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Mitigating Nitrous Oxide Production from Nitritation/Denitritation: Treatment of Centrate from Pig Manure Co-Digestion as a Model

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Abstract : Economic incentives drive the implementation of short-cut nitrogen removal processes such as nitritation/denitritation (Nit/DNit) to manage nitrogen in waste streams devoid of biodegradable organic carbon. However, as any biological nitrogen removal process, the potent greenhouse gas nitrous oxide (N2O) could be emitted from Nit/DNit. Challenges remain in understanding the fundamental mechanisms and development of engineered mitigation strategies for N2O production. To provide answers, this work focuses on manure as a model, the biggest wasted nitrogen mass flow through our economies. A sequencing batch reactor (SBR; 4.5 L) was used treating the centrate (centrifuge supernatant; 2.0 ± 0.11 g N/L of ammonium) from an anaerobic digester processing mainly pig manure, supplemented with a co-substrate. Glycerin was used as external carbon source, a by-product of vegetable oil. Out-selection of nitrite oxidizing bacteria (NOB) was targeted using a combination of low dissolved oxygen (DO) levels (down to 0.5 mg O2/L), high temperature (35ºC) and relatively high free ammonia (FA) (initially 10 mg NH3-N/L). After reaching steady state, the process was able to remove 100% of ammonium with minimum nitrite and nitrate in the effluent, at a reasonably high nitrogen loading rate (0.4 g N/L/d). Substantial N2O emissions (over 15% of the nitrogen loading) were observed at the baseline operational condition, which were even increased under nitrite accumulation and a low organic carbon to nitrogen ratio. Yet, higher DO (~2.2 mg O2/L) lowered aerobic N2O emissions and weakened the dependency of N2O on nitrite concentration, suggesting a shift of N2O production pathway at elevated DO levels. Limiting the greenhouse gas emissions (environmental protection) from such a system could be substantially minimized by increasing the external carbon dosage (a cost factor), but also through the implementation of an intermittent aeration and feeding strategy. Promising steps forward have been presented in this abstract, yet at the conference the insights of ongoing experiments will also be shared.

Keywords : mitigation, nitrous oxide, nitritation/denitritation, pig manure
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