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NITROUS OXIDE EMISSIONS FROM ONE-STEP PARTIAL NITRIFICATION/ANAMMOX PROCESSES

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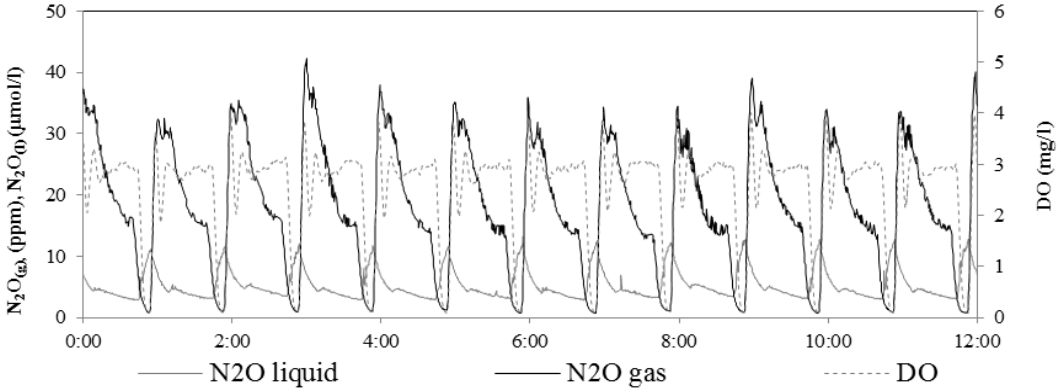
Among all greenhouse gases, nitrous oxide (N_2O) has gotten special consideration because its global warming potential is 300 times higher than for carbon dioxide. It is reported that N_2O can be produced in the biological nitrogen removal processes in the wastewater treatment plants (WWTPs). In most cases, nitrous oxide is the by-product of nitritation and denitrification reactions. Under limited oxygen or complete anoxic condition, nitrous oxide can be generated by AOB. Rapid changes in oxygen levels can stimulate AOB to produce N_2O. In this study, nitrous oxide measurements were carried out in pilot and full scale partial nitrification/anammox processes.

On figure below the dynamic changes of N_2O concentrations in both gas and liquid phase of full scale reactor is shown. With intermittent aeration, N_2O concentrations in the liquid and gas phases followed the oxygen supply pattern. When the aeration stopped, concentrations of N_2O in the gas phase decreased. However, the concentrations of N_2O in the gas phase never reached zero. It is assumed that during the non-aerated phase, a little amount of N_2O, produced in the liquid phase, could transfer into the gas phase. At the same time, most of the produced N_2O stayed in the liquid phase during non-aerated phase; therefore, an increase of N_2O level in the liquid could be observed. When the aeration started, a peak value of N_2O concentration in the gas phase was detected. The reason could be that a large amount of N_2O in the liquid phase was stripped out by the air and causing an increase of N_2O concentration in the gas phase. After the peak, N_2O in the gas and liquid phase reached a stable level. With the continuous aeration applied, N_2O concentrations in both liquid and gas phases showed stable. N_2O level in the liquid phase was much lower than its solubility in the water 1.5 mg/l at the same temperature, which means that a large fraction of the produced N_2O in the liquid phase was stripped out into the gas phase.

The average value of nitrogen load was 112gN/d and the nitrogen removal efficiency was 82% in pilot scale R1. Nitrous oxide emission in the gas phase was 0.6-1.88gN/d, which means that around 0.65-1.7% of nitrogen load was converted into nitrous oxide in the gas phase. N_2O in the liquid phase was 0.48 gN/d, which was around 0.043% of the nitrogen load. Nitrogen loads in R2 was around 84gN/d and N_2O concentration in the gas phase was 0.4-1.2 gN/d, which indicates 0.4-1.6 % of nitrogen load converted to N_2O in the gas phase. Nitrous oxide in the liquid phase was only 0.02% of nitrogen load. Full scale treatment process had nitrogen load of 188 kg N/d and the average nitrogen removal efficiency of 81%. The average value of nitrous oxide emissions was 1.31 kgN/d, which is corresponding to 0.7 % of the nitrogen load and 0.86% of the removed nitrogen.

Around 80-90% of nitrous oxide emissions were in gas phase and rest emitted in the liquid phase in the discharge both in the pilot and full scale reactors. Most of the nitrous oxide emissions happened in the aerated phase. Less than 8% of nitrous oxide emissions occurred in the non-aerated phase. Calculations also showed that most of the N_2O production happened in the aerated condition.



Keywords: N_2O emission, Partial nitrification/anammox process, Moving Bed Biofilm Reactor (MBBR)