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N_2O production dynamics in nitrifying/denitrifying activated sludge under defined environmental conditions

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Nitrous oxide (N_2O) is a gaseous pollutant emitted as an unwanted product in wastewater treatment plants during the nitrification-denitrification process. Even though the emission capacity of the process with respect to this compound is still under debate, N_2O has been identified as an important contributor to global warming and the destruction of the ozone layer. The present study makes use of unique datasets collected during controlled batch tests with activated sludge biomass to test and calibrate a pseudo-mechanistic model that predicts N_2O production by nitrifying and heterotrophic bacteria. The proposed model described successfully the observed N_2O production dynamics and confirmed that the availability of ammonia, low dissolved oxygen and nitrite accumulation were the main factors triggering N_2O production. Nitrifier-denitrification was proposed as the main pathway catalyzing the conversion of fixed nitrogen to N_2O. Heterotrophic denitrification rates were one order of magnitude lower than nitrification rates and contributed marginally to the overall N_2O production. Further data analysis allowed derivation of the overall mass transfer coefficients describing gaseous stripping and revealed that a minor portion of the N_2O produced was actually released to the gas phase. This work represents a step further in the use and calibration of process models to control and understand better N_2O production and emissions during conventional wastewater treatment.