

The N₂O came from **incomplete denitrification**, and a control change cut it sharply

N₂O from denitrification

Frederikshavn · North Jutland · Denmark



KEY FACTS

- In the intermittent tank, N₂O rose sharply at the start of each aeration phase and fell during nitrification, indicating the unaerated denitrification phases are the source.
- Process-data analysis indicated the formation was driven by incomplete denitrification, with nitrate accumulating in the tank.
- After the change the emission factor fell from 2.17% to an estimated 0.55% (about 75% lower), with an estimated 20-30% less residual nitrate and no new hardware.

PROJECT AT A GLANCE

2.17%

CAMPAIGN EMISSION FACTOR

~0.55%

EMISSION FACTOR AFTER, ESTIMATED

≈291 t

N₂O AS CO₂e, CAMPAIGN (77 DAYS)

≈74 t

AFTER, SAME BASIS (ESTIMATED)

≈135,000 PE · activated sludge with N + P removal

1 The question

Frederikshavn Renseanlæg (about 135,000 PE) treats municipal wastewater, among others in an intermittently aerated activated-sludge tank, and its nitrogen removal was already very good and stable. Off-gas analysis with EmiCo lite over a 77-day campaign gave deeper insight and clear, actionable recommendations.

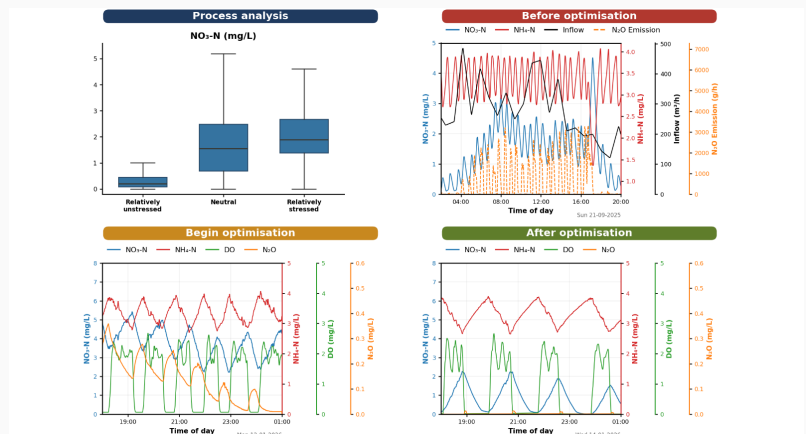
2 What the monitoring showed

Continuous monitoring revealed a characteristic emission pattern: N₂O concentrations rose sharply at the beginning of each aeration phase and declined during nitrification, indicating that the emissions originated from the unaerated denitrification phases. Process-data analysis identified nitrate accumulation as the key indicator of incomplete denitrification, pointing to insufficient nitrate removal as the underlying cause of the elevated N₂O emissions. Over the campaign, the emission factor averaged **2.17%**.

3 What changed

Based on an online nitrate measurement, the denitrification phases were extended and the influent was timed to match them. This enabled more complete denitrification, prevented nitrate accumulation and substantially reduced N₂O emissions. Across the months after the control change, the emission factor is estimated to have decreased from **2.17% to about 0.55%** (≈75% lower). Residual nitrate is estimated to have decreased by **20-30%**, improving nitrogen removal, while the control change required no new hardware and cost only about **670 EUR**.

TYPICAL EMISSION PATTERN: N₂O PEAKS AS AERATION STARTS



Continuous monitoring first identified nitrate accumulation as the main indicator of incomplete denitrification. Based on these findings, the denitrification phases were extended using online nitrate measurements. This led to more complete nitrate removal and a substantial reduction in N₂O emissions.

THE TAKEAWAY

The emission pattern pointed to one root cause: **incomplete denitrification**. Adjusting the control based on online nitrate measurement let denitrification finish and cut N₂O sharply: the emission factor fell from 2.17% to an **estimated 0.55%** (about 75% lower), cutting the campaign N₂O from roughly **291 to about 74 tCO₂e**, with no new hardware. Continuous monitoring turned a hidden cause into a precise, actionable fix.