Effective hydrogen production by low temperature ethanol steam reforming using $30Zn_xNi_y/70MgAl_2O_4$ catalyst

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Prior research of ethanol reforming at high temperatures (> 600 °C) has identified several metallic and oxide-based catalyst systems that improve ethanol conversion, hydrogen production, and catalyst stability [1]. However, in order to generalize the hydrogen utilization, recently, researches have been introduced to obtain hydrogen by reforming ethanol at a lower temperature [2]. The ideal ethanol reforming catalyst will be highly selective to hydrogen, with a low selectivity to methane, acetaldehyde, and a minimal production of CO and other large hydrocarbon complexes while operating in reactor at low temperatures (250–500 ℃) and atmospheric pressures. Catalyst design is particularly critical in the low temperature regime, where reaction kinetics often plays a role larger than thermodynamics.

In this study, $MgAl_2O_4$-supported, 30%-weight Zn_xNi_yO main catalysts will be fabricated and analyzed in their performance as low-temperature ethanol reforming catalysts. We will discuss trends in ethanol reforming over these catalyst systems, identify reaction kinetic parameters for the production of the ethanol reforming byproducts that we detect, and propose future studies to help identify an optimal ethanol reforming catalyst.

In this study, the ethanol reforming reaction was performed at 300 ℃ to 600 ℃ for 1 h at 50 degree intervals. In the catalysts containing no Zn, the amount of hydrogen produced increased as the reaction temperature increased, resulting in the highest amount of hydrogen production at 600 ℃. The result is similar to the results of previous studies in which the typical ethanol reforming reaction starts near 500 ℃ and exhibits the best performance at around 700 ℃ [3]. However, in the case of the catalyst containing Zn only, the best hydrogen generation was observed at 450 ℃. Especially, as the temperature increased, the amount of generated carbon dioxide increased and the generation of hydrogen was decreased. It is believed that Zn was involved in the water gas shift of carbon monoxide positively and eventually increased the rate of carbon dioxide production.

The product distribution for each catalyst at 450 ℃ is shown in Fig. As the amount of Zn increased, the amount of hydrogen generated at 450 ℃ increased, and the highest amount of hydrogen was generated when the ratio of Ni to Zn was 1:3. At this time, the conversion of ethanol was not as high as 75%, because the concentration of ethanol introduced in this experiment was 45%, which was considerably higher than that used in other papers by 10-30% [4], and the catalyst used was relatively small at 0.3g. Therefore, it is considered that there is a need to find an optimal condition. In conclusion, in this study, we could effectively obtain hydrogen at a lower temperature by mixing ZnO, which is used as a water gas shift catalyst, and NiO.

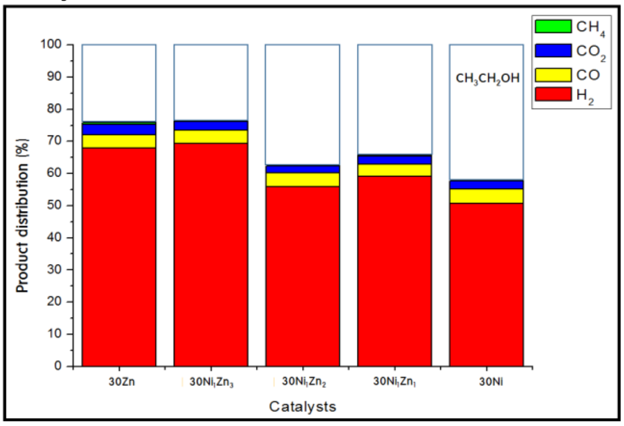

Fig.1. Product distribution in each catalyst during ethanol reforming reaction at 450 ℃.

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