World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:16, No:06, 2022

Enhancement of CO2 Capturing Performance of N-Methyldiethanolamine (MDEA) Using with New Class Functionalized Ionic Liquids: Kinetics and Interaction Mechanism Analysis

Authors : Surya Chandra Tiwari, Kamal Kishore Pant, Sreedevi Upadhyayula

Abstract : CO2 capture using benign cost-effective solvents is an essential unit operation not only in the process industry for CO2 separation and recovery from industrial off-gas streams but also for direct capture from air to clean the environment. Several solvents are identified, by researchers, with high CO2 capture efficiency due to their favorable chemical and physical properties, interaction mechanism with CO2, and low regeneration energy cost. However, N-Methyldiethanolamine (MDEA) is the most frequently used solvent for CO2 capture with promoters such as piperazine (Pz) and monoethanolamine (MEA). These promoters have several issues such as low thermal stability, heat-stable salt formation, and being highly degradable. Therefore, new class promoters need to be used to overcome these issues. Functionalized ionic liquids (FILs) have the potential to overcome these limitations. Hence, in this work, four different new class functionalized ionic liquids (FILs) were used as promoters and determined their effectivity toward enhancement of the CO2 absorption performance. The CO2 absorption is performed at different pressure (2 bar, 4.4 bar, and 7 bar) and different temperature (303, 313, and 323K). The results confirmed that CO2 loading increases around 18 to 22% after 5wt% FILs blended in the MDEA. It was noticed that the CO2 loading increases with increasing pressure and decreases with increasing temperature for all absorbents systems. Further, the absorption kinetics was determined, and results showed that all the FILs provide an excellent absorption rate enhancement. Additionally, for the interaction mechanism study, 13C NMR analysis was performed for the blend aqueous MDEA-CO2 system. The results suggested that the FILs blend MDEA system produced a high amount of carbamates and bicarbonates during CO2 absorption, which further decreases with increasing temperature. Eventually, regeneration energy was calculated, and results confirmed that the energy heat duty penalty was lower in the [TETAH][Im] blend MDEA system. Overall, [TETAH][Pz], [TETAH][Im], [DETAH][Im] and [DETAH][Tz] showed the promising ability as promoters to enhance CO2 capturing performance of MDEA.

Keywords : CO2 capture, interaction mechanism, kinetics, Ionic liquids
Conference Title : ICCCTPM 2022 : International Conference on Carbon Capture Technologies and Pollution Management
Conference Location : London, United Kingdom
Conference Dates : June 27-28, 2022

Open Science Index, Environmental and Ecological Engineering Vol:16, No:06, 2022 publications.waset.org/abstracts/148628.pdf