Influence of positioning of N_2O Wastewater Sensors: A case study from Kralingseveer WWTP, the Netherlands

Nitrous oxide (N_2O) emission from wastewater treatment plants (WWTP) is a significant contribution to global greenhouse gas (GHG) emissions. The Unisense Environment N_2O Wastewater Sensor offers an opportunity to directly monitor N_2O concentrations in wastewater which is essential for quantifying and mitigating its GHG contribution. The design and received wastewater vary between wastewater treatment plants which emphasizes the need for monitoring N_2O emission from individual plants. It is also important to ensure correct placement of the N_2O sensor to achieve representative data of N_2O emissions.

Kralingseveer is a WWTP treating domestic wastewater with a capacity of 360.000 PE. The plant consists of a primary aeration tank followed by two aeration tanks. The mixed liquor flows to the primary aeration tank. The primary aeration tank has an anoxic zone followed by an aerated zone where the majority of the nitrification/denitrification takes place. The influent then flows to the aeration tanks where it is aerated again. Kralingseveer has two aeration tanks that each has six lanes where two of them are aerated (Fig. 1).

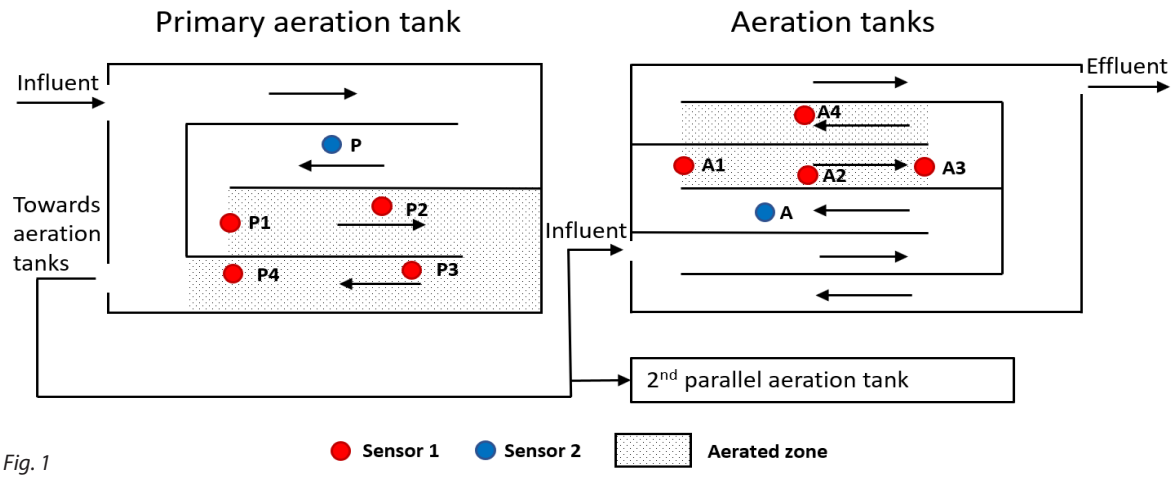

Fig. 1

N_2O monitoring was implemented in the primary aeration tank and aeration tanks. Two N_2O sensors were placed both in the primary aeration tank and in one of the aeration tanks. At each compartment, one sensor was placed in the aerated zone and the other sensor was placed in the unaerated zone (Fig. 1). N_2O emissions predominantly take place in aerated zones due to air stripping and the N_2O emission was assumed more variable in the aerated zone compared to the unaerated zone. In order to quantify and understand the variation in N_2O emissions in the aerated zone, different spots in the aerated zone were each monitored during the course of a week while the sensor in the unaerated zone was kept at the same position (Fig. 1).

In the primary aeration tank, four spots were monitored from the beginning to the end of the aerated zone (P1-P4) as well as one spot in the unaerated zone (P) (Fig. 1). Monitoring showed that N_2O emission were highest at the beginning of the aerated zone and lowest at the end. Overall emissions were higher in the aerated zone compared to the unaerated zone (Fig. 2A).

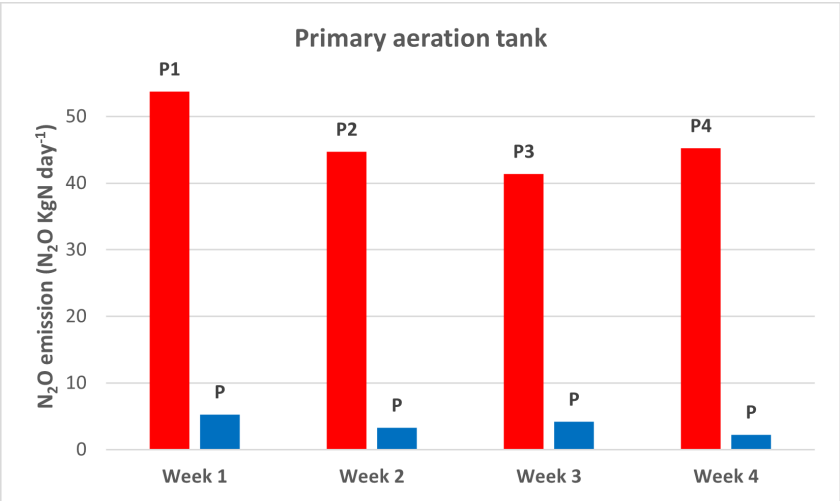

Fig. 2A

In the aeration tank, four spots were also monitored throughout the aerated zone (A1-A4) as well as one spot in the unaerated zone (A) (Fig. 1). This monitoring campaign showed that the N_2O emission was highest in the second half of the aerated zone while overall emission was higher in the aerated zone compared to the unaerated zone (Fig. 2B).

