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Gas solubility of H_2S and CO_2 in aqueous solutions of *N*-methyldiethanolamine

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Abstract

Alkanolamine processes are used in the industry to remove acid gases, like CO_2, H_2S and other sulphur components, from natural gas and industrial gas streams. In this process the acid components react with the basic alkanolamine solution via an exothermic, reversible reaction in a gas/liquid absorber. The composition of these amine solutions is continuously changed to optimise the (selective) removal of the several acid components. For the design of gas treating equipment accurate mass transfer, reaction kinetics and solubility data of acid gases in aqueous alkanolamine solutions are required. In this paper new solubility data of H_2S and CO_2 in aqueous MDEA at different conditions encountered in modern gas treating facilities are presented. The experimental pressure and temperature were varied from 6.9 to 69 bar (methane was used as make-up gas) and from 10 to 25 °C respectively. These new solubility data were evaluated and correlated with an Electrolyte Equation of State Model (EOS) as originally proposed by Fürst and Renon [Fürst, W., Renon, H., 1993. Representation of Excess Properties of Electrolyte Solutions Using a New Equation of State. AIChE J., 39 (2), pp. 335.]. The application of Equation of State Models for the prediction of VLE data for reactive, ionic systems is a rather new development in this field.

Keywords: Chemical absorption; Carbon dioxide; Hydrogen sulphide; Alkanolamines; Vapour liquid equilibrium

1. Introduction

Acid gases like CO_2, H_2S and other sulphuric components are usually to some extent present in natural gas and industrial gases. They may have to be removed (selectively) from these gas streams for operational, economical or environmental reasons. One of the most commonly used processes for the removal of acid components is absorption in alkanolamine based solvents. In this process the acidic components react with an alkanolamine absorption liquid via an exothermic, reversible reaction in a gas/liquid contactor. In a following process step the acidic components are removed from the solvent in a regenerator, usually at low pressure and/or high temperature. For the design of such process systems reliable solubility data of acid gases in aqueous alkanolamine solutions are indispensable. In the present study new obtained solubility data of CO_2 and H_2S in aqueous MDEA solutions will be presented.

The ability of an alkanolamine solution to remove acidic gases is determined by the acid gas solubility, the reaction rate and the mass transfer properties. In this study the experimental determined solubility data of CO_2 and H_2S in aqueous MDEA solutions will be presented at temperatures of 283 and 298 K, acid gas partial pressures

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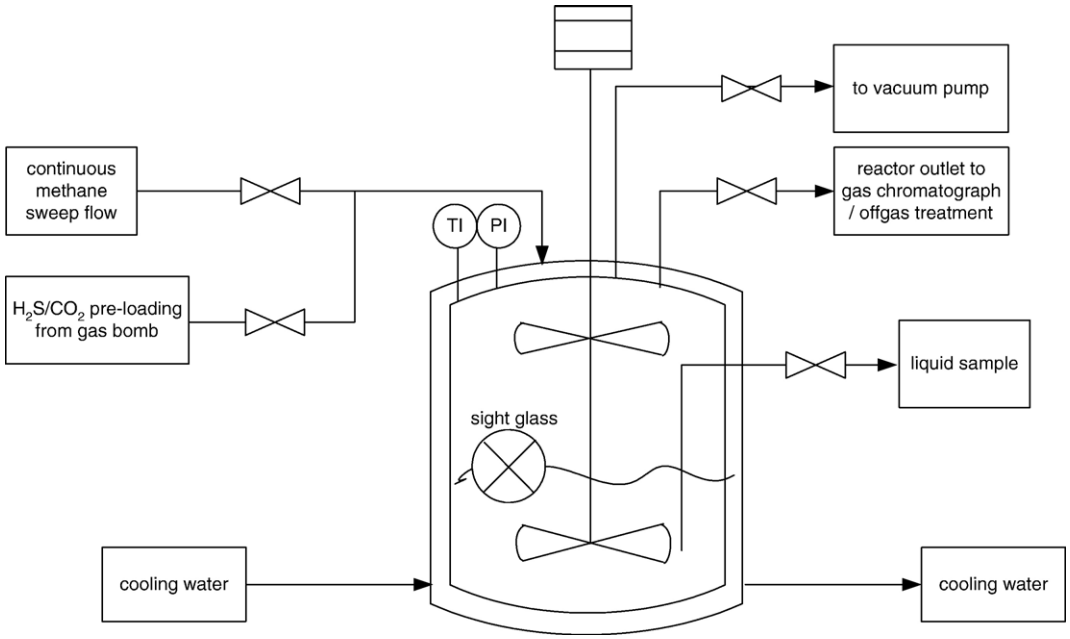

Fig. 1. Schematic representation of the reactor.

0.05–10 kPa and a total system pressure of 6.9–69 bar with methane as make-up gas. In open literature normally only the partial pressure acid gas is specified and not the total system pressure, because experiments are carried out at low pressure. In this study the influence of the total system pressure (with methane as make-up gas) on the acid gas solubility is also shown. This system pressure is an important parameter, because normally there is a substantial difference in total system pressures between an industrial absorber (70–100 bar) and a regenerator (2–3 bar). So if the system pressure influences the acid gas solubility, the low pressure experimental solubility data cannot be used in the high pressure absorber. Also the measured acid gas solubility data at relatively low temperatures of 283 and 298 K are scarce. The new obtained solubility data are used to develop and validate an electrolyte Equation of State Model that can be used to predict the equilibria for these treating processes.

2. Experimental

For all experiments demineralised water was used. *N*-methyldiethanolamine (purity > 99%) was supplied by

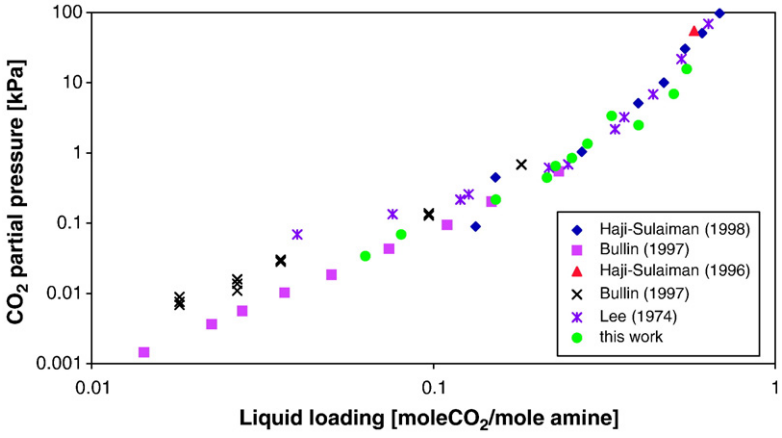

Fig. 2. Validation experiments for the solubility of CO_2 in 20 wt.% DEA at 323 K.