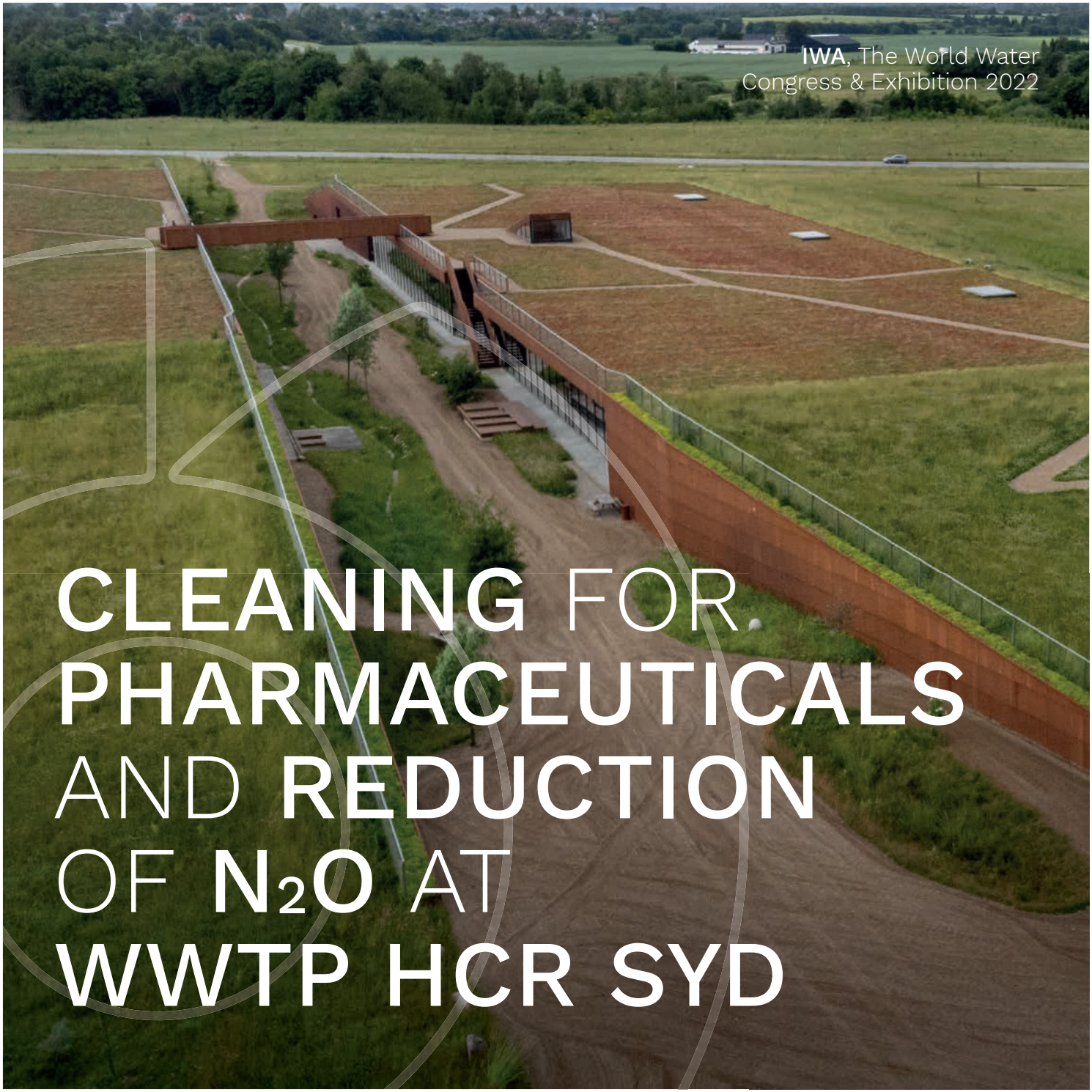


IWA, The World Water Congress & Exhibition 2022

CLEANING FOR **PHARMACEUTICALS** AND **REDUCTION** OF **N_2O** AT **WWTP HCR SYD**

Cleaning for pharmaceuticals at WWTP HCR syd

Pilotplant with ozonation and granular activated carbon (GAC) filtration.

Jørgen Skaarup and Britta Sevelsted Lauritzen from Hillerød Utility

The BAT technology chosen is ozonation followed by Granular Activated Carbon (GAC) filtration.

The Predicted No Effect Concentration (PNEC) is a suggested concentration for a substance below which no unacceptable effect on ecosystems is likely to occur. The PNECs are intended to be conservative and are usually derived assuming that the ecosystems are as sensitive as the most sensitive species in them.

