COSIA CHALLENGE

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

Novel Steam Generator Design

SOLUTION DESCRIPTION:

New design of steam generator focused on improved performance for Steam Assisted Gravity Drainage (SAGD) and Cyclic Steam Stimulation (CSS) produced water recycle.

UPDATED: June 1, 2017

All projects are evaluated and actioned as they are received.

CHALLENGE SPONSOR:

COSIA's **Water EPA** is sponsoring this challenge.

The Water EPA is seeking solutions which **reduce water use and increase water recycling rates at oil sands mining and in situ (in place) operations without causing negative environmental impacts in other areas.**

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/challenge**

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.

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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 including quantity and type(s) energy inputs
- Capital and operating cost estimates if available based on described capacity targets including basis of cost estimation, including estimation scope, contingency, etc.
- 3rd party verified comparison of your proposed technology. 3rd party verifiers should be reputable, independent engineering companies if possible
- 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.

COSIA Members have funded over 400 projects to date, totaling over $1 billion.

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: **http://www.cosia.ca/initiatives/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.

#0018: Novel Steam Generator Design

DETAILED SOLUTION DESCRIPTION

The COSIA Water Environmental Priority Area Steering Committee has identified Once Through Steam Generator (OTSG) reliability as a recurring issue that a new technology could address to improve the environmental performance of the oil sands. This challenge relates to novel steam generator designs that would improve current practices by minimizing the amount of water pre-treatment or reducing/eliminating traditional steam generator tube fouling. At the same time, the energy efficiency of the new technology should be equal to or better than an OTSG at 80% steam quality.

In the in situ oil sands industry, steam generators are taken offline for 2-4 days for cleaning between 6 months and 2 years. The cleaning is done by pushing a variety of pigs through the OTSG pipes to scrape off the scale that has formed on the tube walls. If scaling becomes excessive during operation, tube wall temperatures can increase to the point of tube failure.

Technologies of interest could include (but are not limited to):

- A new steam generator design that can reliably operate with poor water quality (defined below) at >60% steam quality
- Novel design of self-cleaning steam generator
- Modified pipe configurations to reduce/eliminate fouling
- Etc.

Desirable proposals include:

- Proposals with data from lab-scale experiments using produced water from an oil sands in situ facility
- Proposals with experience in relevant service in other industries
- Retrofit-able technology

Typical steam generators in Insitu Oil Sands service operate with SiO_2 < 50 mg/L (minimum, < 25 mg/L desired); Ca/Mg <0.5mg/L; TDS 1,000- 8,000 mg/L; TOC>250mg/L; Oil and Grease <1.0mg/L, at ~80% steam quality delivering 10-15MPa steam at the outlet. Tube wall temperature can reach up to 400°C.

If a novel design to handle poor quality boiler feedwater is being proposed, the new steam generator design must at least be able to operate at a steam quality (>40%) with low quality inlet water (SiO_2 ~250mg/L, Hardness ~10mg/L, TDS ~3000mg/L, TOC >250mg/L, Oil & Grease <1,000mg/L). New steam generator technology must be more reliable than the existing technology and would require >1 year of continuous operation in between cleanings, or have provisions to clean while online.

Natural gas is the preferred fuel, however others could be considered, and the technology must be able to operate on a large scale (50-100 MW thermal, ~150-300 t/hr of steam) with high efficiency (>85% on a higher heating value (HHV) basis).

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

Typical steam requirements in these types of processes range from 2 to 5 barrels or more of water per barrel of oil produced.

Because of the large water requirements, recycling and reuse of the water used in the steam production is mandatory both to protect the environment and to minimize costs. Current recycling rates are 90% or more. Make-up water are typically sourced from brackish water formations to further minimize environmental impacts.

The produced oil water mix is separated, and the remaining water is then treated to be pure enough for steam generation. This produced water has high levels of impurities, including salts, metals, silica and organic compounds. It currently needs to be treated before being fed to the boilers.

Preparing this boiler feed water continues to be challenging with present technologies as they require significant energy inputs and are very capital intensive. Current treatment steps still leave current technology boilers vulnerable to fouling and scaling, which leads to loss of efficiency, tube failures and downtime for cleaning and repairing.

A boiler technology that can create high purity steam from treated water while eliminating fouling and increasing steam quality is sought. One means of meeting this challenge that has not been thoroughly investigated are technologies that capture and remove impurities during the boiling operation, rather than treating the water beforehand.

