

## ABSTRACT

In this research the concept of the continuous process of sorption-enhanced steam methane reforming (SE-SMR) for pure hydrogen production was investigated. First, the structured Pt/Ni/Al<sub>2</sub>O<sub>3</sub> plate catalyst for SMR was developed. The intrinsic kinetic study was performed on the catalyst, and the kinetics was described by the Langmuir-Hinshelwood mechanism. The carbonization kinetics on the CaO sorbent particles was studied separately, and the well-established Random Pore Model was used for the description. Hydrodynamic experiments with trickling CaO or SiO<sub>2</sub> particles through the packing of structured elements (later catalyst) were carried out with different gases at room conditions in a plexi-glass column. These experiments provided information about the dynamic and static holdup, radial distribution of the solid-phase within the column, and pressure drop of the gas-phase at various conditions. Continuous sorption experiments were then performed with CO<sub>2</sub>-N<sub>2</sub> as reaction mixture, and trickling CaO particles as sorbent. These experiments were carried out at higher temperatures (500 °C and 600 °C), varying the partial pressure of CO<sub>2</sub>, volume flow rate of the gas-phase, and solid flow rate. This study was conducted in a reactor column that had the same arrangement of the structured elements as during the hydrodynamic experiments. The process was satisfactorily described with assuming plug flow behavior of both phases, Random Pore Model for the carbonization kinetics, and Ranz-Marshall correlation for the description of the gas-solid mass transfer. Lastly, continuous SE-SMR proof of concept was carried out with the structured packing now being catalytically active for SMR. The operation was performed at the temperatures of 550 °C and 600 °C, total pressure of 4 bar, and with the constant reaction mixture at the inlet. The volume flow rate of the gas-phase and solid flow rate were varied. It was shown that by adding the sorbent to the SMR system, CO<sub>2</sub> as product was successfully removed from the reaction system, generating higher molar flow rates of H<sub>2</sub> at the outlet of the reaction zone.

**Keywords:** sorption-enhanced steam methane reforming, structured plate catalyst, carbonization, hydrodynamics, trickle bed