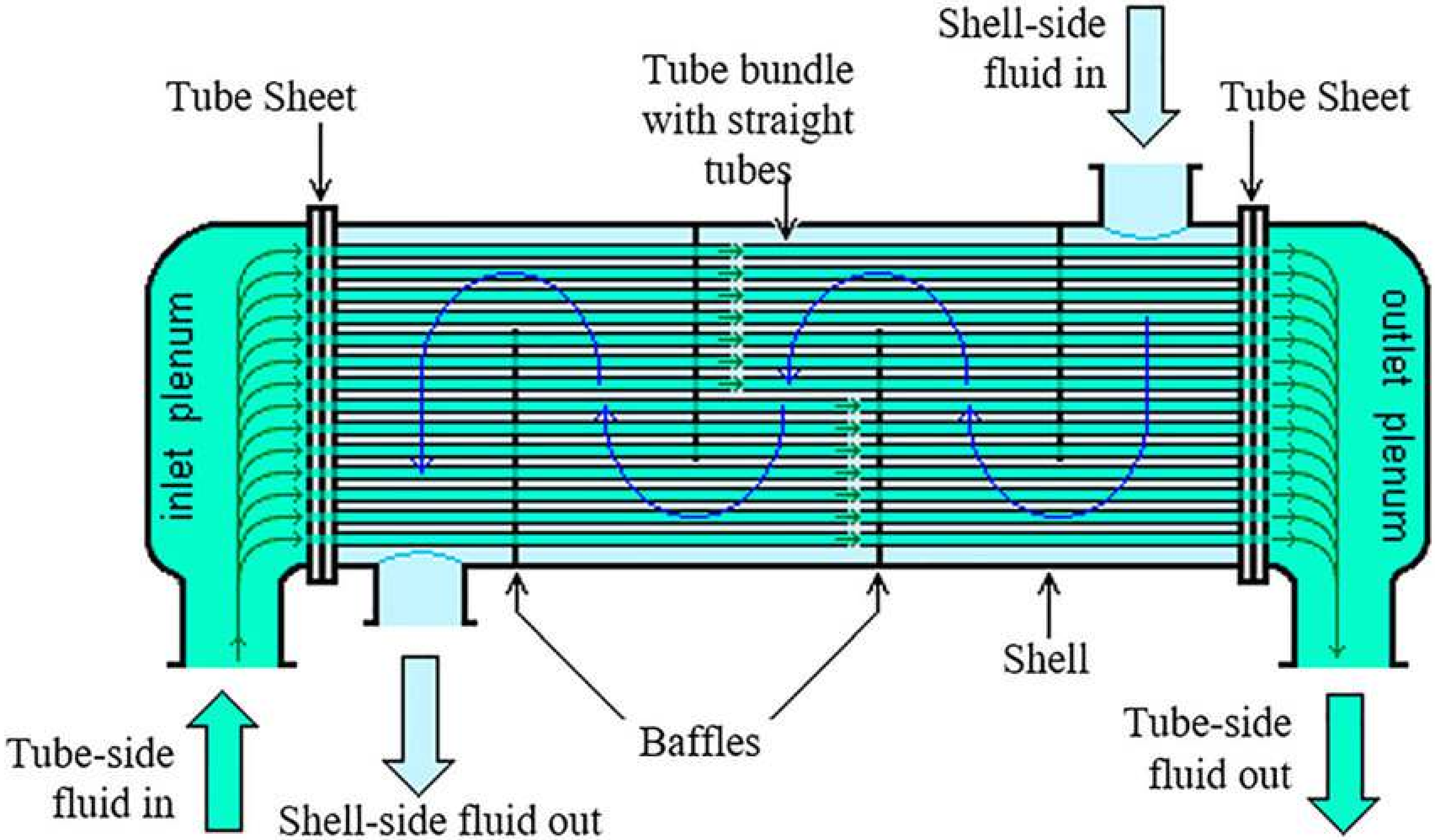
Typical Shell and Tube Heat Exchanger Diagram [1]



