Influence of Flue Gas Contaminants on Solvent Stability and Performance in Amine-Based CO_2 Capture

Svenja Knösch[1]*, Lukas Anthofer[1], Theresa Hauth[1], Hartmut Spliethoff[1], Sebastian Fendt[1]

[1]Chair of Energy Systems, TUM School of Engineering and Design, Technical University of Munich, Germany
**Corresponding author: svenja.knoesch@tum.de*

Abstract:
Mitigation of CO_2 emissions from point sources requires effective post-combustion carbon capture. Chemical absorption using amine-based solvents has been the industrial standard for decades, yet solvent regeneration remains highly energy-intensive. Moreover, elevated temperatures and oxygen in the flue gas promote amine degradation, reducing capture efficiency and increasing operating costs. While thermal and oxidative degradation pathways are well documented, the impact of additional flue gas impurities is less comprehensively understood.
This study investigates the degradation behavior of amines in the presence of representative flue gas contaminants, including HCl, NO_2, and SO_2. These species not only impair CO_2 absorption performance but also induce the formation of degradation products.
The contribution presents the experimental setup and results from multi-cycle absorption–desorption experiments, focusing on changes in CO_2 loading capacity and the qualitative and quantitative profiles of degradation byproducts. To reduce experimental effort, a modeling approach is used to predict degradation trends across cycles. Finally, long-term tests are analyzed to assess how impurities influence solvent corrosiveness.
The findings contribute to a deeper understanding of impurity-driven solvent degradation and provide guidance for improving the robustness and efficiency of future amine-based CO_2 capture systems.

Topics:
Amine degradation caused by flue gas impurities and subsequent formation of degradation products in absorption–desorption cycles

Keywords:
CO_2 Absorption, Amine Stability, Degradation, Corrosiveness