Pharmaceutical concentrations in the effluent of HCR Syd

Measured concentrations of pharmaceuticals in the effluent of the HCR Syd in the pilottest (n=45) are provided in figure 1. Among the 52 monitored pharmaceuticals, 32 were measured above the LOQs. Their average concentrations ranged from 0.02 to 7.88 µg/L (Figure 1). The most prominent, exceeding the average of 0.5 µg/L were blood pressure remedies furosemide and metoprolol, anticonvulsant/ antidepressant gabapentin, analgesic tramadol, wide-spectrum antibiotic sulphapyridine, antidepressant venlafaxine and three iodinated x-ray contrast media: iohexol, iopamidol and iomeprol.

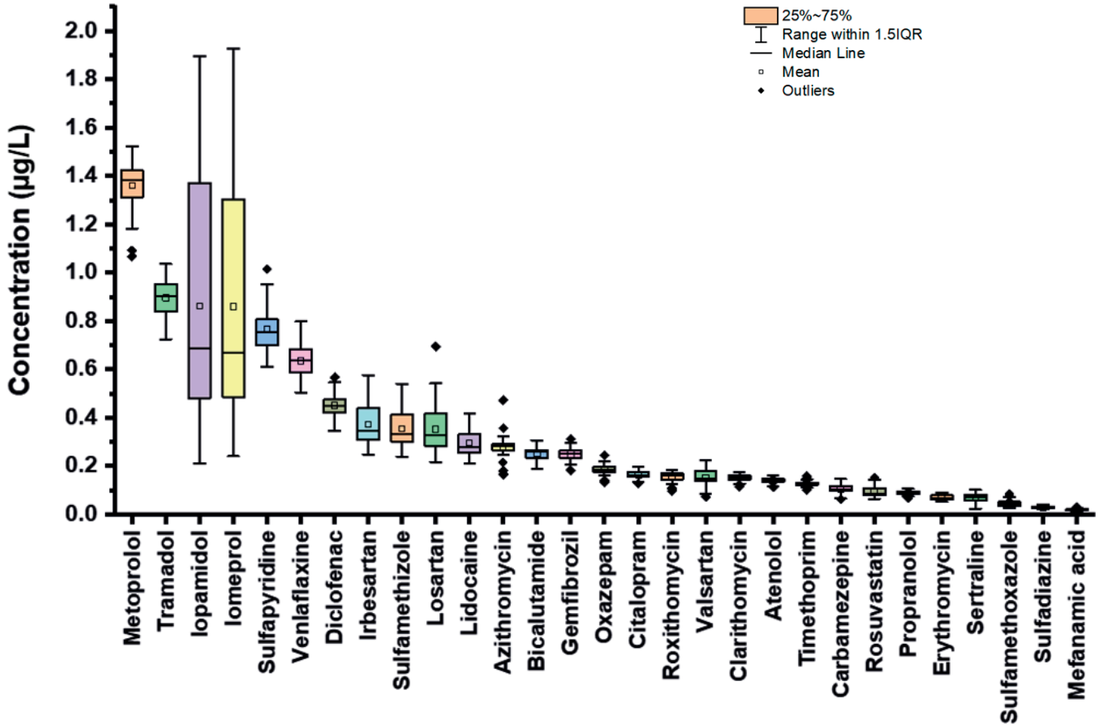


Figure 1. Pharmaceutical concentrations in effluent from HCR Syd

Pilotplant

The goal for the pilotplant has been to clean below PNEC for all measured pharmaceuticals.

The combination of both technologies achieves removal for all measured pharmaceuticals below the requirement of PNEC values.

Combination of ozonation and GAC filtration

The pharmaceuticals identified as limiting operation of GAC (clarithomycin and venlafaxine) did not match with the pharmaceuticals identified as limiting operation of ozonation (bicalutamide, oxazepam and metoprolol). We therefore suggest that combination of the two technologies meet the purpose of the total compound removal below the PNECs. To illustrate that, Table 4 presents extrapolation of the main GAC limiting compound – clarithomycin. The GAC would not be required after pre-treating the compound with specific ozone dose of 0.35, which is below the recommended dose of 0.51 for the operation.

