CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

Absorption by amine solvents are known to be the most promising techniques to remove large amounts of CO_2 from flue gas and process gas streams and aqueous 2-(methylamino) ethanol (MAE) was found to be a potentially good absorber for this purpose.

In this work, the equilibrium solubility of CO_2 in MAE was studied at various operating conditions to quantify the performance of this amine relative to other commercially used solvents used for gas treating.

This chapter summarizes the conclusions of the study and lists the recommendations for future work in the field of gas treatment using MAE.

7.2 CONCLUSIONS

The absorption of carbon dioxide in 1.0 M, 2.0 M and 4.0 M aqueous 2-(methylamino) ethanol (MAE) solutions was investigated at 30, 40 and 60 ^{o}C, where the CO_2 partial pressure was varied from around 1 to 100 kPa using a stirred cell reactor.

In all cases, the solubility of CO_2 in MAE was found to increase with increasing CO_2 partial pressure and decrease with increasing temperature. The variation of the loading with partial pressure is more significant at low pressures.

At low partial pressure, the effect of concentration on loadings is very limited, however, at high partial pressures the loading decreases with increasing amine concentrations.

Results also showed that MAE has better absorption capacity than other commercial amines like monoethanolamine, MEA, diethanolamine, DEA, 2-amino-2-methylpropandiol, AMPD, methyldiethanolamine, MDEA and triisopropylamine, TIPA, while 2-amino-2-methylpropanol, AMP, had higher solubility. The difference in CO_2 loading results between MAE and other amines occur to be more significant at lower CO_2 partial pressures.

The total contribution of the carbamate ion to the overall absorbed CO_2 was found to range between 5 – 40% with an average of 26%. This shows that carbamate ion is not the main product of the reaction which means it is unstable and eventually undergoes hydrolysis to bicarbonate as suggested by Huang *et al.* (2000). Results also show that the carbamate ion concentration decreases with increasing CO_2 partial pressure, and increases with increasing amine concentration. The same trend has been established for DEA by Benamor *et al.* (2007).

A mathematical model was derived based on the various chemical reactions occurring at equilibrium and using published data for the values of the equilibrium constants. The equilibrium constant representing hydrolysis of equilibrium carbamate ions was estimated to be a function of pressure, temperature and amine concentration and hence was determined using a least square fit to the experimental equilibrium carbamate ions concentration by non-linear regression where the values of the correlation parameters were found. The theoretical results of this model were in good agreement with the experimental data especially at low amine concentrations, which proves that the proposed model is suitable for predicting the solubility of CO_2 in MAE.

The concentrations of the different species in the carbonated amine solution were determined by the model and plotted against CO_2 loading. These results show that the most significant ions present at equilibrium are the protonated amine and the bicarbonate. This proves that for MAE the carbamate ion is unstable.

As an overall conclusion, the results of this work indicate that MAE is a good candidate for CO_2 capture and that the proposed model can provide good results within the conditions specified.

7.3 RECOMMENDATIONS

- Investigating the solubility of CO_2 in MAE at a wider range of conditions would give a better picture on the solubility profile and equilibrium behavior of this amine. Future investigations should focus on low CO_2 partial pressures (< 15 kPa) and moderate operating temperatures (40 ^{o}C) as these conditions are close to the actual operating conditions of flue gas streams.
- The proposed model can be modified to include activity and fugacity coefficients by assuming non-ideal conditions. More experimental data at a wider range of conditions would further refine the proposed model parameters in a way that would minimize the discrepancies between experimental and predicted data.
- It is also recommended to investigate blending MAE with other amines, activators or ionic liquids to explore its capabilities when mixed with other absorbents.
- Future work on this amine should consider determining its kinetics, its corrosion and foaming tendencies as well as regeneration requirements, for a complete and accurate assessment.