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Evaluation of process variables on the performance of Sorption Enhanced Methane Reforming

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HIGHLIGHTS

- Calcination at oxidizing conditions does not affect the catalyst performance.
- Calcination using CO_2 and steam does not affect the sorbent performance.
- The SER step can operate at a relatively high mass hourly space velocity.
- It is possible to work at low H2O/CH4 ratios and at sorbent-to-catalyst ratio of 8.
- Effective catalyst activity is promoted by the sorbent due to Le Chatelier principle.

KEYWORDS:

Sorption Enhanced Reforming; Nickel; Synthetic sorbent; Calcination atmosphere; Space velocity; Cycles

ABSTRACT:

The joint performance of a synthetic Ca-based sorbent and a 10%wt.NiO/$NiAl_2O_4$ catalyst is tested under Sorption Enhanced Reforming (SER) conditions in a fixed bed reactor using CH_4 as fuel. The effect of space velocity, sorbent-to-catalyst proportion (Z) for diverse steam-to-methane ratios (S/C) and the behavior of cycled solids under different calcination conditions (inert, oxidant, with steam and CO_2) are studied. H_2 concentration close to equilibrium values (≈95vol% for S/C=3.2) is achieved working at both, high and low space velocities (0.053 and 0.17molCH_4*h^{-1}*$g_{catalyst}^{-1}$ respectively). In addition, it is possible to work with high sorbent-to-catalyst ratios (Z≈8) that implies economic and environmental benefits for the process. It is also demonstrated the stability of both solids, sorbent and catalyst, working cyclically regardless the demanding and realistic calcination environment (including the presence of CO_2, steam and

oxygen). Thus, H2 purity in SER step close to equilibrium values (≈88vol% for S/C=2) is attained and no carbon deposition is found. In summary, the obtained results confirm the good joint performance of the synthesized solids in SER process even working at demanding conditions.