한국환경과학회 가을 학술발표회지 제10권(제2호), 63 - 66, 2001
Proceedings of the Korean Environmental Sciences Society Conference, Nov. 10, 2001

대기-P11

Vapor Pressure of Carbon Dioxide and Solubility of Nitrous Oxide in Aqueous Solutions of Carbon Dioxide Loaded Methyldiethanolamine

Moon-Ki Park*, Young-Soo Moon, Sang-Ki Choi[1]
Dept. of Environ. Sci. & Eng., Kyungsan University
[1]Faculty of Environ. Sci. & Tech., Keimyung University

1. INTRODUCTION

The objective of the work presented here is to measure the total solubility of CO_2 in 50 mass % MDEA solutions over a wide range in temperature and CO_2 partial pressure and to measure the physical solubility of N_2O in these solutions as a function of the CO_2-loading. Haimour and Sandall (1984) showed that predictions of physical solubility and diffusivity using the nitrous oxide analogy method can be used to predict absorption rates of CO_2 into aqueous MDEA under conditions of very short contact times where the chemical reaction does not affect the absorption rates.

2. EXPERIMENTAL

Figure 1 shows a schematic drawing of the modified Zipperclave reactor used in this work. The reactor consists of a one liter stainless steel cylindrical tank with an air-driven magnetically coupled stirrer on the top. There are valves for inlet of gas and liquid, and a connection to a vacuum pump. A thermocouple inserted in the cell measures the temperature to an accuracy of ±0.1℃. The pressure is measured by a pressure transducer with an accuracy of ±0.02 psi.

Initially a weighed sample of approximately 500g liquid is sucked into the reactor. The temperature is then adjusted to the desired value through use of the external heating jackets. A vacuum is then pulled on the reactor so that the liquid exists under its own vapor pressure. This solution vapor pressure, P,, is measured. A known quantity of CO_2, N_{CO2}, is transferred to the reactor from a gas container of known volume

$$N_{CO_2} = \frac{V_T}{RT_a}(z_1 P_1 - z_2 P_2)$$

where V_T is the volume of the gas container, z_1 and z_2 are the compressibility factors corresponding to the initial pressure, P_1, and the final pressure, P_2 in the gas container before and after transferring the CO_2 and T_a, is the ambient temperature. After transferring the CO_2 to the reactor, the stirrer is turned on and equilibrium is attained in about 10 minutes.

3. RESULTS AND DISCUSSION

This equilibrium pressure P_{CO2} (= P_{T1}-P_v) is measured and the moles of CO_2 remaining in the gas phase is determined from

$$N^g{}_{CO_2} = P_{T_2} - P_{CO_2} - P_v$$

The moles of CO_2 in the liquid is then determined from

$$N^l{}_{CO_2} = N_{CO_2} - N^g{}_{CO_2}$$

The CO_2-loading in the liquid phase is defined as

$$L_{CO_2} = \frac{N^l{}_{CO_2}}{N_{Am}}$$

where N_{Am} is the moles of MDEA in the liquid phase.

$$N_{Am} = \frac{W_{MDEA} \rho V_l}{M_{MDEA}}$$

To measure the solubility of N_2O in the CO_2-loaded solutions a known quantity of N_2O is transferred to the Zipperclave reactor containing the CO_2-loaded amine from a gas container. The mass of N_2O transferred is determined in the same manner as for CO_2. After transferring N_2O to the reactor, the stirrer is turned on. An equilibrium is achieved after about 10 minutes and the total pressure, P_{T2}, is measured. The partial pressure of N_2O, P_{N2O}, is calculated from

$$P_{N_2O} = P_{T_2} - P_{CO_2} - P_v$$

The moles of N_2O in the gas phase are determined from P_{N2O} by

$$N^g_{N_2O}=\frac{z_{N_2O}P_{N_2O}V_g}{RT}$$

4. CONCLUSION

The nitrous oxide analogy method may be used with the H_{N2O} data presented here to estimate the physical solubility ofd CO_2 as a function of temperature and CO_2-loading. They physical solubillty of CO_2 is the key physicochemical property needed to calculate CO_2 mass transfer rates.

In this investigation, we have measured the total solubility of CO_2 as a function of partial pressure of CO_2 in 50 mass % MDEA solutions over a wide temperature range. These data should be useful for the design of absorption columns using MDEA to remove CO_2.

REFERENCES

Clark, J. K. A., Kinetics of absorption of carbon dioxide in monoethanolamine solutions at short contact times. Ind. Eng. Chem. Fundam. 3, 239-245, 1964.

Laddha, S. S.; Diaz, J. M.; Danckwerts, P. V., The N_2O analogy: the solubilities of CO_2 and N_2O in aqueous solutions of organic compounds. Chem. Eng. Sci., 36, 228-229, 1981.

Haimour, N. K., Sandall, O. C., Absorption of Carbon dioxide into aqueous methyldiethanolamine. Chem. Eng. Sci., 39, 1791-1796, 1984.

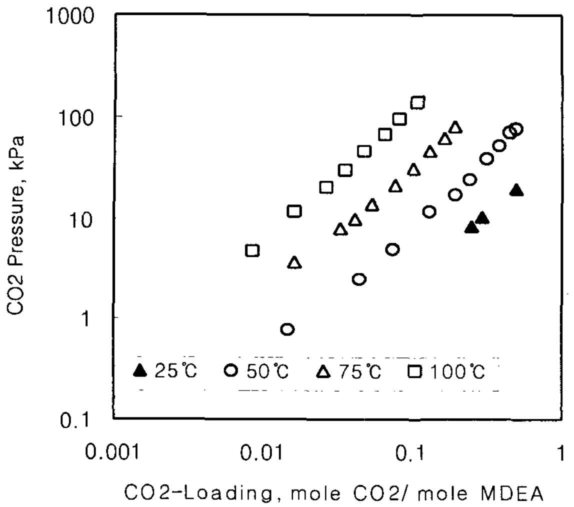

Fig. 2. Solubility of CO_2 in 50 mass % MDEA solution.

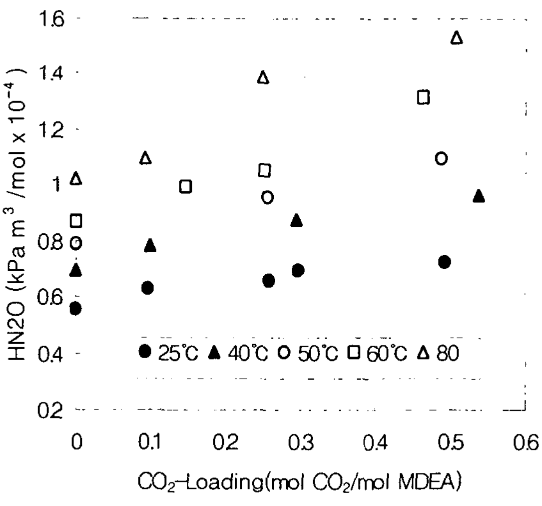

Fig. 3. Henry's constant for N_2O in 50 mass % MDEA as a function of CO_2 loading.