COSIA CHALLENGE

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

Passive Organics Treatment Technology

SOLUTION DESCRIPTION:

Passive treatment of dissolved organic compounds present in Oil Sands Process Water (OSPW).

CREATED: April 30, 2015

All projects are evaluated and actioned as they are received.

CHALLENGE SPONSOR:

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

Our aspiration is to **reduce water use and increase water recycling rates at oil sands mining and in situ (in place) operations without environmental burden shifting**

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**

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
- Energy inputs – quantity and type(s)
- Capital and operating cost estimates if available based on described capacity targets
- 3rd party verification of your proposed technology. 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

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.

DETAILED SOLUTION DESCRIPTION

The COSIA Water Environmental Priority Area Steering Committee has identified a need for technologies to passively treat dissolved organic compounds present in Oil Sands Process Water (OSPW). They are seeking improvement to existing or new non-mechanical technologies to improve environmental performance in the mineable oil sands industry.

The successful technology will:

- Work in a Northern Climate.
- Be a passive system and will not require operator or maintenance interaction.
- Be able to treat 0.5 – 5 Mm³/year of OSPW (mean flow: 0.05 – 1 m³/sec. Peak flow: 1 to 30 m³/sec).
- Produce a treated effluent with the quality specified at the end of this document.
- Meet the following key treatment effluent parameters:
  - Be acutely nontoxic as per Oncorhynchus mykiss (rainbow trout) 96 h test.
  - Remove sufficient acid extractable organics such that it passes the acute bioassays.

See influent and effluent parameters at the end of this document.

Generally the proposed technologies will be of two types:

Once through treatment, in which the treated water meets the discharge requirements following treatment (See Figure 1).

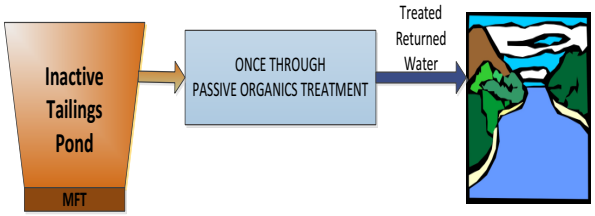


Figure 1 - Once through treatment

In Pond Treatment in which the treatment technology occurs in/ or adjacent to the pond, and gradually improves the water quality until the quality of the entire water body is sufficient that the water can be returned to the Athabasca River (See Figure 2).

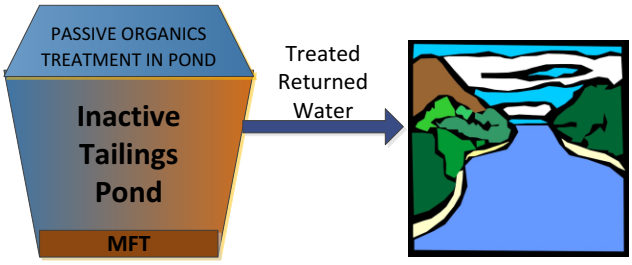


Figure 2 – In Pond Treatment

BACKGROUND

Oil sands are compacted deposits of sand, silt, clay, water and bitumen. In general, they contain by weight about 6 to 14% bitumen, and 80 to 85% mineral solids with water making up the balance. Raw bitumen is produced either by mining/extraction methods or by in-situ techniques using wells to recover the bitumen. For mining operations, imported river water that is not evaporated or chemically consumed is contained on-site within tailings structures to become part of the OSPW inventory. This water is primarily used for bitumen extraction, cooling and material transport. Refer to the typical bitumen production process schematic at the end of this document.

To extract bitumen in surface mining operations, OSPW is heated and mixed with oil sands to separate the bitumen from the mineral solids. The bitumen is floated and the tailings (mixture of water, sand, silt, clay, and some unrecovered bitumen) are deposited in tailings storage. Tailings storage areas have three main features:

- A sand beach which also contains some fines (i.e., particles < 44 micron in size) and OSPW
- Fluid fine tailings (FFT) made up of 20-40% fines with the balance being OSPW
- A cap layer of OSPW.

The cap layer or free water zone in the ponds is reused in the extraction process. The overall process is approximately 80-85% efficient. The 15 to 20% water loss is attributable to that portion that evaporates or becomes pore water within the FFT, sand beaches and dykes. This challenge statement is focused on passive (i.e., low energy) treatment of the organic components present in OSPW. Typically applications include closure of tailings structures and expediting aquatic reclamation using pit lakes.

