

# Evaluation of La-promoted Ni/Al<sub>2</sub>O<sub>3</sub> Catalyst for Ethanol Dry Reforming

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Greenhouse emissions from combustion of fossil fuels have led to undesirable environmental issues. Hydrogen as a clean and renewable energy is therefore demanded urgently for petroleum-based energy substitution. Although the common method for H<sub>2</sub> production is reforming of hydrocarbons which are unsustainable, ethanol has been considered as an economically attractive feedstock for replacing hydrocarbons due to its high availability, renewability and low toxicity [1]. Ethanol steam reforming has been widely researched whilst the knowledge about dry reforming of ethanol (DRE) is still limited, especially rare-earth promoted Ni-based catalyst. Thus, investigating the physicochemical attributes, activity and selectivity of 3%La-10%Ni/Al<sub>2</sub>O<sub>3</sub> catalyst for DRE was the purpose of this research.

Co-impregnation using La(NO<sub>3</sub>)<sub>3</sub>, Ni(NO<sub>3</sub>)<sub>2</sub> precursor solutions and thermally pretreated  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> support was utilized for catalyst preparation. DRE runs were conducted in a quartz fixed-bed reactor (O.D. = 3/8 in) at 873-973 K and 1 atm with catalyst loading of 0.1 g<sub>cat</sub> per run, gas hourly space velocity, GHSV = 42 L g<sub>cat</sub><sup>-1</sup> h<sup>-1</sup> and catalyst particle size of 100-140  $\mu$ m for minimizing the transport resistances. The effect of CO<sub>2</sub> and C<sub>2</sub>H<sub>5</sub>OH partial pressure on DRE was examined by varying CO<sub>2</sub>:C<sub>2</sub>H<sub>5</sub>OH ratios of 1:1 to 2.5:1 at reaction temperature of 973 K. N<sub>2</sub> gas was fed in the system as the diluent gas for ensuring the total flowrate of 70 ml min<sup>-1</sup>.

3%La-10%Ni/Al<sub>2</sub>O<sub>3</sub> catalyst has BET surface area of 86.09 m<sup>2</sup> g<sub>cat</sub><sup>-1</sup> close to that of

calcined  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> support indicating the fine dispersion of metal oxides on support surface. X-ray diffractogram (cf. Fig. 1) of La-Ni/Al<sub>2</sub>O<sub>3</sub> catalyst detected the presence of NiAl<sub>2</sub>O<sub>4</sub>, NiO and NiLa<sub>2</sub>O<sub>4</sub> phases in line with results obtained from temperature-programmed calcination. C<sub>2</sub>H<sub>5</sub>OH and CO<sub>2</sub> conversions increased from 24.7% to 39.3% and from 16.5% to 21.9%, respectively with growing CO<sub>2</sub> partial pressure, P<sub>CO<sub>2</sub></sub> from 20 to 50 kPa as seen in Fig. 2. Ratio of H<sub>2</sub>/CO was greater than unity and rose from 1.1-1.5 reasonably due to the presence of ethanol dehydrogenation reaction. H<sub>2</sub>, CO and CH<sub>4</sub> formation rates also increased considerably with rising P<sub>CO<sub>2</sub></sub>.

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## REFERENCES

- [1] T.N. Veziroglu and D. Das, Int. J. Hydrogen Energ., 26 (2001) 13.

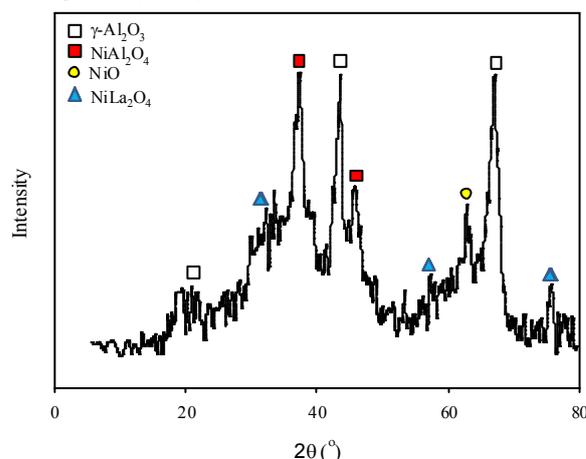


Fig.1 XRD pattern of 3%La-10%Ni/Al<sub>2</sub>O<sub>3</sub>.

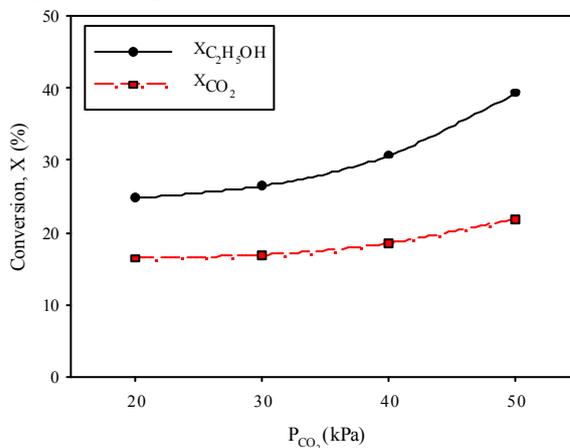


Fig.2 C<sub>2</sub>H<sub>5</sub>OH and CO<sub>2</sub> conversion profile at P<sub>C<sub>2</sub>H<sub>5</sub>OH</sub> = 20 kPa and T= 973 K.