Densities, Viscosities, Refractive Indices, Heat capacities, Thermal conductivities Study of Aqueous Ethylaminoethanol (EEA) Solutions at 293.15 to 323.15 K

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Abstract

Fossil fuel-fired power plants (i.e., coal, oil and natural gas) make large contributions to the increase of atmospheric concentrations of carbon dioxide (CO₂) which has been cited as being responsible for the occurrence of climate change and global warning problems. CO₂ absorption using aqueous amine solutions appears to be the most mature post-combustion strategy for capture of CO₂ from flue gases due partly to its cost efficiency and convenience to retrofit into existing power plants\textsuperscript{[1,2]}. Recently, a class of novel amines has received considerable attention and one secondary alkanolamine of interest is Ethylaminoethanol (EEA). EEA is comprised of one ethyl groups that replaces the hydrogen atom of the amino group in MEA, and has a structure which is very close to diethanolamine (DEA) which, in turn, has been shown to possess high absorption capacity, high absorption rate and relatively low absorption heat, and can be prepared from renewable and/or cheap resources (such as ethylene oxide and ethylene). Although EEA has a much higher rate constant for reaction with CO₂ than DEA, the regeneration energy is still lower than that for tertiary amines\textsuperscript{[3]}. Therefore, in EEA-based solvents, the addition of small amounts of other amines to EEA aimed to enhance the CO₂ regeneration rate, appears to be a commercially attractive proposition for an absorbent for CO₂ capture.

One of the main issues of the amine absorption of CO₂ is the requirement of regeneration energy. High concentration amine solutions are attractive because the amine circulation rate can be reduced and energy can be decreased. Thermo physical properties like density, viscosity, refractive index, heat capacity, thermal conductivity
in such solutions are of great importance for further analysis of the use for CO\textsubscript{2} capture as well as for the equipment design and further implementation in modeling or process simulation, pilot plant operation, and in the commercial plant. Therefore, knowledge and investigation which will provide precise and reliable data regarding these properties are crucial.

The thermo physical properties of unloaded aqueous EEA solutions are not available in the literature. As well, the influence of CO\textsubscript{2} dissolution has not been reported. Therefore, this study focuses on the effect of CO\textsubscript{2} loading, temperature and EEA concentration on the density, viscosity, refractive index, heat capacity, thermal conductivity of aqueous EEA solutions, and we report both experimental measurements and empirical correlations developed for density, and viscosity. Our results show that EEA has relatively lower viscosity. The experimental results for density and viscosity of 3 M EEA with loading are shown in Fig.1.

Fig.1 Density and viscosity of 3 M EEA with loading

Keywords: carbon dioxide; Ethylaminoethanol; thermo physical properties; empirical correlations.

Reference
[4] Han, J., Jin, J., Eimer, D.A., Melaen, M.C., 2012. Density of Water (1)+ Diethanolamine (2) + CO\textsubscript{2} (3) and Water (1) + N-Methyl-diethanolamine (2) + CO\textsubscript{2} (3) from (298.15 to 423.15) K. Journal of Chemical & Engineering Data 57, 1843-1850.