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HYDROGEN PRODUCTION WITH CO_2 CAPTURE: A THERMODYNAMIC ANALYSIS OF SORPTION ENHANCED WGS REACTION USING Li_4SiO_4/MgO SORBENT

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ABSTRACT

Hydrogen is primarily produced from methane reforming and coal gasification, but these processes generate significant CO_2 emissions. The sorption-enhanced water-gas shift (SE-WGS) reaction is a promising technology that enables in-situ CO_2 capture during methane reforming while enhancing H_2 production through equilibrium shifts. The choice of sorbent plays a critical role in the performance of the SE-WGS reaction. This study evaluates different Li_4SiO_4/MgO sorbent combinations in a WGS reaction environment over a pressure range of 1–40 bar using the Gibbs free energy minimization method to assess CO_2 removal efficiency, CO conversion, H_2 yield, and sorbent regeneration enthalpy. The results indicate that increasing the Li_4SiO_4 concentration in the sorbent improves CO_2 removal efficiency, CO conversion, but also increases the energy required for sorbent regeneration. Therefore, an optimal Li_4SiO_4/MgO ratio was determined to maximize CO conversion while minimizing energy consumption. The study found that a sorbent composition of 30 mol% Li_4SiO_4 in the Li_4SiO_4/MgO mixture is optimal for achieving maximum CO conversion with minimal sorbent regeneration energy requirements.