IOWA STATE UNIVERSITY
Department of Civil, Construction, and Environmental Engineering

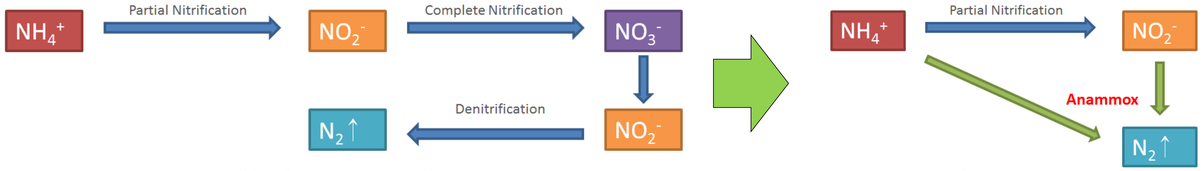
CCEE Graduate Student Council Research Showcase and Poster Competition
Sep. 15, 2011

Jun Meng & Shihwu Sung

Green Nutrient Removal Technology

Introduction

The Anammox (anaerobic ammonia oxidation) process is considered as one of the most innovative nitrogen removal technologies. If the process is under proper control, the ammonia could react with nitrate to produce nitrogen gas, therefore resulting in a higher TN removal efficiency.



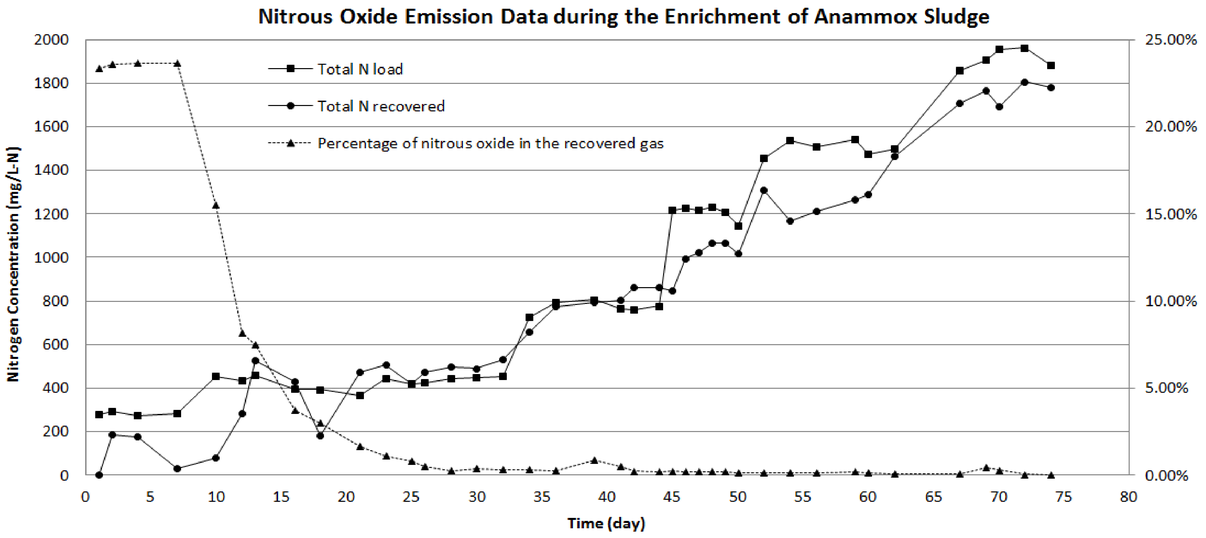
$$NH_4^+ + 1.32NO_2^- + 0.066HCO_3^- + 0.13H^+ = 1.02N_2 + 0.26NO_3^- + 0.066CH_2O_{0.5}N_{0.1}5 + 2.03H_2O$$

BENEFITS

This process usually coupled to the partial nitrification process, which in combine is an environmental friendly and sustainable process that has several advantages over the traditional nitrification and denitrification processes, such as the followings:

