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### Reactive Absorption of CO<sub>2</sub> Using Ethylaminoethanol Promoted Aqueous Potassium Carbonate Solvent

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Atmospheric concentration of CO<sub>2</sub>, which is considered as one of the major greenhouse gases (GHGs), has increased up to 398 ppmv as of 2015. CO<sub>2</sub> concentration in atmosphere was 280 ppmv in pre-industrial era, and due to the continuous discharge, it is expected to increase up to 550 ppmv by 2050. Many of the major industrial sources of CO<sub>2</sub> emissions are natural gas fired power plants, synthesis gas used in integrated gasification combined cycle (IGCC) and power generation, gas streams produced after combustion of fossil fuels or other carbonaceous materials, and oxyfuels. Reactive absorption of CO<sub>2</sub> from the industrial off gases by using chemical solvents is considered as one of the most common, efficient, and cost effective technologies utilized by the industry for CO<sub>2</sub> capture. The captured CO<sub>2</sub> can be stored by using the geological or oceanic sequestration approaches. As an alternative to geological or oceanic sequestration, the captured CO<sub>2</sub> can be re-energized into CO by using solar energy and combined with H<sub>2</sub>, which can be generated from different methods, to produce syngas. The syngas produced can be further processed to liquid fuels such as methanol, gasoline, jet fuel, etc. via the catalytic Fischer-Tropsch process.

In past, a variety of chemical solvents (mostly aqueous amines and their derivatives) have been used for CO<sub>2</sub> capture from different gaseous streams via reactive absorption. Though the amines are attractive for the CO<sub>2</sub> capture application, there are several disadvantages such as very strong corrosion to equipment and piping, high energy requirement during the stripping of CO<sub>2</sub> and they are prone to oxidative and thermal degradation. Recently, use of aqueous potassium carbonate (K<sub>2</sub>CO<sub>3</sub>) as a solvent for the absorption of CO<sub>2</sub> has gained widespread attention. The usage of K<sub>2</sub>CO<sub>3</sub> has been employed in a number of industries for the removal of CO<sub>2</sub> and H<sub>2</sub>S. Due to its high chemical solubility of CO<sub>2</sub>, low toxicity and solvent loss, no thermal and oxidative degradation, low heat of absorption, and

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absence of formation of heat stable salts,  $K_2CO_3$  seems to be more attractive compared to the conventional amines towards  $CO_2$  capture. However,  $K_2CO_3$  solvent shows slow rate of reaction with  $CO_2$  and, consequently, low mass transfer in the liquid phase as compared to the amine solvents. Hence, several investigators are focused towards improving the rate of reaction of  $CO_2$  in  $K_2CO_3$  solvent with the help of different types of promoters.

In this paper, the kinetics of absorption of  $CO_2$  into an aqueous  $K_2CO_3$  (20wt %) promoted by ethylaminoethanol (EAE) solution (hereafter termed as APCE solvent) was studied in a glass stirred cell reactor using a fall in pressure method. Reactive absorption of  $CO_2$  in EAE promoted aqueous  $K_2CO_3$  solution (APCE solvent) was studied at different initial EAE concentrations (0.6 to 2 kmol/m<sup>3</sup>) and reaction temperatures (303 to 318 K). The reaction between the  $CO_2$  and APCE solvent was very well represented by the zwitterion mechanism. The  $N_2O$  analogy was employed for the determination of  $H_-(CO_2)$  in the APCE solvent. The  $H_-(CO_2)$  was observed to be decreased by 5 and 31% due to the increase in the EAE concentration from 0.6 to 2 kmol/m<sup>3</sup> and reaction temperature from 303 to 318 K, respectively. The  $D_-(CO_2)$  in the APCE solvent was also decreased by 21% due to the similar increase in the initial EAE concentration. In contrast, the  $D_-(CO_2)$  increased with the rise in the reaction temperature from 303 to 318 K by a factor of 1.678. The rate of absorption of  $CO_2$  in the APCE solvent was observed to increase by 35.10% and 47.59% due to the increase in EAE concentration (0.6 to 2 kmol/m<sup>3</sup>) and reaction temperature (303 to 318 K). The absorption kinetics was observed to be of overall second order i.e. first order with respect to both  $CO_2$  and EAE concentrations, respectively. The rate constant ( $k_2$ ) for the absorption of  $CO_2$  in the APCE solvent was observed to be equal to 45540 m<sup>3</sup>/kmol•s at 318 K. The temperature dependency of  $k_2$  for the  $CO_2$  – APCE solvent system was experimentally determined as:  $k_2=(1.214 \times [10]^{18}) \cdot \exp((-9822.7)/T)$ . Findings of this study indicate EAE as a promising promoter for the aqueous  $K_2CO_3$  solution.