Abstract

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A new promising way to utilize the dilute solution of ethanol is the reforming process of ethanol to produce hydrogen. This hydrogen gas can be passed through the carbonate fuel cell to generate electricity. In this study, the influences of temperature, steam to carbon ratio and feed rate of dilute ethanol solution on the steam reforming reaction over the Ni/Al_2O_3 catalyst were studied in the fixed bed reactor with a diameter of ½ inch. The temperature of reaction was varied in the range of 400-650° C to identify the preferred operating temperature. A series of tests with different ethanol concentration (5, 10, 15, 20 and 25 % by volume) were performed to determine the effect of steam to carbon ratio (corresponding with the steam to carbon ratio of 30.9, 14.7, 9.23, 6.51 and 4.88, respectively) on the reforming reaction. To evaluate the reforming capacity, the feed rate of dilute ethanol solution was changed from 8 to 14, 35 and 73 cm^3/hr. From the experimental results, the gas product compositions were as follows; H_2 = 50-76%, CH_4 = 2-23%, CO = 8-22% and CO_2 = 0.6-24% by volume. Increasing the temperature further from 400 to 650°C resulted in only a small change in % volume of hydrogen. The optimum steam to carbon ratio for ethanol reforming was 9.23. With the increase of dilute ethanol solution feed rate, the %by volume of H_2 was decreased especially when the space velocity was higher than 4,200 hr^{-1}.

For ethanol feed, the design concept of direct fuel cell (DFC or internal reforming fuel cell) can still be applied. However the preconverter that converts ethanol to CH_4- and CO_2-rich gas prior to entering the fuel cell is required. It can be concluded from this study that the pre-conversion process should be operated at high space velocity of 21,000 hr^{-1} and high temperature of 650°C. This design can prevent the carbon deposit on the Ni/Al_2O_3 catalyst inside the reformer.