DEGRADATION OF NAPHTHENIC ACIDS (NAS) UNDER LOW-CURRENT ELECTRO-OXIDATION ON GRAPHITE

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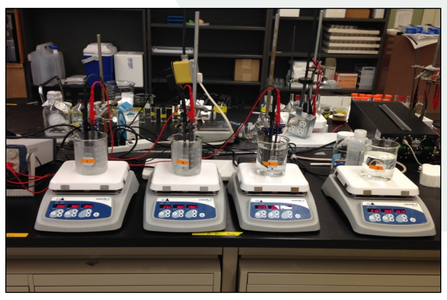
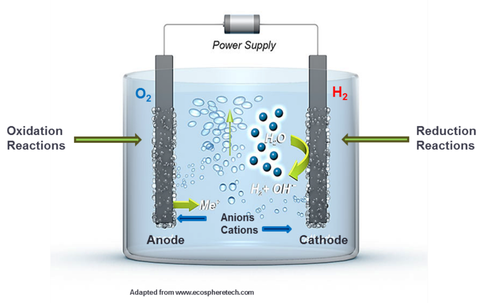
BACKGROUND

- Large amounts of oil sands process water (OSPW) are generated during the extraction of bitumen from mined oil sands and are stored in tailing ponds.
- Tailings ponds are growing in volume and number with accumulated amount of OSPW estimated to be more than 1 billion m^3 in 2013 covering an area of more than 220 km^2.
- OSPW is known to be toxic to both prokaryotes and eukaryotes.
- OSPW contains a group of aliphatic and alicyclic carboxylic acids that known as naphthenic acids (NAs) that are considered one of the main causes of concern because they are recalcitrant and can persist in the environment for many years
- Developing treatment technologies for OSPW treatment and NAs degradation is currently considered one of the main challenges facing the oil sands industry.
- Various chemical, physical and biological processes have been investigated for the treatment of OSPW and degradation of NAs. However, effective and cost-efficient treatment approaches have not been found so far.

AIMS AND OBJECTIVES

- Electro-oxidation has emerged as promising process for the destruction of a variety of recalcitrant organics pollutants present in process water.
- The objective of this study was to investigate the effectiveness of applying low-current electro-oxidation for degrading NAs.
- The study focuses on evaluating the performance of inexpensive carbonaceous electrode materials under low energy operating conditions for degrading NAs and understanding the involved oxidation mechanisms.





Adapted from www.ecosphere tech.com

RESULTS

- The results showed promising performance for electro-oxidation in degrading model NAs, cyclohexanoic acid (CHA), and commercial NA mixture (Sigma Aldrich).
- Graphite was used as an inexpensive anode material for the treatment of CHA and commercial NA mixture with initial concentrations of 50 and 40 mg/L, respectively.
- Different voltages in the range from 2.9 to 10.5 V were applied for CHA degradation in short periods of time (30 to 180 minutes).
- It was found that the degradation rate increased with increasing the applied voltage, with achieving degradation rates of 29.5%, 53%, 72.5% and 81.1% at voltages of 3.3, 6, 7.5 and 10.5 V, respectively (Figure 1).
- The degradation of commercial NA mixture (Sigma-Aldrich) by electro-oxidation was investigated under different current densities (0.5, 2.5 and 5mA/cm^2) for 180 minutes and was then followed with a batch biodegradation experiment to assess the improvement in biodegradability (Figure 2).
- Electro-oxidation under current densities of 5, 2.5 and 0.5 mA/cm^2 was able to reduce NA concertation by 82% , 77% and 76%, respectively. The toxicity toward *Vibrio fischeri* was also reduced by 69%, 56% and 44%, respectively.
- Combining electro-oxidation with biodegradation resulted in complete toxicity removal.