Table 4. Required removal of clarithomycin to reach the PNEC after treatment with ozonation

Specific ozone dose	Ozonation effluent concentration (µg/L) Figure 4)	PNEC (µg/L)	in. further removal required to reach the PNEC (%)	AC capacity to maintain the required removal (BV)*
0	0.15	0.06	60	3 200
0.10	0.06		0	GAC not required
0.30	0.01		< 0	GAC not required
0.51 and above	<LOD		< 0	GAC not required

* Clarithromycin not treated with ozone is removed below PNEC with up to 3200 bed volume (BV) application of GAC. Pre-treatment with ≥ 0.1 mg O_3/mg DOC eliminates further treatment necessity.

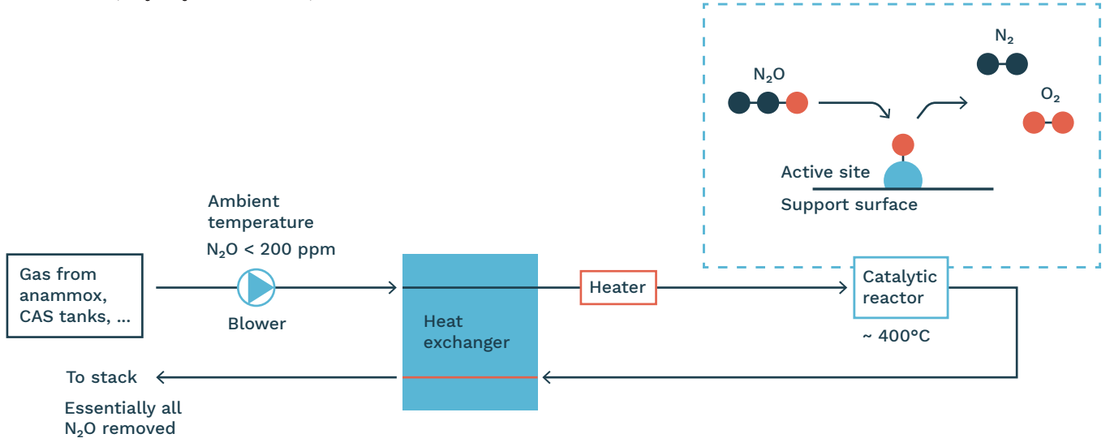
NACAT
Nitrous oxide Abatement by CAtalytic Treatment

Wastewater treatment plants (WWTPs) contribute to climate change through indirect emissions (from energy production and others) and direct emissions, such as gaseous emissions of nitrous oxide (N_2O) or methane (CH4). Direct emissions of N_2O are of great concern as it is a potent greenhouse gas with a global warming potential 265 times higher than CO_2. Nitrous oxide is formed in areas where nitrogen is converted through biological processes, primarily through three processes, nitrifier nitrification, nitrifier denitrification and heterotrophic denitrification pathways with an emission factor of 0,84% of TN to the WWTP (Miljøstyrelsen, 2020).

NACAT is a Danish project investigating the possibility to reduce or even eliminate N_2O emissions from WWTPs by catalytic treatment.

Catalysis pilot set-up design by Haldor & Topsøe will be installed in off-gas systems at three WWTPs, VandCenter Syd, Tårnby & Hillerød forsyning, utilizing that the treatment processes are covered and with process ventilation.

NACAT is supported by MUDP.



Project goals:

1. Test feasibility of catalytic N_2O abatement at three different study sites with covered CAS and/or anammox processes.
2. Test performance of existing odor treatment installations (activated carbon/biological filter) for N_2O reduction in comparison to the catalysis method.
3. Develop a set of mathematical models (digital twins) and sustainability assessment methods to virtually predict process performance and serve as a decision tool for balancing variables such as effluent quality, energy consumption, cost, and N_2O emissions simultaneously.
4. Assessment of the environmental impact of implementing such technologies and develop management strategies, primarily through process optimization, to monitor N_2O emissions from the biological processes at wastewater treatment plants.
5. Build business case scenarios for the catalytic technology with linkage to future national and international regulation.

Expected Impact:

- Short-term: 80% reduction of the N_2O emissions from Ejby Mølle, Hillerød and Tårnby WWTPs equaling savings of ~ 5.000 tons CO_2 eq/year.
- Mid-term: 80% reduction of N_2O at all covered side stream deammonification reactors in DK (approx. 15) equaling extra savings of ~14.000 tons CO_2 eq/year.
- Long term: 80% reduction of the N_2O emissions from the four largest WWTPs in Denmark equaling reduction of up to 23% in emitted CO_2 eq (from N_2O) from the whole wastewater sector ~38.000 tons CO_2 eq/year.

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