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Improving Performance of K_2CO_3 Sorbent Using Core/Shell Alumina-Based Supports in a Multicycle CO_2 Capture Process

Authors : S. Toufigh Bararpour, Amir H. Soleimanisalim, Davood Karami, Nader Mahinpey

Abstract : The continued increase in the atmospheric concentration of CO2 is expected to have great impacts on the climate. In order to reduce CO2 emission to the atmosphere, an efficient and cost-effective technique is required. Using regenerable solid sorbents, especially K2CO3 is a promising method for low-temperature CO2 capture. Pure K2CO3 is a delinquent substance that requires modifications before it can be used for cyclic operations. For this purpose, various types of additives and supports have been used to improve the structure of K2CO3. However, hydrophilicity and reactivity of the support materials with K2CO3 have a negative effect on the CO2 capture capacity of the sorbents. In this research, two kinds of alumina supports (γ-Alumina and Boehmite) were used. In order to decrease the supports' hydrophilicity and reactivity with K2CO3, nonreactive additives such as Titania, Zirconia and Silisium were incorporated into their structures. These materials provide a shell around the alumina to protect it from undesirable reactions and improve its properties. K2CO3-based core/shell-supported sorbents were fabricated using two preparation steps. The sol-gel method was applied for shelling the supports. Then the shelled supports were impregnated on K2CO3. The physicochemical properties of the sorbents were determined using SEM and BET analyses, and their CO2 capture capacity was quantified using a thermogravimetric analyzer. It was shown that type of the shell's material had an important effect on the water adsorption capacity of the sorbents. Supported K2CO3 modified by Titania shell showed the lowest hydrophilicity among the prepared samples. Based on the obtained results, incorporating nonreactive additives in Boehmite had an outstanding impact on the CO2 capture performance of the sorbent. Incorporation of Titania into the Boehmite-supported K2CO3 enhanced its CO2 capture capacity significantly. Therefore, further study of this novel fabrication technique is highly recommended. In the second phase of this research project, the CO2 capture performance of the sorbents in fixed and fluidized bed reactors will be investigated.

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