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Na_2ZrO_3 Stability under Reforming/Regeneration Cycles during the Steam Reforming of Ethanol with CO_2 Absorption

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ABSTRACT

In this work Na_2ZrO_3 and a Ni-Al_2O_3 catalyst were used to evaluate the hydrogen production by the steam reforming of ethanol in combination with CO_2 absorption. The Na_2ZrO_3 was synthesized by the solid state method with a Na_2CO_3/ZrO_2 = 1:1 molar ratio and calcined at 900 °C in air. A 25% W Ni-Al_2O_3 catalyst was synthesized by incipient impregnation and calcined at 900 °C in air. During reforming, operating conditions were: H_2O/C_2H_5OH = 6:1 molar ratio, T = 600 °C, SV = 414 h^{-1}, with a reactor loading of Ni-Al_2O_3/Na_2ZrO_3 = 0.2g/3.7g. Results of the X-ray absorbent confirmed the Na_2ZrO_3 crystalline phase. While, the catalyst shown NiO and Al_2O_3 phases with a surface area of 125 m^2/g. TGA CO_2 absorption tests by Na_2ZrO_3 reached 84.3% of the theoretical absorption value. Ethanol steam reforming without absorbent reached a maximum concentration of 69.1% H_2 (dry basis). After reaction X-ray results shows Ni and Al_2O_3 phases, while maintaining its initial surface area. Regeneration of the absorbent was carried out by separating this from the catalyst followed by calcination in air at T = 900 ° C by 4 hours. For the following reaction cycle the regenerated absorbent was remixed with the catalyst and reloaded to the reactor for a new step of reforming completing a reforming-regeneration cycle (R-Reg). 10 R-Reg cycles were performed resulting an excellent thermal and chemical stability of the Na_2ZrO_3 absorbent. While, during the reforming step an average of 92% H_2 (dry basis), together with 8% CO_2, and CO free with an absorbent carbonation of 17.7% W. These observed values are close to the thermodynamic equilibrium and show excellent compatibility between the reforming and carbonation kinetics, and a great thermal stability of materials resulting in an attractive process for hydrogen production

Keywords: Absorption enhanced reforming; Na_2ZrO_3; Reforming/regeneration cycles