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Aerobic Granular Sludge and Naphthenic Acids Treatment by Varying Initial Concentrations and Supplemental Carbon Concentrations

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Highlights

- Kinetics of three NA and three external COD concentrations were studied using AGS.
- COD removal decreased with increasing NA concentrations.
- CHCA was removed completely, with rate constants up to 200x higher than literature.
- CHAA was removed completely, with rate constants up to 28x higher than literature.
- ACA was removed up to 19.9% using sorption and biodegradation.

Abstract: Aerobic granular sludge (AGS) has previously been utilized in the treatment of toxic compounds due to its diverse and dense microbial structure. The present study subjected mature AGS to model naphthenic acids (NAs) representative of the Canadian oil sands. To this effect, three NA concentrations (10, 50 and 100 mg/L) and three supplemental carbon source concentrations (600, 1200 and 2500 mg/L) were studied in batch reactors for 5 days. The responding variables were chemical oxygen demand (COD), NA concentrations and nutrients. Cyclohexane carboxylic acid (CHCA), cyclohexane acetic acid (CHAA) and 1-adamantane carboxylic acid (ACA) were chosen to study structure-based degradation kinetics. The optimal COD according to the runs was 1200 mg/L. CHCA was removed completely with biodegradation rate constants increasing with lower NA concentrations and lower COD concentrations. CHAA was also removed completely, however, an optimal rate constant of 1.9 d^{-1} was achieved at NA and COD concentrations of 50 mg/L and 1200 mg/L, respectively. ACA removal trends did not follow statistically significant regressions; however, degradation and sorption helped remove ACA up to 19.9%. *Pseudomonas*, *Acinetobacter*, *Hyphomonas* and *Brevundimonas* spp. increased over time, indicating increased AGS adaptability to NAs.

Abbreviations

9-FCA	fluorene-9-carboxylic acid
ACA	1-adamantane carboxylic acid
AGS	aerobic granular sludge
BSTFA	N, O-bis(trimethylsilyl)trifluoroacetamide
CHAA	cyclohexane acetic acid
CHCA	cyclohexane carboxylic acid
COD	chemical oxygen demand
DCM	dichloromethane
EC_{50}	50% effective concentration

Keywords: *1-adamantane carboxylic acid; aerobic granular sludge; cyclohexane acetic acid; cyclohexane carboxylic acid; naphthenic acids (NAs).*