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Performance of a combined CaO-based sorbent and catalyst on H_2 production, via sorption enhanced methane steam reforming

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HIGHLIGHTS

- A hybrid CO_2 sorbent and reforming catalyst was synthesized through physical mixing.
- It presents a CO_2 carrying capacity over 20 wt.% with respect the CaO in the solid.
- H_2 percentages close to equilibrium are achieved even for a steam to carbon ratio as low as 1.5.
- It was tested cyclically under realistic conditions with H_2 yields over 90 vol.%

KEYWORDS

H_2 production; CO_2 capture; Sorption Enhanced Reforming; Multifunctional catalyst

ABSTRACT:

The performance of an hybrid material CO_2-sorbent and reforming catalyst under Sorption Enhanced Reforming of Methane has been assessed. The material was synthesised through physical mixing of CaO, NiO and Calcium cement aluminate (varying the proportion CaO/NiO to produce three different solids) The materials, that presented a stable CO_2 carrying capacity of 20 % wt. of the total CaO in the solid, were able to reach gas product composition very close or even identical to thermodynamical equilibrium (at 650ºC, steam to carbon ratio, S/C, of 3 and

1200h-1 CH4 spatial velocity), with H_2 yields over 94 vol. % (dry basis). In addition, it has also been demonstrated that the hybrid materials with NiO wt. % contents of 14 and 18.5 can fulfil the thermodinamical equilibrium at S/C ratios as low as 1.4. Finally the 18.5 % NiO material has been tested in cyclic operation, under realistic conditions by regenerating the sorbent in oxidizing conditions. The cycled material showed slight increase of NiO crystal size that resulted in slight loose of activity after cycling. However, H_2 yields over 90 vol. % (dry basis) were always obtained.