# The Influences of the Physical Parameters on the Performance of a Methanol Steam Reformer

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Hydrogen energy is emission-free, portable and possesses high energy density. It is therefore considered one of the potential energy resources. In fuel cell applications, the electrical efficiency and the combined heat and power (CHP) efficiency derived from hydrogen can achieve 60% and 90%, respectively. Although hydrogen is abundantly reserved on earth, it should be extracted from a variety of hydrides. These include fossil fuels like natural gas and alcoholic fuels, as well as biomass and water with power input from renewable energy resources. In the near future, hydrogen produced from fossil energy, accompanying carbon-dioxide capture technologies, can still play a significant role in the progress of the emerging hydrogen economy.

Methanol is regarded as an important feedstock for hydrogen production due to its high energy density and superior transportability. In this work, an experimental platform was constructed to evaluate the performance of a small-scale methanol steam reformer (Fig. 1). The objective was aimed at the influences of various physical parameters on the methanol steam reforming (MSR) process. The hydrogen, carbon monoxide and carbon dioxide production rate, as well as methanol conversion, were experimentally analyzed with respect to different levels of the space velocity of the feed fluid, the porosity and temperature of the catalyst bed, and the steam to carbon (S/C) ratio. It revealed the methanol conversion was sensitive to the temperature of the catalyst bed and the S/C ratio. The maximum methanol conversion does not necessarily correspond to maximum hydrogen production rate since a portion of the generated hydrogen was extracted during the water-gas shift process. The hydrogen production rate can reach more than ten times of the methanol feed rate. In addition, the by-product concentration of CO was significantly larger than $CO_2$, especially when the S/C ratio was less than unity. On the other hand, a packed-bed dispersion model of the methanol conversion is established to analyze the influences of the aforementioned physical parameters. The dispersion coefficients were numerically fitted based on the experimental results. Accordingly, dimensionless parameter groups were discussed as well. It is anticipated to provide clues to systematic design of a MSR reactor.

**Keywords:** methanol steam reforming (MSR), conversion, hydrogen production, dispersion model, packed-bed reactor

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Fig. 1 The experimental platform of a methanol steam reformer employed in this work.