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Experimental study of the application of a $NiO/NiAl_2O_4$ catalyst and a CaO-based synthetic sorbent on the Sorption Enhanced Reforming process

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HIGHLIGHTS

- Joint performance of a Ni-catalyst and a CaO-based synthetic sorbent was demonstrated.
- No interaction between the catalyst and the synthetic sorbent was observed.
- 650 °C was the most appropriate temperature value during the tests.
- Equilibrium concentrations were reached at steam/CH_4 ratios as low as 1.6.
- A steam/CH_4=1.6 allowed a self-sustained plant according to simulation work.

KEYWORDS:
Hydrogen; Nickel; Synthetic sorbent; Nickel aluminate; Sorption Enhanced Reforming; Self-sustained plant

ABSTRACT:
A CaO-based synthetic sorbent and a $NiO/NiAl_2O_4$ catalyst are synthesized and tested under Sorption Enhanced Reforming (SER) conditions in a fixed bed reactor. The effect of temperature, steam-to-methane ratio (S/C) and sorbent-to-catalyst proportion (Z) are studied. A SER based plant simulation model is implemented to evaluate if the operating conditions chosen allow for a self-sustained plant from a thermal energy consumption standpoint. The most

appropriate temperature for SER test is 650ºC. At 600ºC the catalyst seems to be not sufficiently active, while at 700ºC, a longer breakthrough period results. SER equilibrium is reached even at the lowest S/C ratio of 1.6, obtaining H_2 purity of 82vol.% (dry basis) . For the SER based plant simulation developed, the low S/C ratio of 1.6 allows a self-sustained plant where the energy required in the calciner for $CaCO_3$ decomposition is supplied by burning the off-gas from the H_2 purification unit.