

ABSTRACT

Removing acidic gases such as CO₂ is a very important process in many chemical industries today. One of the most widely methods used to remove the acidic gases is absorption using aqueous alkanolamine solutions. There are many types of alkanolamine-based solvents used in the industrial gas treating process. Among the amine solvents that have recently received great deal of attention are activated amines where piperazine has been used as the activator.

This work studied the volumetric properties of the aqueous solution of piperazine (PZ) and activated DEA in order to understand the interactions between its constituent molecules, which reflect the amine solvent behavior. Densities of aqueous piperazine, DEA + H₂O, DEA + PZ mixtures and activated DEA solutions were measured at temperature varying from 30 to 80 °C and the concentration of piperazine varies from 0.01 M to 1 M. The density behavior of piperazine-water mixture is different from DEA-Piperazine-water system, where the densities of the aqueous binary mixture of piperazine increase with an increase of piperazine composition but decrease in the aqueous ternary mixture of DEA-Piperazine-water system. Two distinct zones with separation line at mole fraction of piperazine equal to 0.0025 in the total amine concentration of 4M was observed in the ternary system. A Redlich-Kister correlation was used to represent the excess molar volumes of the binary and ternary systems.

In the CO₂ absorption study, solubility of CO₂ into aqueous solutions of piperazine and activated DEA has been measured systematically using a stirred cell reactor at

temperatures ranging from 20 to 50 °C with CO₂ partial pressures varying from 0.4 kPa to 96 kPa. The concentration of piperazine used ranged from 0.1 to 1 M. Generally the aqueous solutions of piperazine and activated DEA exhibited the same solubility curve trend as other amine solutions. Increasing the CO₂ partial pressure increased the gas loading; however, increasing either the temperature or piperazine concentration decreased the CO₂ loading. Compared with other amine mixtures, activated DEA was found to be a potential solvent for CO₂ removal. A mathematical model based on Kent-Eisenberg approach was applied to represent the vapor-liquid equilibrium of CO₂-piperazine-H₂O system. A good agreement between the model representation and the experimental values were achieved except in the region of high CO₂ partial pressure and low piperazine concentration which may be due to the dominant role of physical absorption. When applied to activated DEA system, the model gives reasonable predictions with the experimental data.