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Performance study of activated carbon and silica gel for sorption of CO_2 from a mixture of N_2/CO_2: equilibrium, breakthrough and mass transfer zone

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ABSTRACT

Temperature, feed rate, length of mass transfer zone (L_{MTZ}), utilization factor and partial pressure are parameters for fixed bed sorption of carbon dioxide (CO_2) from N_2/CO_2 mixture. The breakthrough time relies strongly on temperature and feed rate. Prolonged breakthrough time and saturation time have been realized for activated carbon (AC). The response curves of AC are vastly steep, signifying the maximal utilization of bed capacity at the breakpoint. In general, the L_{MTZ} increases with a rise in temperature and feed flow rate. The capacity utilization factor reduces with a rise in temperature and feeds flow rate. A utilization factor of 0.919 was determined for AC at a temperature of 298 K. The maximal capacity for CO_2 reduces significantly with an increase in temperature. The maximal capacity of 32.99 g CO_2/kg was obtained at a temperature of 298 K for AC. This capacity improves considerably with CO_2 partial pressure, and AC exhibits higher adsorption capacity when compared to silica gel. The capacity improves considerably with an increase in feed rates, and a maximal capacity of 39.14 g CO_2/kg was found for AC at a feed rate of 8.33×10^{-5} m^3/s. Owing to its high sorption capacity and utilization factor, the AC can be used for the economical separation of CO_2 from the N_2/CO_2 mixture.

Keywords: Sorption; Utilization factor; Breakthrough; Mass transfer zone; Capacity

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