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Review on CO_2 capture by blended amine solutions

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ABSTRACT

The procedure of CO_2 removal through the absorption/desorption system based on chemical amine solvents offers an interesting commercial technology to absorb CO_2. However, it has a major drawback regarding the high energy required in the regeneration of the solvent, which has turned into the most important challenge of chemical absorption procedures. Through precise analysis and integration of the rise in CO_2 absorption with energy consumption in the desorption process, this review article has investigated two approaches. The first approach evaluates the development of solvents and the use of amine blends in four forms, i.e., aqueous solutions, non-aqueous solutions, two-phase blends, and ionic blends, with high capacity and absorption. The second approach discusses the changes in operational conditions, process modifications, and integration of thermal power plants to improve efficiency and reduce the high energy demand for PCC technologies. Moreover, an effort has been made to help further the development of absorption technology by presenting future perspectives considering the current condition of absorption, the barriers of amine scrubbing in steam boilers, and reduced thermal efficiency.

1. Introduction

Carbon dioxide emissions are now a serious concern across the globe (Aghel et al., 2022a; Chen et al., 2021). In this sense, the global community is confronted with two competing challenges: rising global energy consumption to accommodate the world's expanding population and mitigating climate change (Aghel et al., 2022c; Helei et al., 2021). A variety of methods, including pre-combustion, post-combustion, chemical looping, as well as, oxyfuel combustion, have been used to minimize CO_2 gas emissions (Chen and Lai, 2019; Liang et al., 2016). Adsorption, Physical/chemical absorption, membrane separation, bioremediation, and cryogenic separation, are the currently available CO_2 collection technologies (Wu et al., 2015). At room temperature and pressure, chemical absorption is the most popular technique of CO_2 removal. In comparison to other CO_2 capture methods, the employment of an amine-based solvent for post-combustion CO_2 capture can directly extract CO_2 from flue gas, which is the rational technique, comparatively cheap, and readily adapted to current power plants. As a result, it has been recognized as the most revolutionary method for capturing CO_2 from power plants (Bui et al., 2018; Liang et al., 2015). Absorption and separation are the two primary steps in amine processing. When Carbon dioxide is absorbed by a lean amine aqueous solution solvent via an absorption procedure, the device used is referred to as an absorber; when Carbon dioxide is extracted from an aqueous solution via a separation or regeneration procedure, the device used is referred to as a regenerator or stripper (Hasan et al., 2021). The absorption stripping technology is especially appealing due to its ability to continually replenish the solution, resulting in a nearly closed cycle (Mofarahi et al., 2008). Unfortunately, one of the major downsides is the high amount of heat needed to renew the amine solvent, which causes a significant power plant performance penalty (Romeo et al., 2008). The fundamental reason for the performance penalty for a power plant incorporated with a CO_2 capture system is that a large volume of steam collected from the steam cycle is needed for the stripper's reboiler for solvent regeneration In a power plant, up to 40% of the steam produced from the power cycle at 3-6 bar may be used in the reboiler (Rochelle, 2016). Amine scrubbing is the greatest commonly acknowledged process for capturing Carbon dioxide from gas mixtures, and it is simple to adapt to existing power plants. Fig. 1 depicts a conventional amine scrubbing method for CO_2 collection from the exhaust gas. The flue gas reaches the absorber first, and CO_2 then interacts with the aqueous amine solutions.

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