Results of the third Technology Centre Mongstad campaign: FEED, process intensification, and simulation

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Abstract
Technology Centre Mongstad (TCM), Norway, is conducting the 3rd test campaign (MEA-3) to investigate the underlying process optimization and cost reduction possibilities for a system using Mono Ethanol Amine (MEA) as a solvent for CO₂ capture. The campaign has been running from June 2017 and is planned to continue until February 2018. The MEA-testing at TCM will afterwards proceed with a 4th test campaign (MEA-4) which is planned until May 2018.
There are several stakeholders focused on full scale carbon capture and storage (CCS) demonstration. Many industries around the world could significantly benefit from full scale implementations of CCS, like the cement industry, ammonia production, and waste incineration. These and many future CCS sites will rely on sound data for accurate low cost Front End Engineering Designs (FEEDs). This is the objective of the study presented here.

The main objective of MEA-3 is to produce knowledge and information that can be used to reduce the cost as well as technical, environmental and financial risks of commercial scale deployment of post-combustion capture (PCC). Some of the more specific focus areas of MEA-3 are:
1. Absorber design
2. Solvent composition
3. Flexibility of inlet gas
4. Wash optimization
5. Heat exchange optimization

TCM collaborates with academia by offering operational test hours from the MEA campaigns to researchers.
The work presented in this paper focuses on the data which will be generated in January 2018. DTU will participate in the design, control and post evaluation of the results coming out of specific campaigns during 2018.

DTU MEA-3 Campaign Objectives:
The aim of DTU is research into new principles of CO₂ capture, combined with knowledge creation for model development, cost reduction and FEED focus.

DTU will specifically focus on the following topics during the MEA-3 campaign:
1. Column height for FEED
2. Lean temperature control to reduce the need for lean cooling
3. CO₂ content in gas inlet

The envisaged GHGT paper and conference presentation to be given in Australia will include:
1. TCM experimental campaign data supported by DTU
2. Simulation of TCM pilot data
3. Prediction of improved design (FEED) based on simulation and optimization

The MEA-3 campaign is ongoing for 2018, as of December 2017, the data has of cause not been created and analysed. Therefore we cannot show preliminary data in this abstract. Even though, the following paragraphs exemplify previous results from DTU on a much smaller scale.

**Results**
The MEA-3 campaign will among many parameters have an emphasis on the lean composition in terms of flow, loading, and solvent composition. DTU has a history of process simulation and rate based modelling [1,2,3,4].

Figure 1 below, shows a recent campaign conducted at DTU for 6 L/G ratios which spans a very interesting process window. All runs were performed with the same inlet solvent and loading. The example shown here only concerns the absorber results. The presented work at GHGT will include the closed loop capture plant, entailing the desorber too.

Case “1.8” show a clear example of a too low solvent flow. The solvent is saturated over the first top 3 meters of the column and the remaining 7 meters in the bottom renders inefficient. This absorber column could have easily been reduced to a much smaller size. Even though, it would not be able to capture 90% CO₂ due to an insufficient amount of solvent flow.

Case “3.5” and “4.5” reveals more optimal solvent conditions which gives an increased loading in the solvent reaching a loading close to 90% capture.

![Figure 1: Experimental data and rate based CAPCO2 model results of a 30 wt% MEA campaign from DTU 2017 at various L/G](image-url)
Case “5.4” and “6.3” are both non-optimal cases. They clearly show that CO₂ is not absorbed above a height of 5 meters. Basically, the majority of CO₂ has been removed from the gas. In these cases, the solvent doesn’t reach a high loading, simply because of the excess of solvent being used. The consequence is of cause a very high capture percent but also a very high specific reboiler duty due to the relative extreme consumption of solvent.

Conclusions
The CAPCO2 model has previously shown to reproduce the MEA[3,4], PZ[3], MDEA-enzyme[5] cases very well. In this study, we expect to validate the TCM demonstration cases and we expect to apply the model in Aspen Plus for simulation of the cases and for prediction of more optimal cases in terms process intensification. The simulation will include the overall process of CO₂ capture site. These results will naturally contribute to FEED of future CO₂ capture cases and help to reduce the cost of emission reduction from industry like the cement, steel, paper, bio, ammonia, refinery and many more.

References