Design and operation of water-wash sections to minimize MEA emissions

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Abstract

Absorption-based carbon capture with amine solvent is now a proven technology. However, potential emissions of amine solvent and volatile degradation compounds are real problems, and it is, therefore, essential to control them. These emissions, formed in the absorber, depend on the composition of the solvent used (volatility of the solvent and its degradation products), the absorber design and the operating conditions. These emissions can be gases, aerosols or droplets.

To mitigate this phenomena, it is common to have a water-wash section after the absorber, sometimes coupled with an acid treatment and a mist eliminator [1]. The water-wash is a packed column ensuring good contact between the rising gas phase and the falling water. It allows for the capture of gaseous compounds, especially amines. Moreover, scientific literature and campaign results seem to show that the washing sections can be effective also in reducing aerosol emissions, both by reducing the aerosol amine content and by increasing the average drop size, which can then be retained with the help of a demister [2].

As explained above, the wash section is of paramount importance for controlling emissions of amines and their degradation products into the atmosphere. At the same time, for the moment, most VLE models are fitted for concentration ranges pertinent for the absorber operation, e.g. from 15 to 60wt% MEA as shown in Figure 1. However, the amine concentrations are much lower in the washing section and the CO_2 loadings higher, making an extension of the models to low amine concentrations and high loadings necessary. In particular, it is important to improve available information of amine volatility in these concentration and loading ranges.

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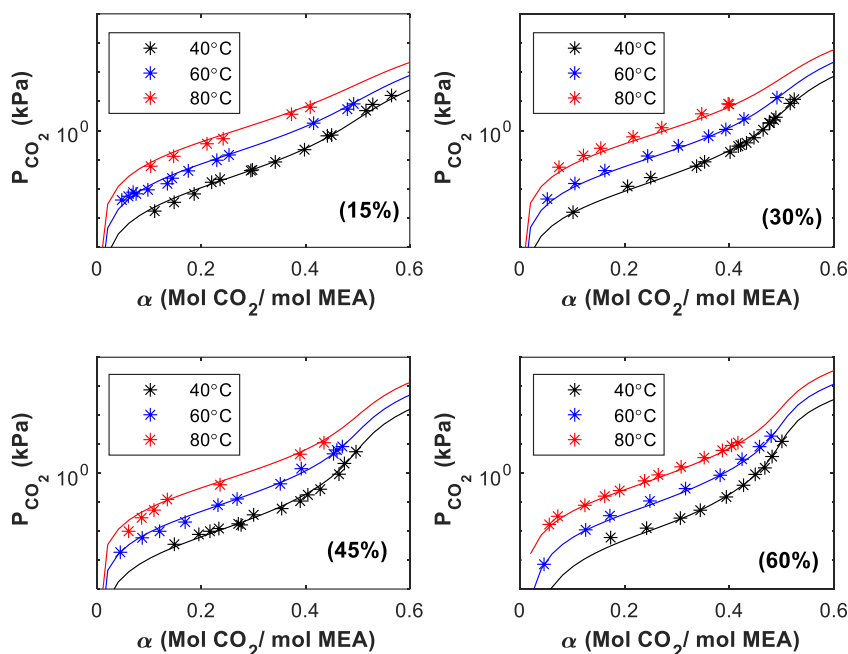 *E-mail address:* hanna.knuutila@ntnu.no

Figure 1. Representation of the eNRTL for MEA/H2O/CO2 at different concentrations and temperatures (Points [3]).

In this work, we will focus on low concentration MEA solutions. VLE data will be measured using a low temperature atmospheric vapor-liquid equilibrium apparatus, designed to operate at temperatures up to 80 °C [3]. After equilibrium is obtained, both gas and liquid phases are analysed so that the partial pressure of CO_2 and the CO_2 loading can be determined. In addition, a Fourier-transform infrared spectroscopy (FTIR) is connected to the gas phase to measure the MEA concentrations. An example in is given in Figure 2 for low concentrations of MEA showing present predictions of our eNRTL model. No data for gas phase MEA content are available.

For the simulation part, this work refits an existing eNRTL VLE-model to describe the activities of the species in the liquid phase [4]. This new fitted model will then be implemented into an existing simulator and aerosol model to predict mist behaviour through the absorber [5][6][7]. The combined use of these two improved models to account for low concentrations will improve the accuracy of the water-wash section simulation.

In the conference, we will present how the design of the water-wash section or the operational conditions can impact both aerosol and volatile amine emissions. Especially, the height and the temperature profile of the water-wash section will be studied, as well as the water flow and the amine concentration in the water-wash section. We will then discuss the options available to minimize MEA emissions.
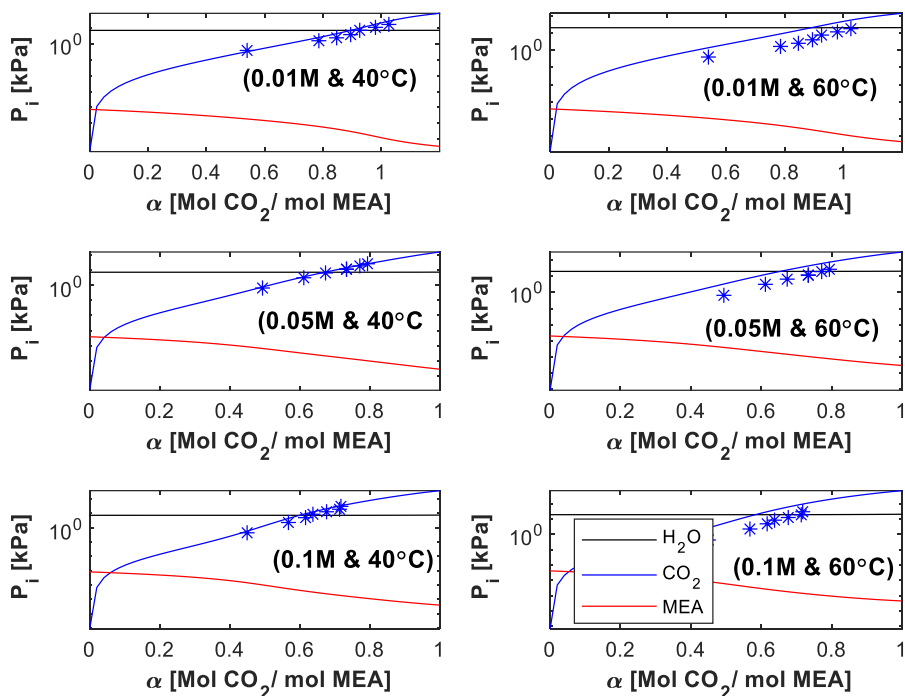
Figure 2. Representation the eNRTL for MEA/H2O/CO2 at low concentrations of MEA (Points, This work).

Acknowledgments

Keywords: water-wash; CO2 capture; solvent technology; emissions; VLE model

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