BIOFILTRATION AS A SEMI-PASSIVE APPROACH TO TREAT PROCESS WATER

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BACKGROUND

- Large amount of oil sands process water (OSPW) has been generated and the volume is keeping on increasing with the expansion of bitumen production. Technically practicable and economically feasible OSPW remediation methods need to be established urgently.
- Attached-growth biological treatment processes are supposed to benefit microorganisms for better adaption to harsh conditions and faster degradation of organic compounds in wastewater can be observed through the cooperation of microorganism with metabolic diversity.
- As a fixed-bed attached-growth biological treatment process, biofiltration has been used for water and wastewater treatment due to its robustness, ease and simplicity of construction, and low energy input.
- With clear economic and environmental advantages, biofiltration may be a promising approach for OSPW treatment, which can be easily scaled up and applied by the industry.

AIMS AND OBJECTIVES

- Establish a sand biofiltration system with the utilization of indigenous microorganisms from OSPW.
- Determine the efficiency of the biofiltration system to biodegrade naphthenic acids (NAs) from OSPW (Process I) (Fig. 1).
- Investigate the impact of mild ozonation as a pre-treatment on the biofiltration performance (Process II) (Fig. 1).

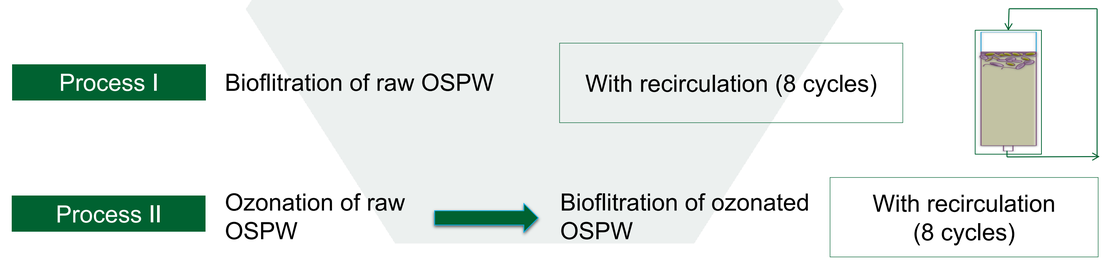

Fig. 1. Schematic of the OSPW treatment processes.

RESULTS

- The biofiltration system reached a relatively steady state after 23 days of operation with 3.3 ± 0.8 × 10^9 copies/g total bacteria on the sand media (Fig. 2A, 2B).
- After 8 times of circulation, the concentration of the classical NA from raw OSPW was decreased from 13.06 mg/L to 10.22 mg/L, while the classical NA from ozonated OSPW was decreased from 8.88 mg/L to 0.95 mg/L (Fig. 2C, 2D).
- *Proteobacteria* was the most abundance bacterial phylum in biofilters treating both raw and ozonated OSPWs (Fig. 3).

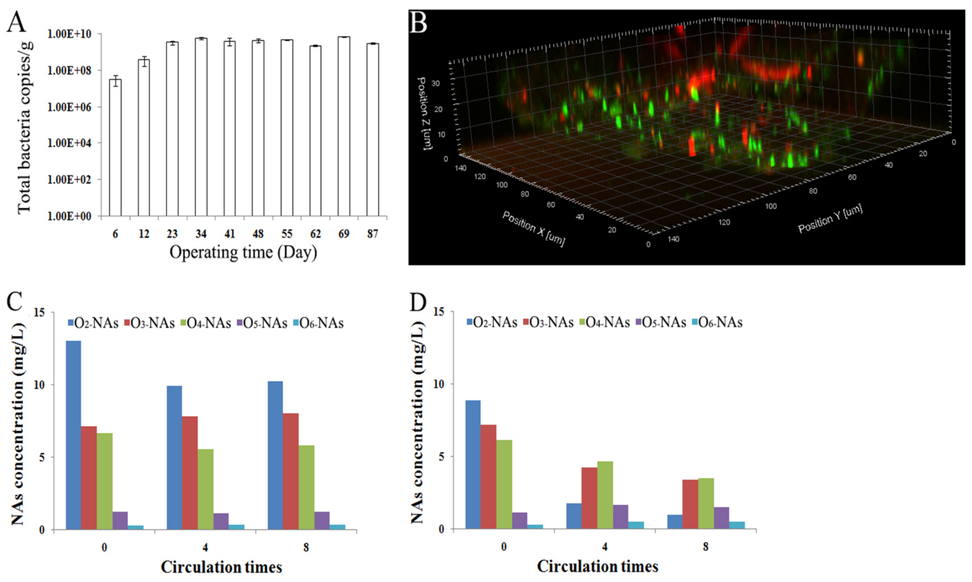

Fig. 2. Indigenous microorganisms based biofilter development and performance on the OSPW treatment. A - B: Total bacterial quantification and biofilm thickness measurement; C - D: Biodegradation of NAs from raw OSPW and ozonated OSPW.

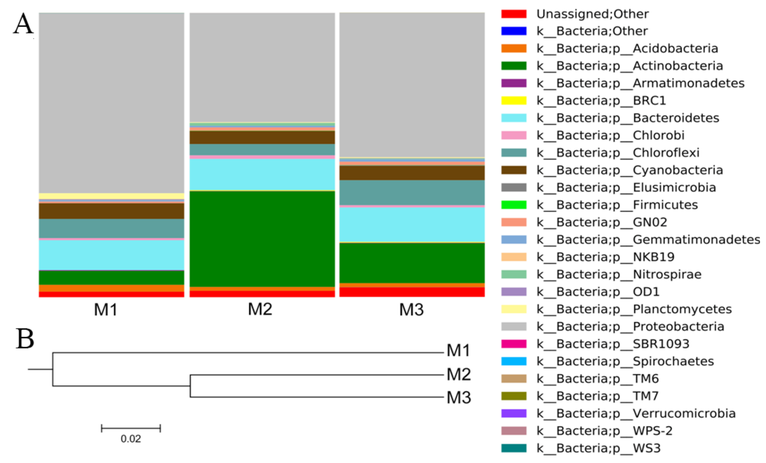

Fig. 3. Abundance of bacterial phyla and phylogenetic analysis. A: Abundance of bacterial phyla from raw OSPW (M1), from biofilter after raw OSPW treatment (M2), and from biofilter after ozonated OSPW treatment (M3); B: Hierarchical clustering of different microbial communities.

FUTURE DIRECTIONS

- Investigate the dynamics of the characteristics of the microbial community structure along the fixed-bed biofilm reactor (i.e., determine dominant bacteria on the top, middle and bottom of the fixed-bed biofilm reactor) through the analysis of the microbial community using next generation sequencing technology.
- Compare the biofiltration performance using different bed media such as native soil and granular activated carbon.
- Explore the potential degradation pathways for the NA biodegradation by biofiltration through metatranscriptomic analysis.

PARTNERS

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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