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Temperature dependent of absorption heat in phase-change solvent in carbon dioxide capture

Authors and affiliation

Tran Viet Bao Khuyen[1], Yamaguchi Tsuyoshi[2], Machida Hiroshi[*,1], Koyo Norinaga[1]

[1]Department of Chemical Engineering, Graduate School of Engineering, Nagoya University

[2]Department of Molecular Design and Engineering, Graduate School of Engineering, Nagoya University

Key Word (3 words)

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Abstract (less than 300 words)

Capturing carbon dioxide using amine solvents has been a mature method. However, the energy penalty is the disadvantage of this chemical method. The homogeneous solvents that separate into liquid-liquid or solid-liquid phases after CO_2 absorption are named phase-change solvents (LLPS and SLPS solvents, respectively). Regeneration only the CO_2-rich phase or regeneration based on the properties of CO_2-rich and -lean phases is expected to overcome the energy consumption in the regeneration process [1, 2]. The absorption heat is an important property in evaluating the efficiency of solvent in CO_2 capture. In this study, LLPS solvents were investigated with 2-(ethylamino)ethanol (EAE) in organic solvent (Diethylene Glycol Diethyl Ether, DEGDEE) with/without water presence (named as EAE/DEGDEE 30/70 and EAE/DEGDEE/water 30/60/10 (weight base), respectively). In these solvents, the product of EAE and CO_2 – carbamate – has low affinity to the hydrophobic DEGDEE; therefore, it forms a new phase. Aqueous solution of 2-amino-2-methyl-1-propanol (AMP) at 50 wt% was used as SLPS solvent. The absorption heat of 100g of each solvent was examined with absorption temperature range of 25 - 80°C with 1 L/min of N_2:CO_2 mixture (4:1 ratio). The amount of CO_2 absorbed was measured by the total organic carbon as well as the difference between the CO_2 concentration of the inlet and the outlet gases. EasyMax102 (Mettler Toledo, Inc.) was used to continuously measure the generated heat and to maintain the isothermal condition during CO_2 absorption.

The obtained absorption heat curves exhibit the loading point – the ratio of the moles of CO_2 absorbed to that of amine in solvent – where the solvent changes its phase. The LLPS solvent with water presence separates at lower loading than that of LLPS solvent without water. The absorption heat of those phase change solvents and the loading point of solvent change are independent to the absorption temperature.

[1] Barzagli, F.; Mani, F.; Peruzzini, M. Efficient CO2 Absorption and Low Temperature Desorption with Non-Aqueous Solvents Based on 2-Amino-2-Methyl-1-Propanol (AMP). *Int. J. Greenh. Gas Control* **2013**, *16*, 217–223.

[2] Machida, H.; Oba, K.; Tomikawa, T.; Esaki, T.; Yamaguchi, T.; Horizoe, H. Development of Phase Separation Solvent for CO_2 Capture by Aqueous (Amine + Ether) Solution. *J. Chem. Thermodyn.* **2017**, *113*, 64–70.