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PTR-MS-Based Emission Profiling of the CESAR1 Solvent: First Insights from the 2025 AURORA Project at TCM

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Abstract

The AURORA project (Accelerated Deployment of Integrated CCUS Chains based on Solvent Capture Technology; https://aurora-heu.eu) is an EU-funded initiative dedicated to advancing post-combustion CO_2 capture through the optimization and commercial qualification of CESAR1 – a non-proprietary, aqueous solvent blend of 2-amino-2-methylpropan-1-ol (AMP) and piperazine (PZ). CESAR1 has emerged as a leading alternative to conventional amine systems due to its superior energy performance and capture efficiency. One of the core objectives of the AURORA project is to demonstrate that CO_2 capture using the CESAR1 solvent can be achieved with minimal environmental impact, placing particular emphasis on the identification, quantification, and mitigation of amine emissions and their degradation products.

As a key partner in the AURORA project, Technology Centre Mongstad (TCM) – the world's most advanced open-access CO_2 capture test facility – provides a critical platform for large-scale testing and environmental qualification. Since its establishment, TCM has consistently prioritized the use of advanced emission monitoring technologies. As part of this effort, it has engaged the University of Oslo to implement proton-transfer-reaction mass spectrometry (PTR-MS), which is regarded as the most sophisticated real-time emission monitoring technique for amines and amine degradation products available today. PTR-MS offers unmatched sensitivity, capable of detecting a broad spectrum of volatile and semi-volatile compounds – including parent amines and degradation products – at concentrations ranging from ppm down to single-digit ppt, with a temporal resolution of one minute. The PTR-MS technique was initially introduced at TCM over a decade ago as a research-grade tool and has since evolved into a routine monitoring method used at post-combustion carbon capture sites around the world. In the upcoming AURORA campaign (April–June 2025), a PTR-MS instrument will be deployed at TCM to conduct comprehensive, high-resolution emission monitoring during CESAR1 operation. Building upon previous work during the ALIGN-CCUS campaign, the study will target real-time quantification of AMP and PZ, as well as of key degradation products (*e.g.*, formaldehyde, acetaldehyde, acetonitrile, methylamine, formamide, morpholine, 4,4-dimethyloxazolidine, nitrosopiperazine). The resulting dataset – focusing on emission profiles, short-term variability, and implications for mitigation – will be shared openly with the research community. These insights will be vital for informing regulatory frameworks, and supporting the safe, large-scale deployment of CESAR1.

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