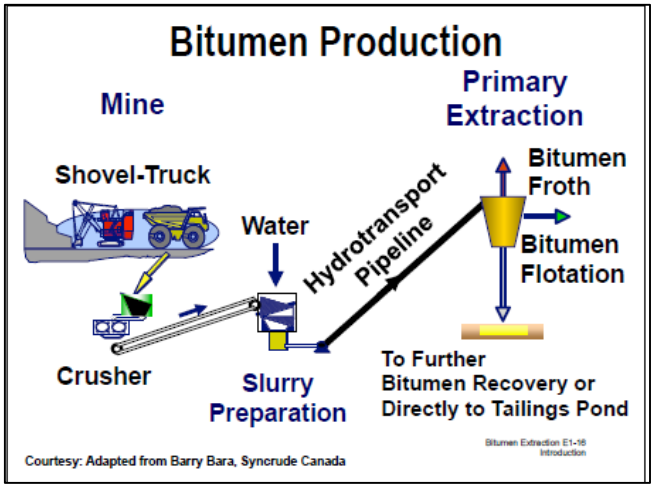
Pit lakes are former in-pit tailings facilities that will become a permanent reclaimed feature in the closure landscape. Typically, these lakes consist of a layer of OSPW overlying a FFT deposit. Surface water will be supplied by the surrounding watershed and, over time, the outflow will report to the environment. Research efforts to date demonstrate that these lakes will evolve into natural ecosystems and over time support healthy communities of aquatic plant, animals and fish.

APPROACHES NOT OF INTEREST

The following approaches are not of interest:

- Approaches that have not demonstrated proof of concept.
- Mechanical treatment requiring significant and routine operator input including ozonation.
- Studies which focus only on chemical analysis and organics speciation. Any analytical work must be coupled with a proposed treatment technology.
- Adsorption – if not self-regenerating.
- High energy technologies such as desalination techniques using membranes.

ADDITIONAL INFORMATION



Typical Bitumen Production Process Schematic

Influent and Effluent Range Data

Parameter	Unit	Influent Range	Treated Return Water Design Basis

Average Flow	Mm3/year	0.5-5	0.5-5
Average flow	m^3/sec	0.05 – 1	0.05-1
Peak Flow	m^3/sec	1 – 30	1-30
Temperature	°C	4-21	4-21
pH		7.5-8.8	6.5-8.5
BOD_5	mg/L	4-320	2-20
COD_{Total}	mg/L	175-650	See below toxicity
TOC	mg/L	40-250	See below toxicity
DOC	mg/L	30-120	See below toxicity
TSS	mg/L	20-800	<25
TDS	mg/L	1200-3000	Treatment not required
Alkalinity	mg/L as $CaCO_3$	600-900	Treatment not required
Hardness	mg/L as $CaCO_3$	40-120	Treatment not required
O&G	mg/L	5-150	<10
Ammonia	mg/L	0.0076-30	See below toxicity
Phenols	mg/L	0.0036-0.0270	See below toxicity
PAHs	mg/L	0.0004-0.015	Treatment not required
Acid extractible organics	mg/L	15-80	See below toxicity
BTEX	mg/L	0.01-5	See below toxicity
Arsenic	mg/L	0.0033-0.05	
Cadmium	µg/L	0.00006-0.4	
Chromium	mg/L	0.0005-0.04	

Copper	mg/L	0.0001-0.03	Treatment not required
Lead	mg/L	0.0001-0.04	
Mercury	µg/L	0.0005-0.2	
Nickel	mg/L	0.005-0.04	
Selenium	mg/L	0.0009-0.15	
Strontium	mg/L	0.31-0.8	
Vanadium	mg/L	0.001-0.05	
Zinc	mg/L	0.002-0.35	
Toxicity			• Acutely nontoxic as per *Oncorhynchus mykiss* (rainbow trout) test. • Sufficient removal of the acid extractable organics such that it passes the acute bioassays.

Common Misconceptions:

Tailings ponds need to be completely eliminated:

- During the active life of an oil sands mine they are an integral part of the process.

Pit Lakes are not effective reclamation tools:

- Pit lakes are an integral part of the closure landscape for all mining sectors including oil sands.

Better Oil Water Separation technologies are needed to treat OSPW:

- While improved oil water separation is always welcome the current technologies separate oil and water quite well, as a result oil water separation is not a limiting factor for oil sands environmental performance]