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Semi-Continuous Treatment of Naphthenic Acids using Aerobic Granular Sludge

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Abstract: Process-affected water from the Canadian oil sands industry contains long chain cycloalkane carboxylic acids called naphthenic acids (NAs). The present proof-of-concept study aimed at assessing the shock response and treatability of commercial NAs using aerobic granular sludge (AGS) over 21 days. Mature aerobic granules were cultivated in a 5L sequencing batch reactor (SBR) using synthetic acetate-based wastewater, and subjected to the NA mixture in three stages with varying organic loading rates. The introduction, starvation and the monitoring phases each had COD (chemical oxygen demand) removal efficiencies of 54.8%, 23.9% and 96.1%, and NA removal efficiencies of 71.8%, 43.3% and 67.0%, respectively. AGS biomass concentrations requiring higher COD consumption, and AGS surface area facilitating biodegradation and biosorption produced high specific removal rates. Specific COD removal rates ranged between 2678 - 6864 g COD/m^3/d, whereas specific NA removal rates ranged between 0.5-12.2 g NA/m^3/d. Supplemental nutrients were also degraded with over 90% removal efficiencies.

Keywords: *aerobic granular sludge; naphthenic acids (NAs); oil sands process-affected water (OSPW); industrial wastewater treatment.*

Abbreviations

9-FCA	fluorene-9-carboxylic acid
AEO	acid extractable organics
AGS	aerobic granular sludge
BSTFA	N, O-bis(trimethylsilyl)trifluoroacetamide
COD	chemical oxygen demand
DCM	dichloromethane
EPS	extracellular polymeric substances
FBBR	fluidized-bed biofilm reactor
GC-MS	gas chromatograph – mass spectrometer
HRT	hydraulic retention time
MBBR	moving bed-biofilm reactor
MBR	membrane bioreactor
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
MW	molecular weight
NAs	naphthenic acids
OLR	organic loading rate
OSPW	oil sands process-affected water
PBS	phosphate buffered saline
SBR	sequencing batch reactor
SVI	sludge volume index

1. Introduction