Monitoring and mitigation of process gas emission in wastewater treatment plants

POSITION PAPER ON THE EU URBAN WASTEWATER TREATMENT DIRECTIVE (UWWTD) REVISION
As technology and application experts, we welcome the latest ambitious proposal for a revised Urban Wastewater Treatment Directive (UWWTD). However, we now feel there is a need to specifically address the monitoring and mitigation of process gas emissions and suggest important amendments to the UWWTD proposal to address this.

Emissions of process gases, i.e., nitrous oxide (N\textsubscript{2}O) and methane (CH\textsubscript{4}), from wastewater and sludge treatment make up 60-70% of the GHG from wastewater treatment plants. N\textsubscript{2}O emissions represent a global warming potential 273 times higher than that of carbon dioxide. Technologies to monitor and mitigate N\textsubscript{2}O emissions have been developed in last 2 decades and successful case studies of their application are available in this paper.

The revision of the Urban Wastewater Treatment Directive presents an important opportunity to address the monitoring and mitigation of N\textsubscript{2}O emissions, paving the way for the wastewater treatment sector’s contribution to EU’s Climate Law targets.

We strongly recommend the inclusion of monitoring requirements for emissions of all process gas, including N\textsubscript{2}O and CH\textsubscript{4}, in the revised Directive, outlined in more detail in this paper.

Summary
As technology and application experts, we welcome the latest ambitious proposal for a revised Urban Wastewater Treatment Directive (UWWTD). With this paper, we highlight the following facts and core element for improvement regarding monitoring and mitigation of process gas emissions in wastewater treatment plants:

- Emissions of process gases, i.e., nitrous oxide (N\textsubscript{2}O) and methane (CH\textsubscript{4}), from wastewater and sludge treatment make up 60-70% of the GHG from wastewater treatment plants.
- N\textsubscript{2}O emissions represent a global warming potential 273 times higher than that of carbon dioxide.
- Technologies to monitor and mitigate N\textsubscript{2}O emissions have been developed in last 2 decades and successful case studies of their application are available in this paper.
- The revision of the Urban Wastewater Treatment Directive presents an important opportunity to address the monitoring and mitigation of N\textsubscript{2}O emissions, paving the way for the wastewater treatment sector’s contribution to EU’s Climate Law targets.

We strongly recommend the inclusion of monitoring requirements for emissions of all process gas, including N\textsubscript{2}O and CH\textsubscript{4}, in the revised Directive, outlined in more detail in this paper.
of their biological process. For example, recent full-scale work in Australia, Denmark and The Netherlands reported emissions reductions of 35%\(^7\), 74%\(^8\) and 90%\(^9\), respectively, in published studies.

Beyond the application of demonstrated mitigation approaches, there are significant opportunities to further develop treatment technologies, optimize the harvesting of resources, and prevent the generation of nitrous oxide – this potential remains very much untapped but, critically, it also requires an understanding of nitrous oxide emissions through site-level monitoring. Only with a requirement for nitrous oxide monitoring in the monitoring obligation of the UWWTD proposal will Member States be able to support near-term mitigation and accelerate the technology development required for advanced wastewater treatment - for example to technologies that do not produce nitrous oxide. This opportunity is currently missing in the UWWTD proposal.

In addition, conventional biological treatment technologies with high N\(_2\)O-emissions are widely implemented in Europe and it would not be realistic to replace them all with zero-emission treatment technologies (if these existed) within the next 50 years. Therefore, it is of critical importance to simultaneously advance wastewater treatment and implement today’s monitoring and mitigation solutions to start minimizing emissions from our current and future infrastructure through process optimization, while gradually retrofitting them into zero-emission treatment technologies.

To provide the opportunity to reduce the potent greenhouse gas emissions from wastewater treatment, we recommend Member States be required to monitor the emissions of all process gas, including nitrous oxide, produced by the operational activities of the water utilities, in addition to the energy used and produced by urban wastewater treatment plants of above 10 000 p.e.

---

\(^1\) Monitoring, modelling and mitigating nitrous oxide emissions. Market Map, GWI Magazine, December 2022

\(^2\) Evaluation of greenhouse gas emissions from the European urban wastewater sector, and options for their reduction, Science of the Total Environment 838 (2022) 156322

\(^3\) https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/ N\(_2\)O and CH\(_4\) have global warming potential of 273- and 30-times that of CO\(_2\) for 100-year time horizon according to IPCC AR6 2021


\(^5\) Baresel et al., (2016) Comparison of nitrous oxide (N\(_2\)O) emissions calculations at a Swedish wastewater treatment plant based on water concentrations versus off-gas concentrations, Advances in Climate Change Research 7


\(^7\) Duan et al. (2020) https://pubmed.ncbi.nlm.nih.gov/32738601/ which resulted in a 35% reduction in N\(_2\)O emissions and 20% aeration energy reduction.

\(^8\) Andersen et al., (2022) https://unisense-environment.com/applications/direct-effect-of-activated-sludge-concentration/ - which undertook a 2 year testing period for full scale mitigation with 74% reduction realised relative to reference lanes in a 12 month period.
