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Pilot-Scale evaluation of CO_2 loading capacity in AMP aqueous solution beside the improvers HMDA-NH_3 under a series of operational conditions

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ABSTRACT

Nowadays, carbon dioxide removal has to be ingeniously managed due to its environmental and health effects. CO_2 as a heat-trapping greenhouse gas is pumped into the atmosphere through anthropogenic activities. This specific characteristic of CO_2 gas not only adversely impacts the environment but also imposes noxious effects on human life. In spite of all the various and potential scientific technics for CO_2 removal, gas absorption using alkanolamines solvents has played a significant role in industries in recent decades. In the present research, the equilibrium set up for measuring CO_2 solubility in aqueous solvents was assembled. CO_2 loading data in aqueous Amp and Amp (3M) activated with HMDA and NH_3 were assessed under the influence of various operational conditions of CO_2 partial pressures (8.44, 25.33, and 42.22kPa), temperatures (303, 313, and 323K) and solvent concentrations of (0.5, 1.5 and 3M) for pure AMP and (0.4, 0.8 and 1.2M) for HMDA-NH_3. The results show that, for AMP activated HMDA-NH_3, CO_2 loading increased with decreasing system temperature and increasing CO_2 partial pressure. Furthermore adding the HMDA solvent into the pure AMP increased CO_2 loading before it followed a slight decrease.Although, adding NH_3 as an improver into the pure AMP decreased CO_2 loading. Concerning efficiency enhancement, it was comprehended that, HMDA could be considered among promising improvers. However NH_3 as an additive beside AMP or as a based solvent, promote CO_2 absorption characteristics only under specific operational conditions.

Keywords: CO_2 solubility, AMP absorption capacity , Ammonia (NH_3), CO_2 Loading, Absorption Improver

1. INTRODUCTION

The anthropogenic increase of greenhouse gases concentration in the atmosphere is stated to be the root cause of global warming. Among these greenhouse gases, CO_2 is believed to be highly responsible contributing to this issue. The accumulation of CO_2 in the air stems from diverse sources such as steel plants, cement industry and coal-fired power plants [1]. It is estimated that, if these large emitters continue to release CO_2 up into the atmosphere, by the year 2100 the atmosphere may will have loaded up to 570 ppm CO_2. This will then increase the mean global temperature by 1.9 C and the sea level by 3.8 m [2]. To find a solution to this severe environmental concern and to reduce the amplified greenhouse effects, several CO_2 removal methods have been designed after tremendous amounts of laboratory works. Some of them include chemical absorption, physical absorption, refrigerating methods, membrane separation and biological absorption. However gas absorption using aqueous alkanolamine solutions as a mature well-established technology has proved both efficacious and viable among others. Some of the most sought-after solutions in this category which have been exercised by many industries are monoethanolamine (MEA), diethanoleamine (DEA), and methyldiethanolamine (MDEA). Owing to a recent advancement in gas treating technology, a sterically hindered amine 2-amino-2-methyl-1-propanol (AMP) has been proposed as a different class of chemical absorbent [3]. Due to several supremacies in absorption capacity, absorption rate, selectivity, degradation resistance and regeneration energy over conventional alkanolamines it has been called a commercially attractive solvent [4]. Preliminary work on hindered amine solution was conducted by A.K. Chakraborty et.al. Also pahlavanzadeh and jahangiri were the priors to undertook the similar experiment with the introduced CO_2 absorption set up which showed good results [6]. Another study with AMP solvent was conducted by Anoar Ali Khan et.al to prove high loading capacity of this hindered amine [1]. Concerning efficiency enhancement, many researchers made a start on the utilization of blends of alkanolamines, or

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