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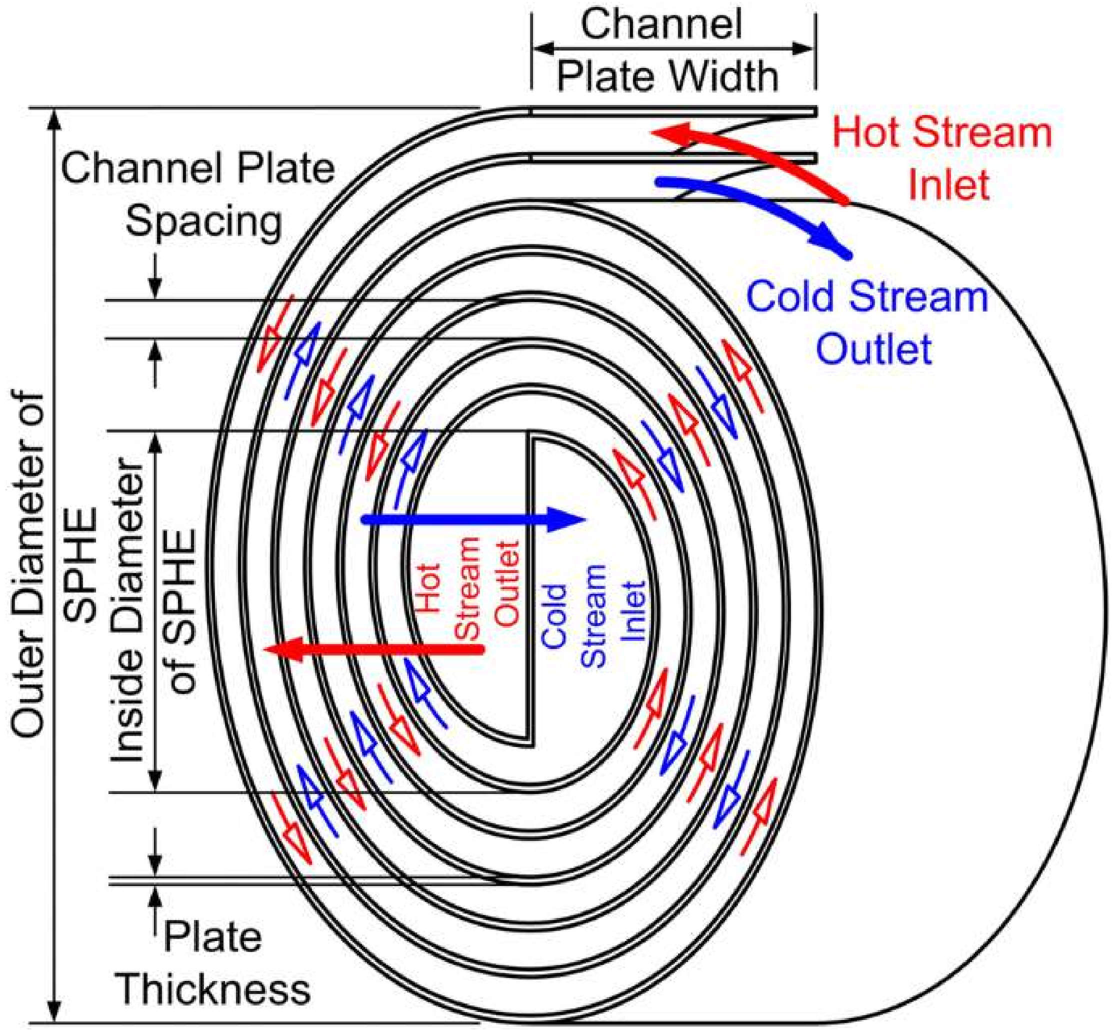
Typical Spiral Heat Exchanger Diagram [2]



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References

[1] Wang, R., Wang, G., Yan, Y., Sabeghi, M., Ming, Z., Allen, J. K., and Mistree, F. (October 26, 2018). "Ontology-Based Representation of Meta-Design in Designing Decision Workflows." ASME. *J. Comput. Inf. Sci. Eng*. March 2019; 19(1): 011003. https://doi.org/10.1115/1.4041474

[2] Sabouri Shirazi, A.H., Jafari Nasr, M.R. & Ghodrat, M. Effects of Temperature Differences in Optimization of Spiral Plate Heat Exchangers. Process Integr Optim Sustain 4, 391–408 (2020). https://doi.org/10.1007/s41660-020-00128-5