

## ACT LAUNCH Project No 299662



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Lowering **A**bsorption process **UN**certainty, risks  
and **C**osts by predicting and controlling amine degradation

Public Summary of D.3.3.2 Memo describing the results of the volatility  
of degraded solvents using the simple boiling method

<b>Dissemination level</b>	Public	
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## Introduction

Absorption-based carbon capture with amine solvents is now a proven technology. However, potential emissions of amine solvent and volatile degradation compounds are real problems; therefore, it is essential to control them [1]. These emissions formed in the absorber depend on the solvent composition (volatility of the solvent and its degradation products), the absorber design, and operating conditions. Concerning MEA, a considerable amount of (volatile) degradation compounds are known [2]. Some of these degradation products are known to be volatile, but this knowledge is the result of years of research. In the race to develop the next generation solvents, it is essential to identify the volatile degradation compounds of potential solvent candidates in the early stage of development, in a short time and before piloting.

This public summary summarizes the work performed in the LAUNCH project in task T3.3.2 related to developing a simple and quick method to identify the volatile degradation products of a given (novel) solvent in a qualitative and semi-quantitative way. This summary describes the tested experimental approach.

A journal publication is planned, and the results will be made available on this page after acceptance of the manuscript.

## Methodology and results

Nitrogen (N<sub>2</sub>), purity >99.7%, was used to carry the volatile compounds out of the round-bottom flask (by bubbling and entrainment) during the boiling experiment. Sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) solutions were prepared from a Titrisol® ampoule (Merck). 2,4-dinitrophenylhydrazine (DNPH) cartridges from Waters® were used to capture volatile aldehydes and ketones.

This work used two different CO<sub>2</sub>-loaded degraded solutions: an oxidatively degraded 30wt% MEA solution and a 40wt% MEA degraded solution degraded in a cycled degradation setup [4] where both oxidative and thermal degradation happens. The degradation setups that were used to degrade the solutions have been described in detail previously with the experimental procedures (Høisæter et al. [3], Einbu et al. [4]).

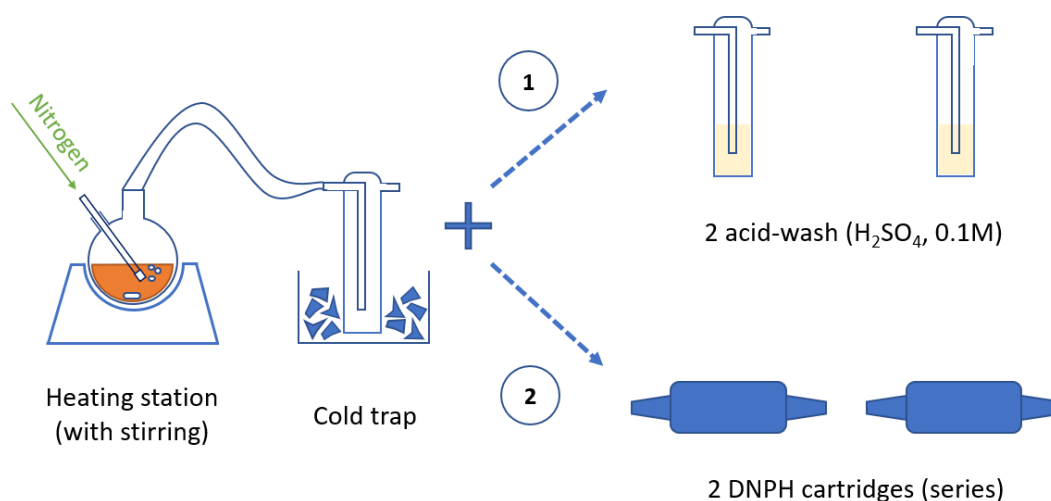
The setup used for the simple boiling method experiments consisted of 200 mL of the tested solution in a 250 mL round-bottomed, three-neck flask placed in a heating mantle. The central neck and only exit for the gas phase were connected to a cold trap consisting of a wash bottle placed in a crystallization bowl filled with crushed ice. The second neck of the flask was occupied by a sparger fitted with a fine sinter and used to deliver a constant stream of nitrogen. The nitrogen was sparged into the degraded solution to facilitate the carryover of the volatile components. The flow rate used was approximately 100mL/min. The third neck was fitted with a thermometer to monitor the liquid temperature.

Two different configurations were used. For the first configuration, the cold trap was connected to two wash bottles connected in series containing a 0.1M sulphuric acid solution (approximately 100mL each). The second configuration had two DNPH cartridges connected in series at the outlet of the cold trap. Both configurations are presented in Figure 1.

Each experiment was divided into two parts: one run with a train of acid wash bottles and another with a train of DNPH cartridges (Figure 1).

The collected samples (solvent, condensate, and acid wash) were analysed by LC-MS, using a method developed by SINTEF, for 40 known MEA degradation products and MEA itself. The DNPH cartridges were analysed by column chromatography. The CO<sub>2</sub> loading of the solvent samples was determined using a Total Organic Carbon (TOC) Analyzer (Shimadzu).

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**Figure 1: Simple boiling method setup description**

A total of 41 components were analysed from the AW bottles, including MEA and 40 known degradation products, while during DNPH cartridge runs, three different components were analysed for (formaldehyde, acetaldehyde, and acetone). Ammonia, the most well-known volatile degradation product of MEA, was detected in the most significant amounts in the wash water bottles, followed by MEA, which is an expected component due to its volatility. Further, acetone, formaldehyde, and methylamine are some of the components detected in this work.

## Concluding remarks

Overall, the relevance of generalising such a method for rapidly identifying volatile degradation products during solvent development is unclear. Firstly, this is a very simple method using quite highly degraded amine solutions, and the volatility of the degradation compounds is detected directly from the solution (not after water wash). The developed method does not tell which compounds can easily be mitigated with water wash sections. This method also depends on the analytical methods available to identify the studied solvent's degradation products. This might not be available in the early stage of solvent development (however, it should be available before larger-scale piloting). The focus of this work has been limited to MEA in the absence of existing analytical methods for a large number of degradation products of second-generation and third-generation solvents.

However, the development of existing knowledge about the potential degradation products of a novel solvent and the development of analytical methods for identifying such compounds could allow the implementation of this simple boiling method to identify the most volatile degradation product(s). This would enable preparation for piloting with some additional knowledge of the volatile degradation compounds.

## References

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