II-475 The Effect of Type of Organic Substrate on N_2O Production in Denitrification Process

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INTRODUCTION

Nitrous oxide (N_2O) is a key atmospheric gas, both for stratospheric chemistry and for global climate. Nitrification-denitrification process has been successfully used for different kinds of wastewater treatment. However, there are possibilities of N_2O release into the atmosphere as a by-product of nitrification, or as an intermediate of denitrifcation. Although there are estimations of N_2O emissions from tropical soils, marine sediments, nitrogenous fertilizers, the N_2O emission from wastewater has not yet been evaluated.

The previous study by the authors (Hanaki et al., 1992) showed that low COD/NO_3-N, short SRT and low pH were favorable conditions for N_2O production during denitrification using acetate as carbon source. However, it is believed that N_2O production depends on type of organic matter which determines the species of denitrifying bacteria. The present study aims at examining the effect of various carbon sources on N_2O production.

MATERIALS AND METHODS

Four experimental units (Fig. 1) were installed in a 25°C constant temperature room. Four kinds of substrate containing KNO_3 as nitrogen source, and yeast extract and four different organic matters as carbon sources were prepared (Table 1). Each kind of substrate was fed into a separate reactor. COD/NO_3-N ratio in the substrate was fixed at 2.5. Reactor pH was maintained at 6.5.

The following parameters were monitored : amount and content of produced gas, NO_3-N, NO_2-N and COD of the effluent.The dissolved N_2O flowing out with the effluent was also taken into account to estimate the total amount of N_2O production in following way. The dissolved N_2O (referred as D-N_2O) is product of partial pressure in gas phase (which is represented by N_2O fraction in the produced gas) and saturation concentration of N_2O, 734mg/l as N.

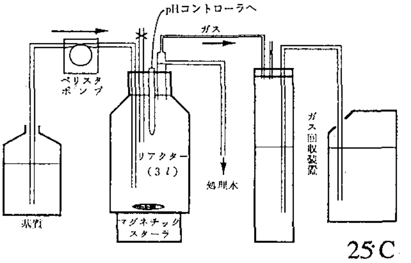

Fig.1 Experimental Unit

Table 1
Substrate Compsition in Denitrification Experiment

Acetate, Pepton, Glucose, or Methanol	909 mg/l as COD
Yeast Extract	91 mg/l as COD
KNO3	400 mg/l as NO3-N
KH2PO4	200 mg/l
CaCl2·2H2O	30 mg/l

RESULTS AND DISCUSSION

Three different SRTs were examined with each type of substrate. As wide range of SRT was already tested with acetate as substrate in the previous study, the SRT was varied from 1 day to 5 days with four substrates. Fig. 2 shows N_2O production in steady state with each substrate at various SRTs. N_2O production is expressed as its content in the nitrogenous gas : $N_2O/(N_2+N_2O)$.

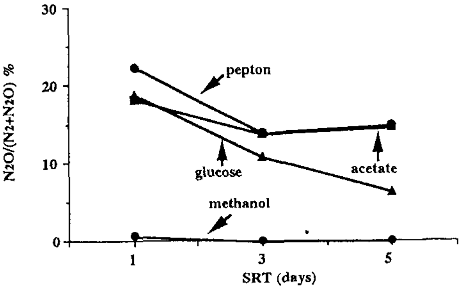

Fig.2 Production of N2O with Various Substrate and SRT

The experiments were started with a 3-days SRT. With methanol, N_2O production was only about 1% at the beginning of the operation. In contrast, much higher N_2O productions and more significant variations were observed with pepton, acetate, and glucose until the steady state was reached. Both pepton and acetate resulted in about 14% N_2O concentration in the gaseous phase, while slightly lower concentration (10%) of N_2O was observed from glucose as carbon source.

Reducing SRT down to 1 day resulted in the increasing of N_2O production. With pepton as the substrate, N_2O in the nitrogenous gas reached up to 22%. Both with glucose and acetate reached 18% of N_2O. With methanol, at steady state, only 1% of N_2O was observed. These results suggest that shorter SRT result in higher N_2O productions, even with organic matters such as methanol.

Upon increasing SRT up to 5 days, the N_2O production from glucose substrate was dramatically decreased by 2/3 (from 18.9% to 6.3%). With acetate and pepton substrates, N_2O production did not decrease as significantly as with glucose substrate.

These results indicate that type of organic matter isan important parameter that influences N_2O production. With organic matters similar to acetate and pepton, N_2O producing species could grow well, even at longer SRT ; whereas with other organic matters, such as glucose, the N_2O production depends more on SRT. Among the four substrates examined, methanol is the most suitable carbon source for avoiding N_2O production. The selection of N_2O producing species perhaps happen depending on the nature of substrate.

The fate of influent NO_3-N in steady state condition with acetate and glucose are illustrated in Fig.3 and Fig.4. With acetate as carbon source in the substrate, about 6% of influent NO_3-N was converted to N_2O. There was almost no effect of varing SRT on N_2O production. However, with glucose as carbon source, shorten SRT greatly affects the N_2O conversion rate. N_2O production accounted for up to 7.5% of influent nitrogen in this case. Although such N_2O conversion percentages may appear small, they are high enough to have a significant impact on global warming.

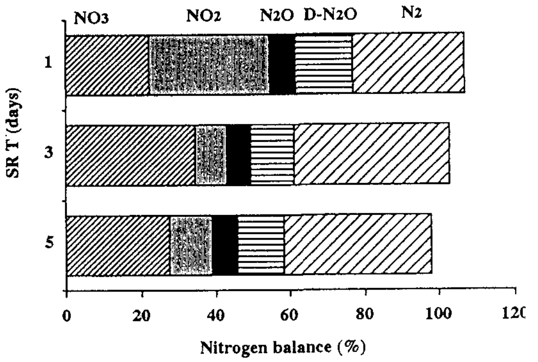

Fig.3 Fate of Nitrogen with Acetate as Substrate

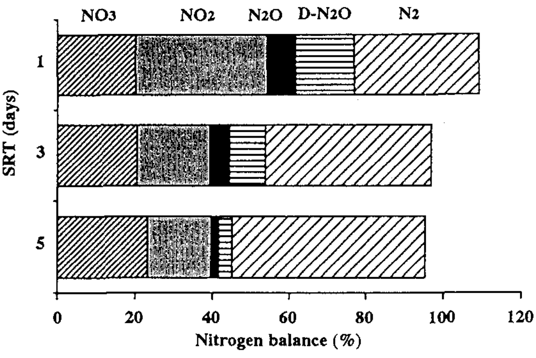

Fig.4 Fate of Nitrogen with Glucose as Substrate

SUMMARY

The produced N_2O gas could reach higher than 20% of the output nitrogenous gas, and up to 8% of the influent NO_3 during denitrification.The experimental data suggest that organic matter is an extremely important factor governing N_2O production. With acetate and pepton substrates, $N_2O$was released whatever the SRT, short or long.With glucose substrate, significantly higher N_2O production occurred with shorter SRT. Methanol substrate was the most suitable carbon source for preventing N_2O production.

REFERENCE:K. Hanaki, H.Zheng and T. Matsuo (1992). Production of nitrous oxide gas during denitrification of wastewater. Water Sci. Technol. Vol, 26, 5/6, 1027-1036.