Case: Frederikshavn Water Utility

N_2O Emission Monitoring Made Simple

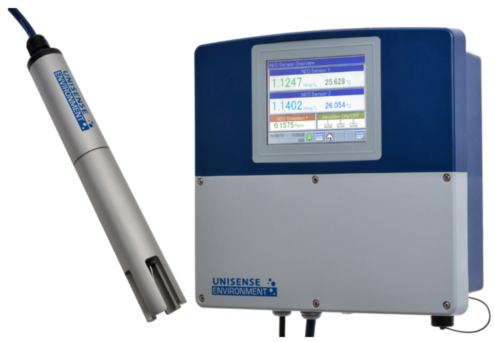
The municipal water utility "Forsyningen" located in Frederikshavn, Denmark has focused on the implementation of methodologies to better estimate and quantify greenhouse gas emissions from a number of different wastewater processes within their municipal wastewater treatment plants (WWTPs).

	Frederikshavn WWTP
PE	130.000 (split in two streams)
Influent	300 m^3/h
Anoxic Vol	1195 m^3
Aerated Vol	2290 m^3
COD, TKN, TP	2800, 240, 40 Ton/yr

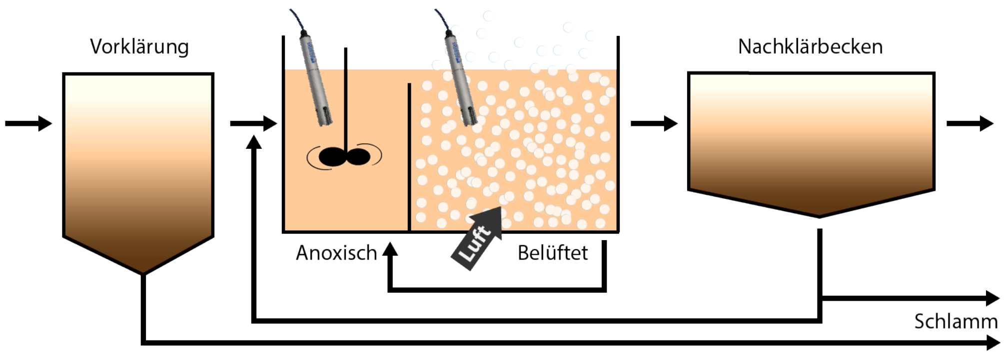
The utility runs both recirculation and biofilm wastewater processes. Due to increasing uncertainty in using emission key numbers, the utility contacted Unisense Environment for assistance in determining the actual N_2O derived CO_2 footprint. As the foundation for the new initiative, the N_2O emission from a standard recirculation was firstly monitored.

In order to save energy and increase the N-removal capacity, the aerobic zone was operated with intermittent aeration, allowing denitrification in the aerated zone depending on the ammonium levels in the tank. Unisense Environment installed two N_2O Wastewater Systems, one placed in the anoxic tank and the other in the aerobic tank. To facilitate the understanding of the N_2O formation, N_2O sensor data was logged with all other plant data though a standard integration with the SCADA system.

Following a quick 2-point calibration procedure, the sensors were left to monitor N_2O levels. After a 14 day measuring period a full data series extracted from the SCADA system was sent to Unisense Environment for data analysis. Using different data managing tools the overall correlations and in particular the N_2O production were documented.



