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Viscosity and Density data for the CESAR1 solvent.

Diego Morlando[a], Ardi Hartono[a], Hanna K. Knuutila[a,*]

[a]*Department of Chemical Engineering, NTNU, NO-7491 Trondheim, Norway*

Abstract

Global warming by anthropogenic CO_2 emissions is a major issue and technologies to slow down this process need to be commercialized. Amine-based absorption is the most mature technology for post-combustion CO_2 capture, Dutcher et al. (2015); Morlando (2024). Ethanolamine (MEA) has been considered the solvent benchmark for CO_2 capture by chemical absorption and many data for different properties are available. Feron et al. (2020) proposed an aqueous blend of 3 M 2-amino-2-methyl-1-propanol (AMP) and 1.5 M piperazine (PZ), also known as CESAR1, as the new benchmark for this technology.

The CESAR1 solvent has been widely studied and piloted, however, a comprehensive literature review of the available data for this solvent was performed and outlined that experimental gaps exist, Morlando et al. (2024). Viscosity and density data for CO_2-loaded and CO_2-unloaded solutions are missing in the open literature even though necessary in the design of a gas-liquid contactor.

This work wants to fill these experimental gaps by measuring the physical properties of CESAR1 solvent as a function of temperature and CO_2 concentration. Furthermore, an uncertainty analysis and correlations for these properties will be developed and made available for use when modelling absorption kinetics and vapor-liquid equilibrium.

This work will use an Anton Paar Density meter DMA 4500 M coupled with a Lovis 2000ME viscosity meter, to measure the density and viscosity simultaneously. The DMA 4500 was calibrated by air and ultra-pure H_2O at 298.15 K. The methodology and description of the apparatus can be found in Hartono and Knuutila (2023). The apparatus has been validated by using 30 wt.% MEA. The absolute average relative error (AARD) calculated by Eq 1 can be used to quantify the error between the measurements from this work, $\boldsymbol{y_{this\ work}}$, and the measurements available in the open literature, $\boldsymbol{y_{reference}}$.

$$AARD = \sum \frac{y_{this\ work} - y_{reference}}{y_{this\ work}} \cdot 100 \qquad Eq\ 1$$

The AARD for the density measurements is 0.03% and 0.05% on the Hartono et al. (2014) and Han et al. (2012) datasets respectively. The AARD for the viscosity measurements is 1.7% and 1.4% for the Hartono et al. (2014) and Arachchige (2013) datasets respectively.

Preliminary results of CESAR1 measurements are available in Figure 1.

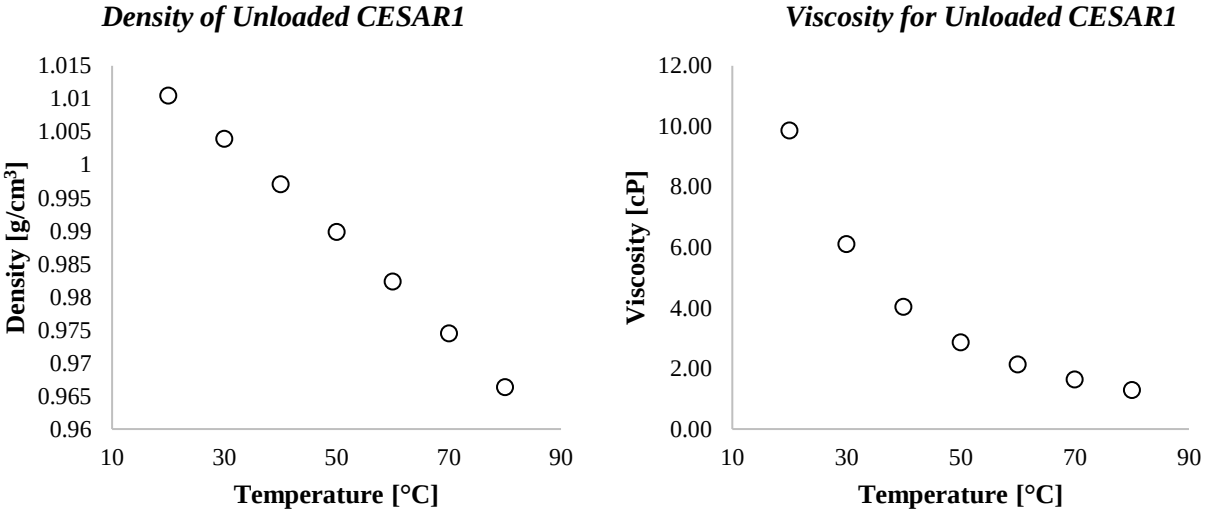

Figure 1: Density and viscosity experimental results for unloaded CESAR1 solvent.

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* Corresponding author. Tel.: +47-73594119, *E-mail address:* hanna.knuutila@ntnu.no

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* Corresponding author. Tel.: +47-73594119, *E-mail address:* hanna.knuutila@ntnu.no