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Kinetic experimental study on desorption of decarbonization solution using ammonia method

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HIGHLIGHTS

- Kinetic of desorption in carbon capture using ammonia method was studied.
- The study shows some improvements on experimental method compared with others.
- The kinetic factors are gained through experiment and calculation.

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ABSTRACT

In order to understand the desorption characteristics of decarbonization solution, desorption kinetics of decarbonization solution using ammonia method in carbon capture was investigated. The desorption reaction mechanisms of decarbonization solution was analyzed firstly. The kinetic experimental results indicated that two reaction stages, rapid and slow reaction zones involved in desorption reaction. The experiments also proved that the desorption reaction was a second order reaction, the activation energy and reaction rate constant were 67.5 kJ mol^{-1} and 9.8×10^6 exp $(-8113/T)$, respectively.

1. Introduction

Mainly emitted from coal-fired power plants, carbon dioxide (CO_2) emissions not only became to one of the most concerns to the human beings, but also grown rapidly with the rapid development of power industry [1,2]. It is estimated that about 75% of CO_2 emissions discharged from fossil fuel combustion [3]. How to capture CO_2 efficiently, therefore, has been the key problem for sustainable development.

Carbon capture and storage technology (CCS) plays an important role in reducing global greenhouse gas emissions in recent years [4,5]. International Energy Agency (IEA) predicted that the CCS emission reduction would contribute from 3% in 2020 to 10% in 2030 and further to 19% in 2050 in order to limit the global temperature rise in the scenario of less than 2 °C, and CCS would become the largest abatement share of single technology [6]. Both separation and capture of CO_2, the foundation of the CCS technologies, are the basic forefront research in the international carbon reduction community [7–9].

Nowadays, the technology of ammonia method has become an important direction for the carbon capture. Compared with the traditional monoethanolamine (MEA), using ammonia as decarburization absorbent is better than the MEA solution in many aspects, e.g., removal efficiency, absorption capacity, equipment corrosion, by-product utilization and so on, it has, therefore, a good application prospect in the future [10–12].

Products formed by the reaction of CO_2 and ammonia can be easily decomposed to release subsequently, therefore the absorbent can be regenerated in this way. Desorption and regeneration of decarbonization absorption solutions in carbon capture process has attracted much attentions world widely [13]. Yeh et al. [14] studied the desorption of CO_2 from the main products of the ammonia absorption process under different temperature conditions and found that the desorption efficiency of CO_2 is 60%, when 20% ammonium bicarbonate solution was heated to 87.8 °C.

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