Investigating the competitive adsorption of CO2 and H2O on hydrotalcite-based adsorbents for sewgs processes

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INVESTIGATING THE COMPETITIVE ADSORPTION OF CO2 AND H2O ON HYDROTALCITE-BASED ADSORBENTS FOR SEWGS PROCESSES

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Abstract:

Sorption Enhanced Water-Gas-Shift reaction (SEWGS) is a promising technology for hydrogen production with integrated CO2 capture. SEWGS involves the capture of CO2 in a sorbent material during the water-gas shift reaction, effectively shifting the equilibrium to higher hydrogen yields (due to Le Châtelier’s principle). A pure CO2 stream, which is obtained during sorbent regeneration with steam and further steam condensation, can be used directly for carbon storage. Hydrotalcite-based adsorbents have been investigated as possible candidates for the adsorption of CO2 at elevated temperatures and pressures due to their high stability, fast adsorption/desorption kinetics and high CO2 capacity.
However, there is still lack of understanding of the interactions between small gas molecules such as H2O, CO2 and H2S and the adsorbent. It has been reported in the literature that steam enhances the CO2 sorption capacity of hydrotalcite-based adsorbents. A comprehensive experimental investigation on the ability of these adsorbents to adsorb steam and detailed knowledge on the interactions between H2O and CO2 in a mixed sorption system, are still lacking in the literature.

This study focuses on the influence of water vapor on the sorption kinetics and capacity of hydrotalcites. Isotherms for CO2, H2O and a mixture of CO2 and H2O, have been measured at 400 °C for three different materials. Two potassium promoted hydrotalcite-based adsorbents, with different Mg/Al-ratio (Sasol Germany) and potassium promoted γ-alumina have been investigated to study the influence of the material composition on the sorption properties. We have developed a dedicated Thermogravimetric (TGA) setup to study the adsorption of the gases CO2, H2S and H2O on hydrotalcite-based adsorbents up to 10 bar pressure at elevated temperatures. Five consecutive adsorption –desorption cycles have been found to be sufficient to determine the cyclic adsorption capacity at a certain partial pressure of the reactant gas. The isotherms have been determined in a pressure range from 0 to 8 bar. Based on the adsorption isotherms for the individual gases and their mixtures, the adsorption properties of various HTC materials will be discussed and compared in terms of composition, adsorption sites and sorption kinetics.

Reference 1:
Reference 2 :
Reference 3 :
Reference 4 :

Highlight 1: Sorption Enhanced Water Gas Shift Reaction (SEWGS) for hydrogen production
Highlight 2: Steam adsorption on hydrotalcite based adsorbents
Highlight 3: Adsorption Isotherms at elevated temperatures and pressure