ANALYTICAL AND TOXICOLOGICAL EVALUATION OF BIOAVAILABLE NAPHTHENIC ACIDS FROM OIL SANDS PROCESS WATER USING BIOMIMETIC EXTRACTION - SOLID PHASE MICROEXTRACTION

Rongfu Huang[1], Fang Zhi[1], Pamela Chelme-Ayala[1], and Mohamed Gamal El-Din[1]

Collaborators: Asfaw Bekele[2], Aaron Redman[3], and Daniel Letinski[3]

BACKGROUND

- The biomimetic extraction - solid phase micro-extraction (BE-SPME) method can be used as a surrogate measurement of bioavailability and ecotoxicity of organics to aquatic organisms. In a biomimetic extraction process, a small portion of the freely dissolved fraction of hydrophobic organic chemicals is extracted from water samples by a surrogate hydrophobic phase, typically a polydimethylsiloxane (PDMS) polymer.
- The total molar concentration of the chemicals extracted by SPME can be analyzed by gas chromatography flame ionization detector (GC-FID) or gas chromatography mass spectrometry (GC-MS).
- An important advantage of biomimetic SPME is that only the bioavailable fraction of the compounds that partition to the fiber is measured.

AIMS AND OBJECTIVES

- The objective of this study is to characterize and determine the composition of organics in oil sands process water (OSPW) that contribute to its toxicity and to build capacity of SPME experience in the region to support expanded water quality assessments.

RESULTS

- Raw and ozonated (80 mg/L utilized ozone dosage) oil sands process water (OSPW) samples were prepared via BE-SPME method. The GC-FID was used to analyze SPME fibers for semi-quantification of total organics. Microtox assays were preformed for raw and ozonated OSPW samples with pH adjustment to 7.0-8.5.
- For GC-FID analysis, the response of Fluka standard is averagely 65% of the response of dimethylnaphthelene. Generally, the BE-SPME analysis results follow the trend of Microtox results. For individual samples, the correlation of GC-FID and Microtox results is also related to the composition of organic species in raw and treated samples.
- Atmospheric pressure gas chromatography time-of-flight mass spectrometry (APGC-TOF-MS) was used to analyze SPME fibers for compositional analysis of organic species including hydrocarbon and naphthenic acids species. The minor inconsistency between GC-FID and Microtox results for some samples could be explained by the different composition of organic that was interrogated using APGC-TOF-MS.

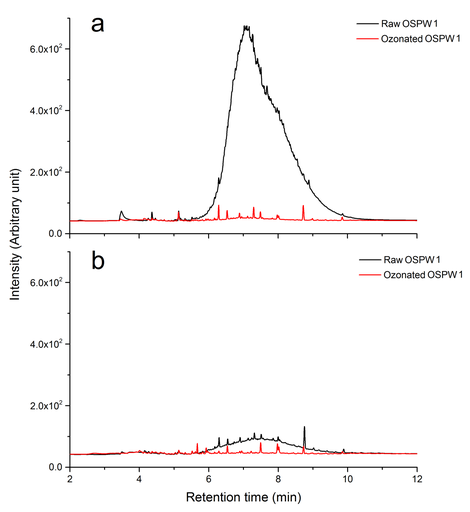

Figure 1. GC-FID chromatograms of SPME fibres that were used to extract raw and ozonated OSPW1 at adjusted pH 2.0 (a) and at natural pH without adjustment (b). To obtain the peak areas for SPME injection, manual integration was used to integrate the area at retention time of 5-11 min.

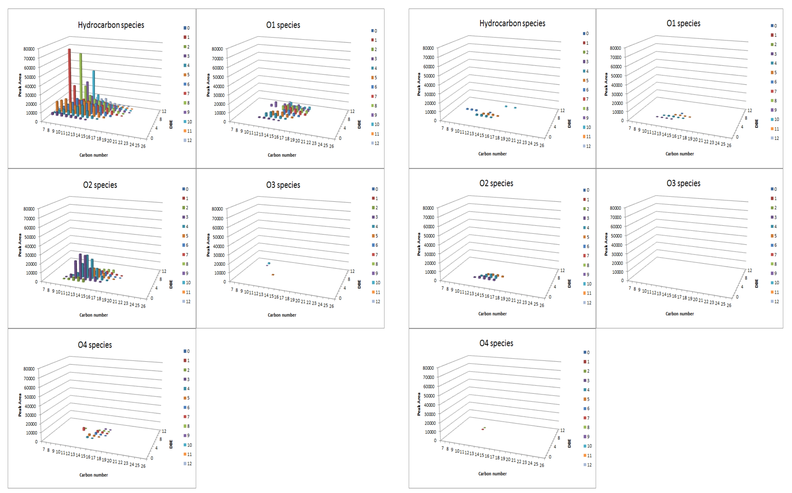

Figure 2. The distribution of measured peak areas of hydrocarbon and O1-O4 species, regarding the carbon number and DBE, in raw OSPW (left) and treated OSPW (right) through SPME extraction at pH 2.0 and then APGC-TOF-MS analysis.

FUTURE DIRECTIONS

- The BE-SPME method developed could be applied to various OSPW reclamation/treatment options to evaluate the removal of bioavailable contaminants including NAs.
- To confirm the APGC-TOF-MS analysis results of hydrocarbon species, the hydrocarbon mixture standard will be analyzed using APGC-TOF-MS to validate with results from OSPW samples.
- The APGC-TOF-MS method developed in this project could be used to characterize both NAs and PAH species in the same sample run; thus it has potential to be used for more comprehensive environmental chemistry and water treatment applications.

PARTNERS

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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.

[1]Department of Civil and Environmental Engineering, University of Alberta;
[2]Imperial Oil, Canada; [3]ExxonMobil Biomedical Sciences, New Jersey.

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