Nitrous Oxide, Methane and Ammonia Mitigation Trials in Swine Wastewater Purification

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1. Introduction

The animal sector handles a huge amount of organic material and N during feed production, feeding and manure treatment. CH_4 is produced when organic materials with high moisture content decompose under anaerobic conditions during manure storage. Nitrous oxide is generated on farms as an intermediate product of nitrification and denitrification by microorganisms in manure or wastewater and in soils.

With the growing worldwide demand for animal products such as meats, eggs and dairy, it is imperative that the animal industry develops methods to mitigate GHG emissions.

2. GHG mitigation from wastewater treatment

N_2O in particular is a potent greenhouse gas, accounting for 7.9% of global anthropogenic greenhouse gas emissions in 2004, and having an approximately 300-fold stronger effect than carbon dioxide (Intergovernmental Panel on Climate Change 2007). Kampschreur et al. (2009) reported that N_2O was emitted from various types of wastewater treatment. Online measurements suggest that N_2O emission is responsible for 0.01–90% of the total nitrogen load.

To develop treatment methods that reduce the amount of N_2O generated in the process of converting NH_4^+ within wastewater into N gas, we focused on and examined the biofilm method. The microbial reactions in this method differ from those of the conventional wastewater purification treatment method, or activated sludge (AS) method. A biofilm method uses carriers (materials that hold the microorganisms) to purify wastewater. We employed carbon fibers (CF) as carriers, because CF adhere strongly to microorganisms and are expected to hold them for longer and at higher concentrations than can be achieved with the AS method. Mitigation of nitrous oxide (N_2O) emission from swine wastewater treatment was demonstrated in an aerobic bioreactor packed with CF reactor (Yamashita et.al 2015, 2016). The CF reactor had a demonstrated advantage in mitigating N_2O emission and avoiding NOx (NO_3 + NO_2) accumulation. The N_2O emission factor was 0.0003 g N_2O-N/gTN-load in the CF bioreactor compared to 0.03 gN_2O-N/gTN-load in AS reactor.

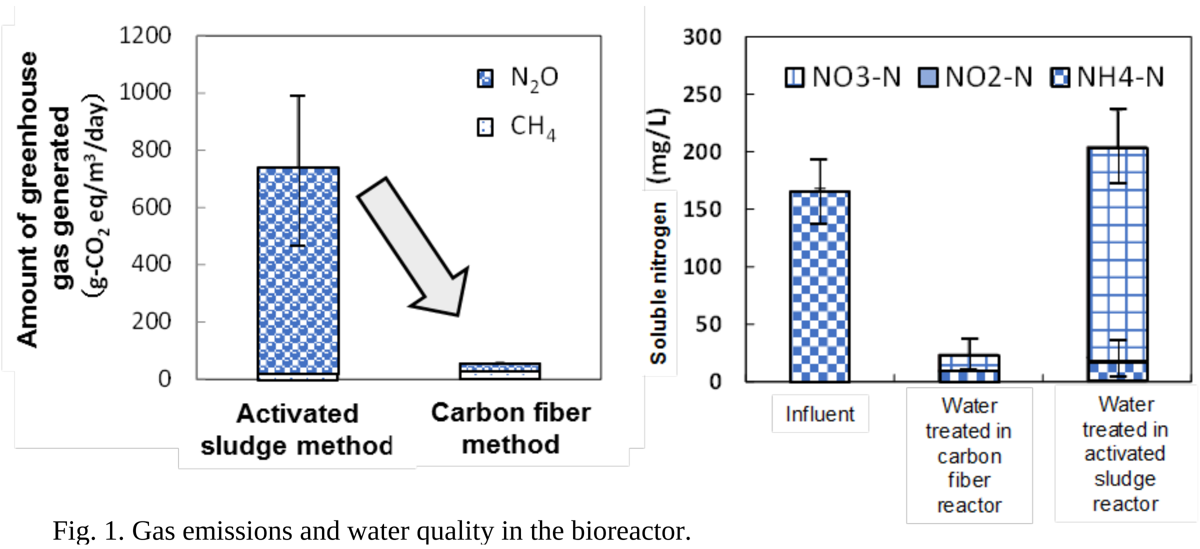

Fig. 1. Gas emissions and water quality in the bioreactor.

N_2O and CH_4 emissions from the CF reactor were 42 g-CO_2 eq/m^3/day, while those from the AS reactor were 725 g-CO_2 eq/m^3/day (Fig.1). The dissolved inorganic nitrogen (DIN) in the CF reactor removed an average of 156 mg/L of the NH_4-N, and accumulated an average of 14 mg/L of the NO_3-N. In contrast, the DIN in the AS reactor removed an average 144 mg/L of the NH_4-N and accumulated an average 183 mg/L of the NO_3-N. NO_2-N was almost undetectable in both reactors (Fig.1). The CF method can be introduced by loading CF carriers into existing AS treatment equipment. No special equipment needs to be newly installed, and this reduces the initial investment required. The CF method is therefore likely to be adopted for use on livestock farms.

Fig.2 The wastewater purification facility for swine waste surveyed in this study.

3. Conclusions

And, now CF reactor treatment are evaluating the cost-effectiveness of GHG regulation on farm. In the research project that began this fiscal year, the economical introduction strategies of GHG regulation measures for the domestic farm will be considered based on Life Cycle Assessment.

References

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