MONTANA STATE UNIVERSITY
NORM ASBJORNSON College of ENGINEERING

Sabine Olds
PhD Thesis Defense
MSU Department of Civil Engineering

Ammonium by-product management in the bio-cementation process

This study investigates the management of ammonium by-products generated during Microbially Induced Calcite Precipitation (MICP). MICP is a bio-cementation process that uses ureolytic bacteria to induce calcium carbonate precipitation. This process has gained significant attention for its potential in various applications, including soil stabilization, sealing leakage pathways, and bio-concrete production. Although MICP offers an alternative to conventional cementation methods, its large-scale application is hindered by the production of ammonium ions (NH_4^+) in the waste which can accumulate in the environment, posing environmental and health risks. Researchers have explored ammonium removal from the MICP-produced wastewater using zeolite adsorption. Zeolites, with their high surface area and cation exchange capacity, can adsorb ammonium ions from aqueous solutions effectively.
The objective of this study was to evaluate zeolite adsorption to mitigate ammonium accumulation in MICP-related waste streams. Batch experiments were conducted to assess ammonium–nitrogen removal efficiency using natural and synthetic zeolites with varying particle sizes and configurations, including zeolites embedded in polyvinyl alcohol (PVA) hydrogels (ZAPs). Tests were performed on both microbial growth waste (without calcium) and treatment waste (with calcium) with growth waste being tested under different temperature conditions. Results showed that zeolite adsorption effectively reduced ammonium–nitrogen concentrations by 31.4±1.2% (6.6±0.1 mg NH_4^+–N per gram of zeolite) to 88.9 ± 13.4% (12.1 ± 1.8 mg NH_4^+–N g-1) for growth waste and 33.4±14.7 to 91.2 ± 4.4% (7.1 ± 0.4 mg NH_4^+–N g^{-1}) for treatment waste. ZAPs demonstrated the highest removal efficiency and offer a potential operational practicality for field deployment. An automated injection system was also developed to improve efficiency, consistency, and scalability of bio-cementation experiments.

Ways to join:

11/18/25
1:00PM - 4:00PM
Herrick Hall, room117

Center for Biofilm Engineering
366 Barnard Hall
P.O. Box 173980
Bozeman, MT 59717-3980

www.biofilm.montana.edu

Tel 406-994-4770
Fax 406-994-6098
cbeinfo@biofilm.montana.edu

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