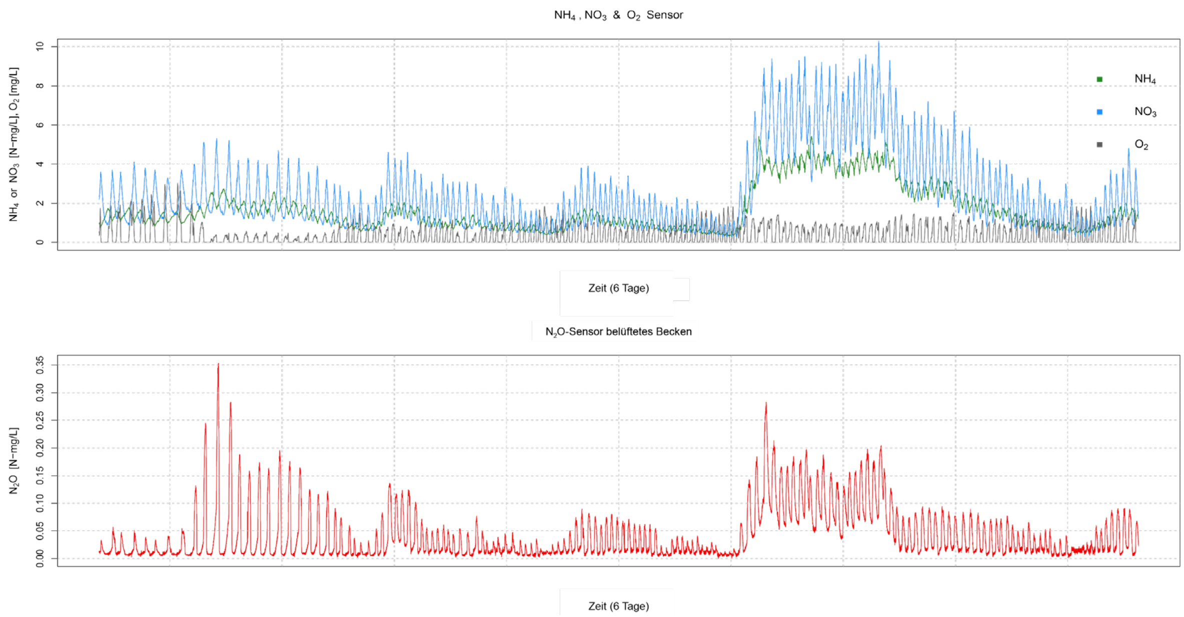
N_2O Wastewater System



Standard recirculation setup at Frederiskhavn WWTP

From the 14-days period it was clear that the variation in N_2O emission is extensive. The main emission over the period was linked to two high load events that led to 53% of the total N_2O emission during 42 hours out of the 14 days. Furthermore, low dissolved oxygen set points in the beginning of the campaign led to a significant increase in the N_2O concentration, clearly stressing the correlation between low oxygen and N_2O formation. During the analyzed period the N_2O formation in the anoxic tank was very low and only during a high ammonium period did the N_2O concentration increase to 0.3 N-mg/L for 30 hours. In the aerated part N_2O was mainly produced during the anoxic phases introduced by the intermittent aeration and subsequently stripped to the atmosphere by the aeration.

Finally, emission calculations were performed using peer reviewed and validated models to assess the N_2O emissions and derived CO_2-equivalents. This was compared with the aeration power derived CO_2-equivalents and presented to the management of the water utility as part of a 2-day consultancy service. The total carbon footprint from the period was calculated to be 10 ton CO_2-equivalents with N_2O derived CO_2 accounting for 59% of the total emission.

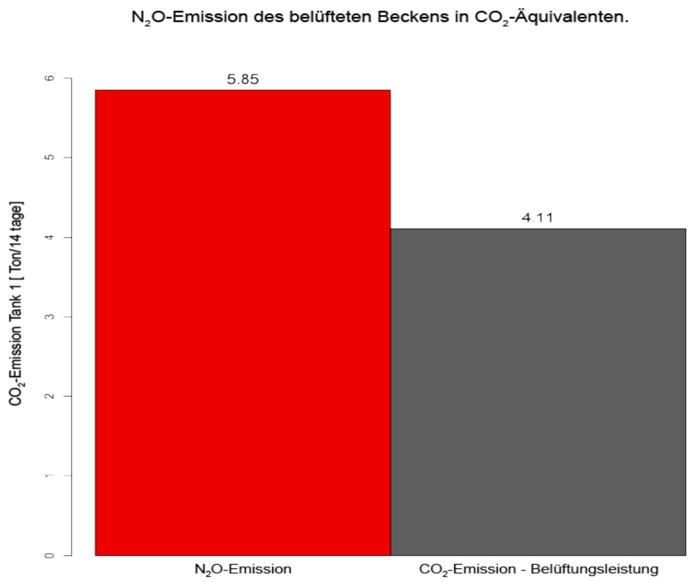


A 6 day section of the 14 day measuring period. NH_4, NO_3, O_2, and N_2O data series are plotted and include the low O_2 set point and one of two high load periods.

From the short monitoring and data analysis campaign a short list of problems and possible solutions was derived.

- The N_2O concentration and emission is highly variable.
- Dissolved oxygen control is important to avoid elevated N_2O production and emission.
- Short periods of high ammonium loads should be avoided by balancing the influent load.
- Control strategies with COD enhanced denitrification can potentially diminish the N_2O emission.
- Energy optimization using pause-aeration strategies must be coupled with N_2O monitoring to avoid excessive N_2O emissions.

With a small investment the utility has gained a real insight into the source and causes of their N_2O derived emissions and can now act towards minimizing their climate impact from N_2O.



Cumulated CO_2 emission over 14 days derived from the calculated N_2O emission and from the kWh used for aeration. CO_2 equivalent factors used: 296 kg CO_2 /kg N_2O and 0.418 kg CO_2 / kWh used.