UNISENSE
ENVIRONMENT

Nitrous oxide emissions from trickling filters

Nitrous oxide (N_2O) is a greenhouse gas (GHG) which is released from wastewater treatment plants (WWTP) during nitrogen removal.

Removing nitrogen is an essential function of WWTPs and there are many ways of constructing plants to achieve this. Therefore, it is important to understand the N_2O emission triggers in order to implement mitigation controls through changes of process parameters.

The triggers for N_2O release are well understood in some type of plants but information in scarce for other types of plants.

measure
to kN_2Ow

In the UK, trickling filters account for between 60-70% of the biological wastewater treatment units but information regarding N_2O emissions from trickling filters is limited, partly caused by the difficulties in capturing off-gases. Implementing a hood for gas collection and analysis has been applied to provide an estimate of N_2O emissions.

Unisense N_2O sensors have mainly been used for N_2O analysis in liquid but have also been applied for off-gas measurements[1] and thus present an opportunity for cost-effective monitoring off-gas N_2O concentrations. The N_2O Wastewater Sensor can be implemented for gas phase analysis in a hood as well as for liquid monitoring of the effluent to quantify the emissions from trickling filters (see Fig. 1).

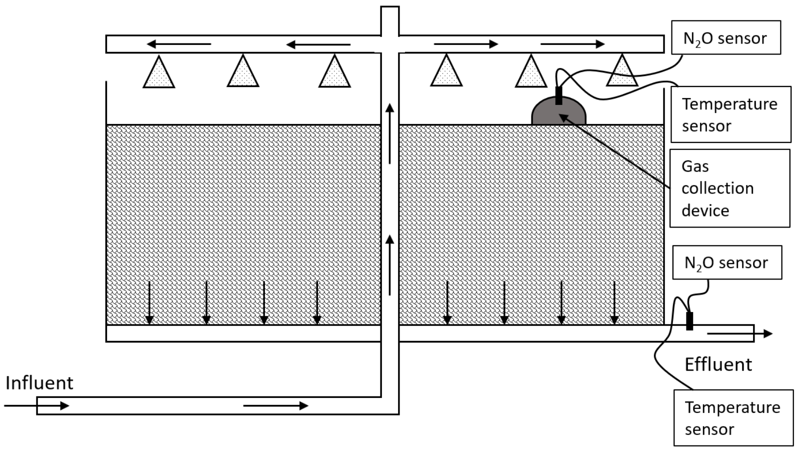

Figure 1

One of very few studies is Wang et al. (2014) who investigated the effect of temperature on N_2O emission from a trickling filter treating domestic wastewater. The N_2O emission was monitored during a year and it was observed that the emission was higher during the summer compared to winter. In trickling filters, where air is supplied through natural ventilation, the ventilation is driven by temperature differences. With limited temperature differences between air and water during summer, temperature becomes the governing factor for N_2O release since low air flow and oxygen limitation leads to incomplete nitrification and N_2O release.

A low COD/N ratio has been shown to lead to N_2O formation during denitrification but as nitrification is the dominant process in the trickling filter, it is not a significant factor for N_2O release. Søvik and Kløve (2007) also found that the N_2O release from a trickling filter was related to nitrification.

The air flow used for calculating N_2O emission was calculated according to *AR* = ε · u_s · f, where *AR* is the airflow ($m^3 \cdot s^{-1}$), ε the surface fluid velocity ($m \cdot s^{-1}$) and f the area of the trickling filter (m^2). They estimate an emission of 20.5-554 g $N_2O/(m^3 \cdot year)$, corresponding to 0.1%-0.8% of the oxidized ammonia released as N_2O-N. Studies are limited but Søvik and Kløve (2007) and references therein **report that 0.004-8% of the nitrogen load was released as N_2O-N.** Wang et al. (2014) suggest that a solution to limiting N_2O emission could be to control the O_2 supply to the trickling filter biofilm by relying on controlled ventilation instead of natural ventilation.

In conclusion, the lack of data and high reported emissions emphasize the need for further monitoring N_2O emissions from trickling filters. To implement N_2O monitoring, it is important to further develop a method for implementing N_2O measurements and constructing a N_2O emission model for this type of system. Monitoring the N_2O emission using the N_2O Wastewater Sensor will drive a deeper understanding of the N_2O release triggers in trickling filters and mitigate the N_2O emission.

References

[1]Marques et al. 2016. *Assessment of online monitoring strategies for measuring N_2O emissions from full-scale wastewater treatment systems*. Water Research 99, 171-179.

Søvik and Kløve. 2007. *Emission of N_2O and CH_4 from a constructed wetland in southeastern Norway*. Sci. Tot. Environ. 380, 28–37.

Wang et al. 2014. *Impact of temperature on nitrous oxide emission in a tricking filter*. Zhongguo Huanjing Kexue/ China Environmental Science 34, 2796-2804.

Version: April 2024

UNISENSE ENVIRONMENT

Nitrous Oxide process sensor for online wastewater treatment optimization, low-cost greenhouse gas reduction, and reliable sustainability accounting

Unisense Environment A/S

Web: www.unisense-environment.com
LinkedIn: Unisense Environment

E-mail: sales@unisense.com
Phone: +45 8944 9500

Office hours:
Monday-Thursday 8 am to 4 pm (CET)
Friday 8 am to 3.30 pm (CET).

measure to kN_2Ow