List of typical PW and BFW Parameters:

Parameter	De-oiled Produced Water	Boiler Feed Water
Oil and Grease (mg/L)	<10mg/L	<1mg/L
Total Dissolved Solids (mg/L)	~2,000/7,000 mg/L for SAGD/CSS	<12,000mg/L
pH	7.0-8.0	8.5-10.3
Hardness (mg/L)	~20/150mg/L for SAGD/CSS	<1mg/L
Silica (mg/L)	~220/250 mg/L for SAGD/CSS	20-50mg/L
Total Organic Carbon (mg/L)	350-500mg/L	350-600mg/L

APPROACHES NOT OF INTEREST

The following approaches are not of interest:

- Approaches that have not demonstrated proof of concept
- Configurations that produce steam that is co-mingled with other products (such as the products of combustion from the boiler, or nitrogen)

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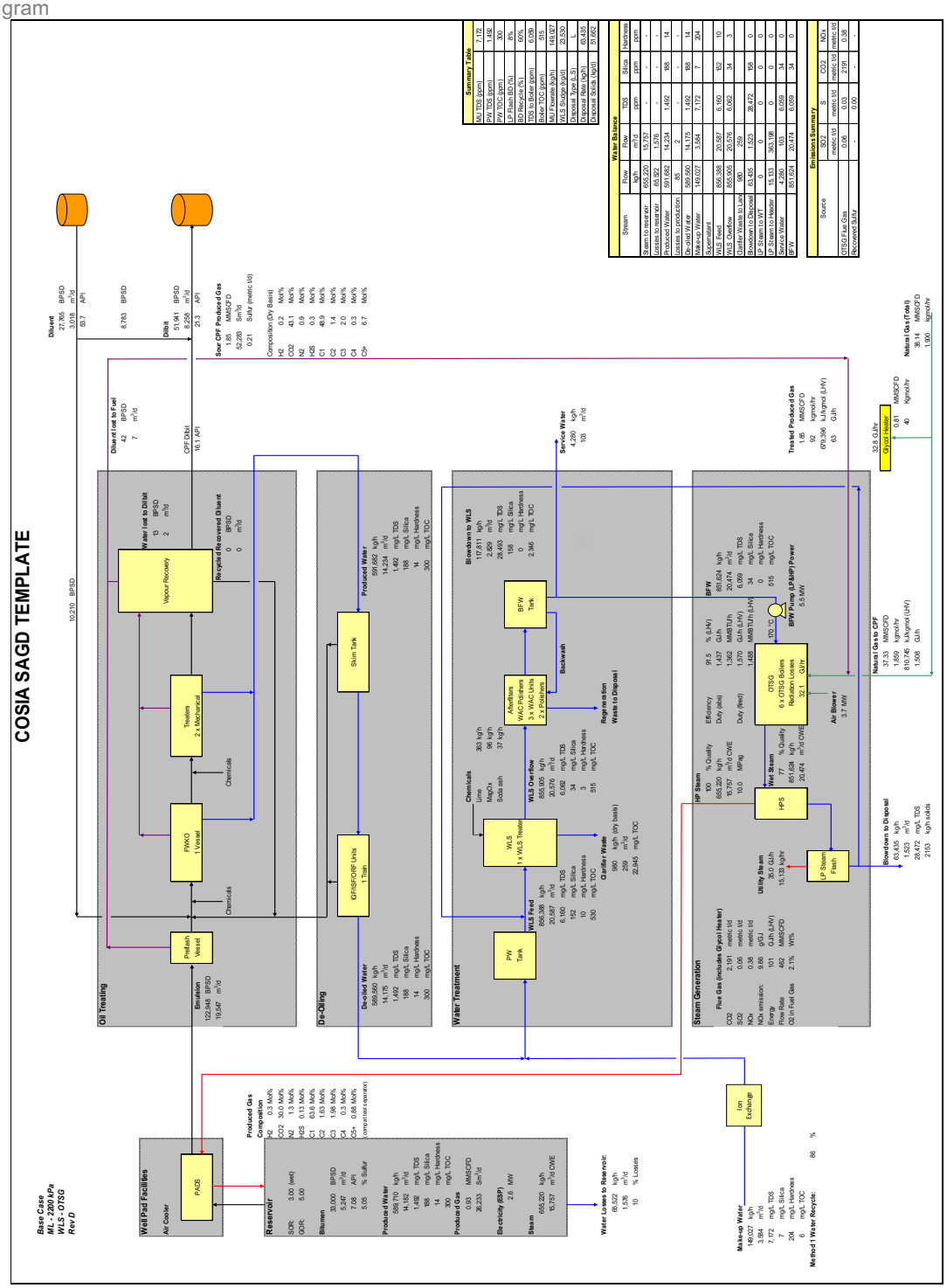
ADDITIONAL INFORMATION

Supplemental Information – Typical SAGD Flow Diagram



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Supplemental Information – Typical SAGD Energy Flow Diagram