Novel Thermal Swing Sorption Enhanced Reaction Process for Simultaneous Production of H_2 and CO_2 from Synthesis Gas Produced by Coal Gasification

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The goal of this study is to test the feasibility of a novel concept called thermal swing sorption enhanced reaction (TSSER) process to carry out simultaneously the water gas shift (WGS) reaction for the production of a pure stream of H_2 (dry basis) and the separation of CO_2 as a single unit operation in a sorber-reactor. The sorption enhanced reaction (SER) can circumvent the thermodynamic limitation of the WGS reaction and enhance the rate of the forward reaction. New equilibrium and column dynamic data for chemisorption of CO_2 from inert N_2 on K_2CO_3 promoted hydrotalcite and Na_2O promoted alumina were measured. The SER concept was successfully tested using a commercial WGS catalyst and the chemisorbents by both experiments and numerical simulations. The proposed TSSER process was numerically simulated and the results show that the TSSER process is capable of directly producing a fuel-cell grade H_2 product (~10 ppm CO) at feed gas pressure using synthesis gas as the reactor feed. The TSSER process also produces a pure and compressed CO_2 by-product.