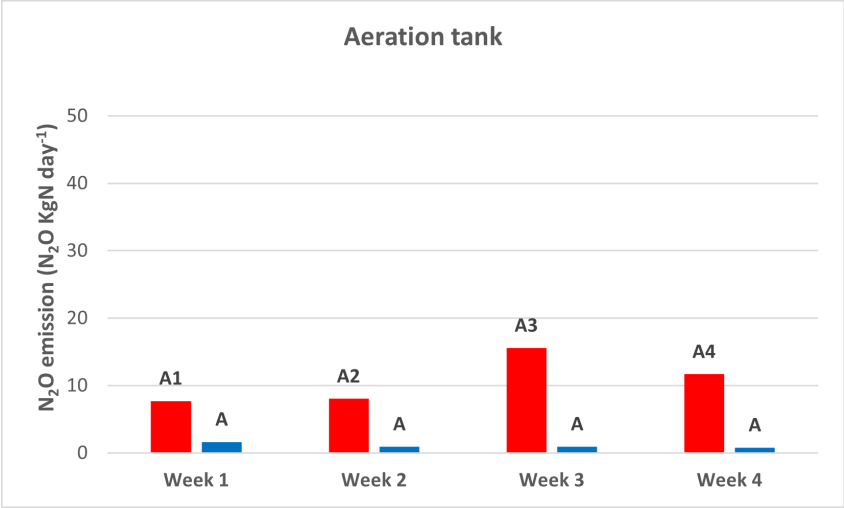

Fig. 2B

The N_2O emissions were higher from the higher loaded primary aeration tank compared to the aeration tanks. For both sections, the N_2O emissions were higher in the aerated zone and accounted for about 90% of the N_2O emission which emphasizes the need for focusing on the aerated zone. The scouting campaign showed that the position of the N_2O Wastewater Sensor in the aerated zone yielded differences in the measured N_2O emission. In the primary aeration tank, the emission varied with just 23% and all positions would offer a good estimate of the N_2O emission. The variation in the aeration tank was higher (50%) and the trend of increasing emission towards the end of the aerated zone could indicate a COD limitation which has been shown to increase N_2O emission. In that case, a representative position needs to be more carefully selected.

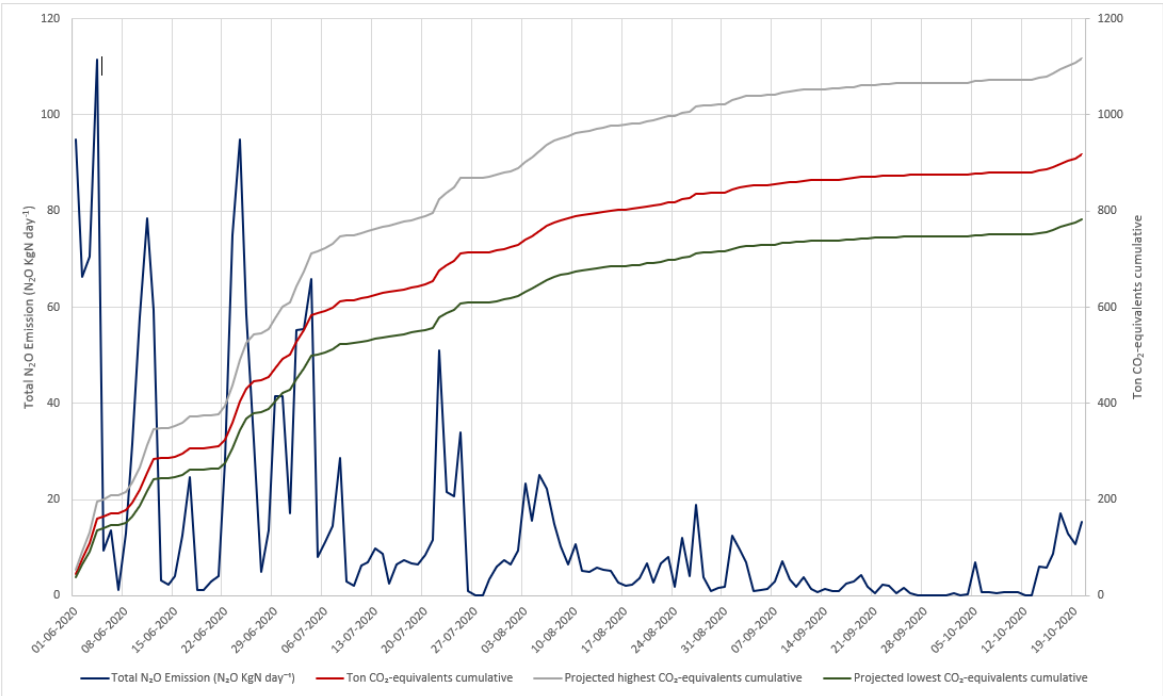

Fig. 3

After the scouting campaign was completed, a position representing an average value was chosen for long term monitoring in each aerated zone. In the primary aeration tank, a position between P2 and P3 was chosen and in the aeration tank, a position between A2 and A3 was chosen. Fig. 3 shows long term N_2O emission monitoring from the plant as well as cumulative CO_2-equivalents and projected cumulative CO_2-equivalents based on the highest and lowest emission estimates from the monitored positions. The lowest estimate leads to a 15% lower estimate of cumulative CO_2-equivalents whereas the highest estimate leads to 22% higher estimate of cumulative CO_2-equivalents. In conclusion, a good estimate can be achieved from several positions in the aerated zone, but a more carefully selected position will yield a higher accuracy.