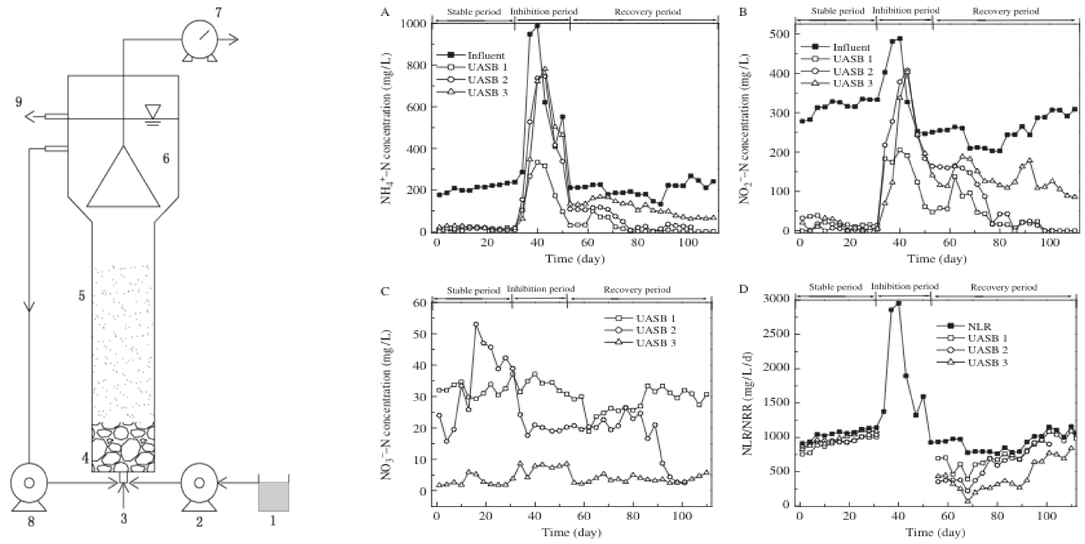
- Cost effective: No aeration required (less electricity consumption) and no external carbon sources addition (economical). **Energy saving up to 62.5%** when coupled with partial nitrification compared to traditional process.
- No excessive sludge production: Anammox bacteria grow by using CO_2 as the sole carbon source with a very low biomass yield.
- High efficiency: Maximum total nitrogen (TN) removal efficiency can reach 89%.
- Environmental friendly: very little green house gas (nitrous oxide) emission compared to traditional wastewater nutrient removal.

Greenhouse Gas Emission Study During the Enrichment of Anammox Granule



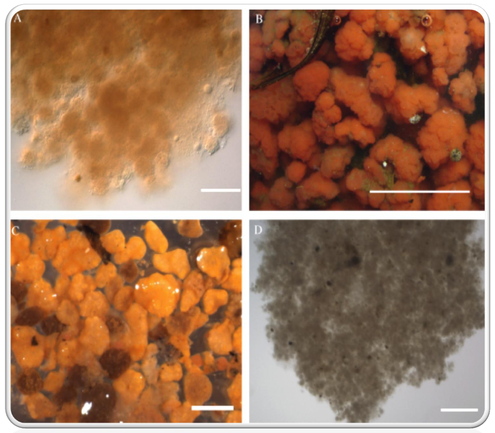
Progress to Date

In order to study the performance, inhibition and recovery processes of different types of Anammox sludge, three up-flow anaerobic sludge blanket reactors were inoculated with flocculent sludge, granular sludge, and cultured inactive methanogenic granules. During stable period, with nitrogen loading rates of 0.9–1.1 kg/m^3/d, the total nitrogen removal efficiencies of these reactors averaged at 86.5%, 90.8% and 93.5%, respectively.



PROMISING RESULTS

- Both the experimental data and model kinetics showed that reactor seeded with cultured inactive methanogenic granules possessed the highest nitrogen removal ability during stable operation, followed by granular Anammox reactor and flocculent Anammox reactor.
- The study suggested that a concentration as high as 988.3 mg NH_4^+-N/L and 484.4 mg NO_2^--N/L could totally inhibit granular Anammox bacteria and result in a inhibition of 50% flocculent Anammox activity.
- Reactors seeded with flocculent sludge and Anammox granules could be fully recovered by decreasing their influent substrate concentrations.
- The decrease of influent substrate concentration for the reactor with cultured inactive methanogenic granules could only restore about 75% of its bacterial activity.
- Free ammonia was a more appropriate indicator for the Anammox recovery process compared to free nitric acid.



Different types of Anammox sludge
(A) Flocculent sludge for UASB 1 (bar ¼ 50 mm).
(B) Granular sludge for UASB 2 (bar ¼ 1 cm).
(C) Cultured inactive methanogenic granules for UASB 3 (bar ¼ 2 mm).
(D) Sludge in UASB 1 after inhibition (bar ¼ 200 mm).