CO2 adsorption over ion-exchanged zeolite beta with alkali and alkaline earth metal ions

The need to reduce anthropogenic CO_2 emissions has been the driving force to consider new approaches and novel ideas for CO_2 management, and carbon capture and storage (CCS) are considered to potentially be the most effective means to alleviate the problem. The most common method for CO_2 capture is via gas absorption, with monoethanol amine (MEA) being the most widely used solvent. The current amine based systems for CO_2 removal, however, suffer from a high energy requirement for solvent regeneration and corrosion. Thus, alternative processes for CO_2 removal via selective adsorption on solid media such as zeolites, activated carbons, alumina, hydrotalcite-like compounds, metal oxides, and metal organic frameworks (MOFs) are being investigated in this laboratory. Solid adsorbents typically employ cyclic and multi module processes of adsorption and desorption, with desorption induced by either a pressure or temperature swing.

Fig. 1. Breakthrough instrument.

The gas-separation properties of zeolite beta after ion-exchange were recently tested by breakthrough experiments using a CO_2/N_2 (about 15:85 v/v) gas mixture. 0.5 g of pretreated adsorbent was placed inside a U-type stainless-steel column (1.27 cm inner-diameter and 45 cm total length), and the gas mixture was fed into the column at a flow rate of 30 mL/min. All the experiments were carried out at room temperature. The relative amounts of the gases passing through the column were monitored on a Hiden Analytical HPR20 gas analysis system. The relative intensity of each gas component was normalized to the same level by purging gas mixtures through the bypass before they passed through the column. Similar experimrntal work was also conducted over mesoporous alumina prepared by sol-gel process.

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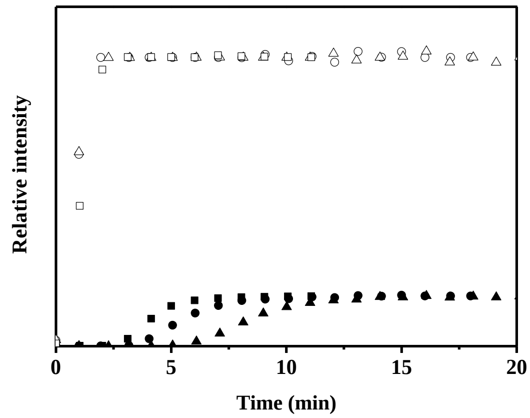

Fig. 2. Breakthrough curves for CO_2 (15 vol%, N_2 balance) adsorption over M-BEA; (○) N_2 Na-BEA, (●) CO_2 Na-BEA, (△) N_2 K-BEA, (▲) CO_2 K-BEA, (□) N_2 Cs-BEA, and (■) CO_2 Cs-BEA.

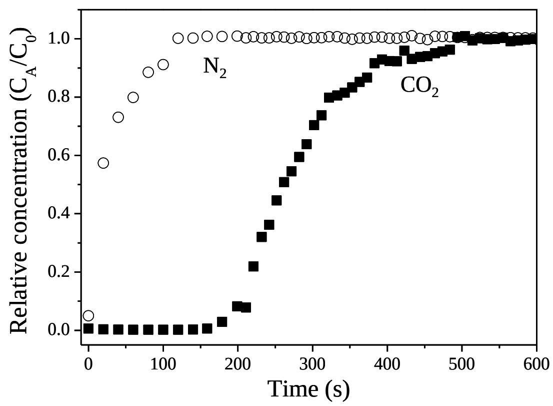

Fig. 3. Breakthrough curve of CO_2 (15% CO_2, 85% balance N_2) on mesoporous alumina.

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