Solvents with Low Critical Solution Temperature for CO_2 Capture

Xu Zhicheng Wang Shujuan
Department of Thermal Engineering, Tsinghua University, Beijing, China
wangshuj@tsinghua.edu.cn

Keywords: carbon dioxide, biphasic, absorption, desorption, solvent selection

Because of its high potential of reducing energy penalty, the biphasic absorption system for CO_2 capture has attracted increasing attention. As have been stated by the previous researchers, finding solvents that have low critical solution temperature (LCST) and investigating their relative absorption and desorption performance are of great importance for the biphasic system.

In this work, based on their absorption and desorption performances, five amine solution with LCST were compared with MEA in terms of their absorption-desorption performance using screening test facility. The five amines are 2M Diisopropylamine (DIPA), 2M and 5M N-Ethyl-n-butylamine (EBA), 3M Triethylamine (TEA), 5M Diallylamine (DAA), and 5M N-Ethylmethallylamine (EMAA), their LCST are 25^{o}C, 15 ^{o}C, 18 ^{o}C, 6 ^{o}C and 18.6 ^{o}C respectively.

The screening test was conducted in a 150 ml reactor with efficient gas distributor. For absorption, the CO_2 concentration in the simulated gas was 12% in terms of volume, neutralized by N_2, with a total gas flow rate of 463 ml/min. The temperature of the reaction was controlled at 40 ℃. The absorption process determinated until the outlet CO_2 concentration reached 12%. For desorption, the temperature was controlled at 80 ℃, and N_2 was used to accelerate the process, with a flow rate of 874 ml/min. The outlet CO_2 concentration was real timely recorded by IR CO_2 analyzer.

After experiment, the loading of the liquid sample was analyzed by the barium chloride precipitation method, and results showed that the calculation agreed with the precipitation method very well. The repeated trial revealed using 5M MEA revealed the system was reliable, as Fig. 1 shows.

As shows in Fig.2, 2M DIPA and 2M EBA have better performance in terms of loading and initial absorption rate, while 5M EBA and 5M MEA show highest absorption capacity.

Fig. 3 reveals that both 5M DAA and 3M TEA attained a lean loading of about 0.1. 5M MEA had the largest desorption capacity, while 5M DAA showed extraordinary high desorption rate.

None of these five amines showed phase transition during absorption at 40oC, while 3M TEA and 5M DAA became two phases after desorption, and after cooling to room temperature, they maintained this status.

We can conclude from this work that:

1) A fast solvent screening system was established with suitable calculation methods. The results of the calculation agreed well with barium chloride precipitation method.
2) The absorption and desorption properties of 5 amine solution with LCST were measured. 2M DIPA showed best performance in terms of overall analysis.
3) All these five amines' phase transition disappeared with the increase of CO2 concentration. 3M TEA and 5M DAA became two phases after desorption.

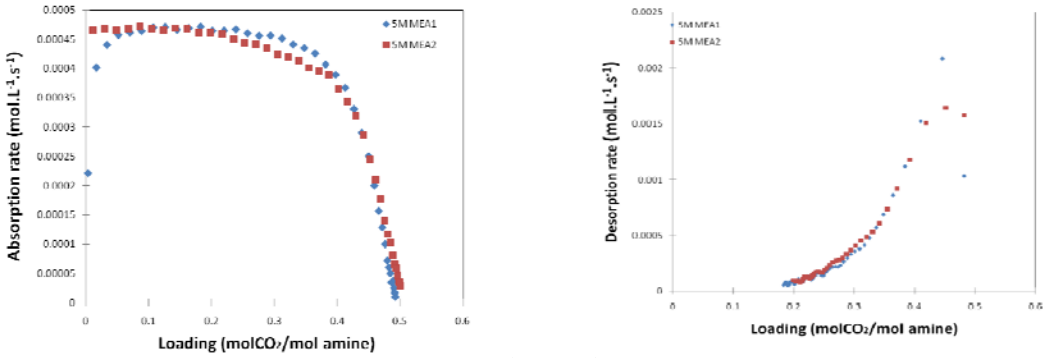

Fig.1 Repeated trial using 5M MEA

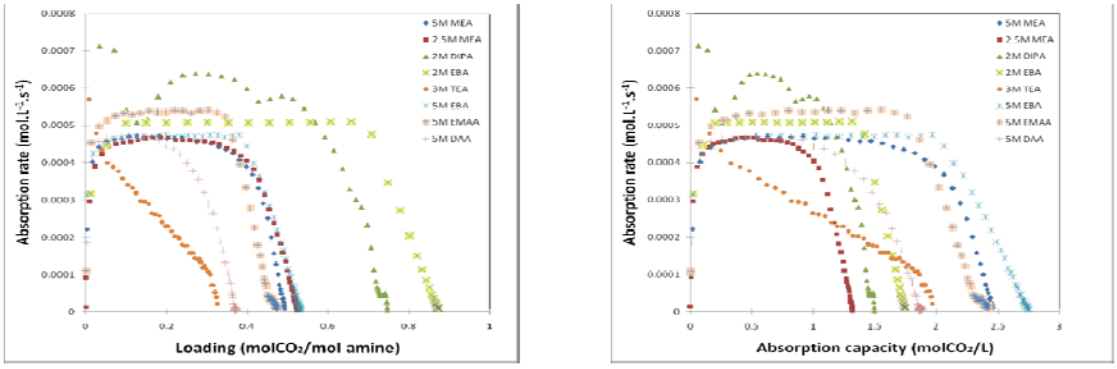

Fig. 2 Absorption characteristics of the solvents

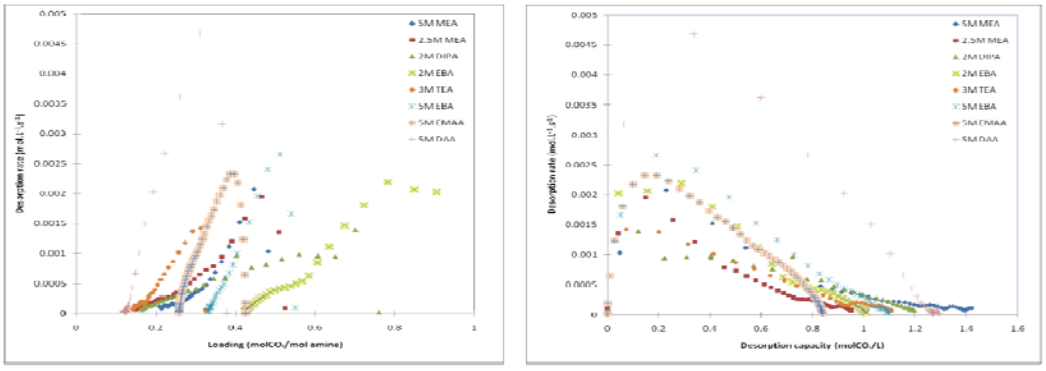

Fig. 3 Desorption characteristics of the solvents