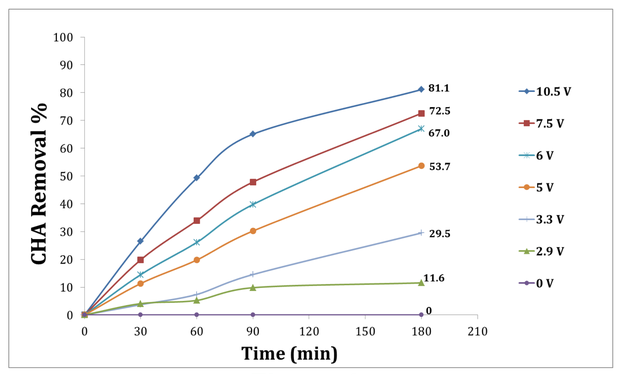


Figure 1

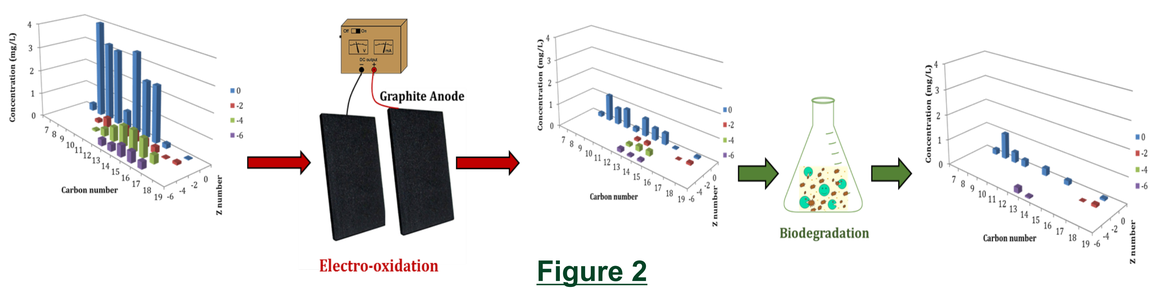
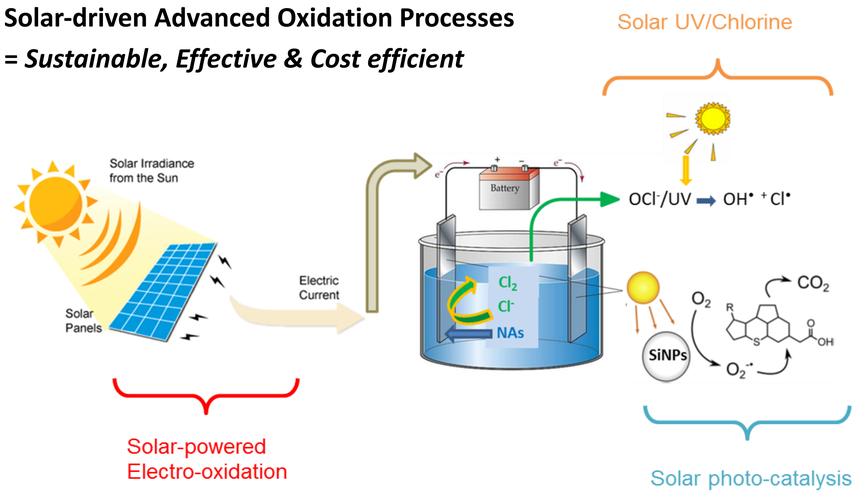


Figure 2

FUTURE DIRECTIONS

- Investigate the effectiveness of combining EO with UV/chlorine process (EO under UV light).
- Develop a special type of electrodes by depositing Si nanoparticles on the surface which can work as a solar photocatalyst.
- Optimize the combination of the three processes and evaluate the contribution of each process.

➢ **Solar-driven Advanced Oxidation Processes**
= *Sustainable, Effective & Cost efficient*



PARTNERS

This research has been undertaken thanks in part to funding from the Canada First Research Excellence Fund.

FES PROJECT OVERVIEW

Resilient Reclaimed Land and Water Systems: Environmental issues associated with energy development, management and supply must be addressed for all energy systems. Regardless of the type, source or transport mode of energy, land and water will be affected. Hence, land and water will be integral components of all future, current and legacy energy systems, addressing land and water use, management, conservation and reclamation. After disturbance from energy focused activities, land and water require reclamation to resilient systems that support desired end land uses. Reclamation success can be achieved if metrics to determine trajectories and final outcomes are robust and science based, with good communication among stakeholders and practitioners. Our theme projects address a systemic approach to energy production and delivery and cross theme benefits.

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UNIVERSITY OF ALBERTA
FUTURE ENERGY SYSTEMS

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