HYDROGEN PRODUCTION VIA CO_2 DRY REFORMING OF GLYCEROL OVER Re-Ni/CaO CATALYSTS

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Extended Abstract

Hydrogen (H_2) has become a promising alternative energy source due to its high efficiency, clean emission and impact in reducing the dependency on non-renewable energy sources [1]. Glycerol has become one of the attractive feedstock for H_2 production and it has received considerable attentions from researchers worldwide [2,3]. Glycerol dry reforming offers a better pathway for the production of H_2 as it is reported to have a greener process where it utilize waste products; glycerol and greenhouse gases (CO_2) as its feedstock. This dry reforming reaction was carried out over two catalysts which is 15%Ni/CaO and 5%Re-Ni/CaO in a packed bed reactor with CGR ratio of 1 – 5, reaction temperature of 600 – 900 °C and GHSV of 1.44 x 10^4 – 7.2 x 10^4 ml g_{cat}^{-1} s^{-1}. From the characterization analyses, fresh 5%Re-Ni/CaO catalyst was found to have lower specific surface area when compared to 15%Ni/CaO due to the plugging of pore. The addition of Re also improved the reduction temperature and contributed to higher acidic sites concentration, hence, improving the catalytic activity of the reaction by enhancing the surface adsorption of OH group in glycerol. From the reaction studies, it was found that suitable operating condition for both catalysts was at 800°C and GHSV of 3.6×10^4 hh^{-1} with CGR of 1.0 for non-promoted and CGR of 3.0 for promoted catalyst. Hydrogen gas was directly produced from glycerol decomposition and indirectly produced through the water gas shift reaction. Post reaction analysis of the spent catalysts using FESEM-EDX and TPO analysis showed existence of whisker carbon from the CO_2 hydrogenation and methanation process.

Keywords: glycerol; dry reforming; hydrogen; nickel-based catalyst; whisker carbon

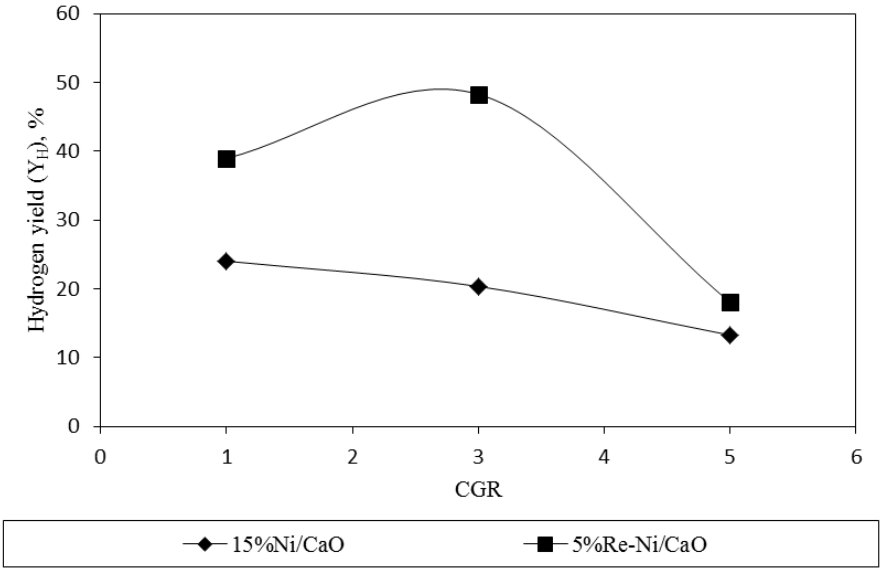

Fig. 1: The hydrogen yield of 15%Ni/CaO and 5%Re-Ni/CaO at different CGR [Reaction conditions: T=700 ˚C, Pgly = 8.41 kPa and GHSV = 3.6 x 10^4 ml g_{cat}^{-1} s^{-1}]

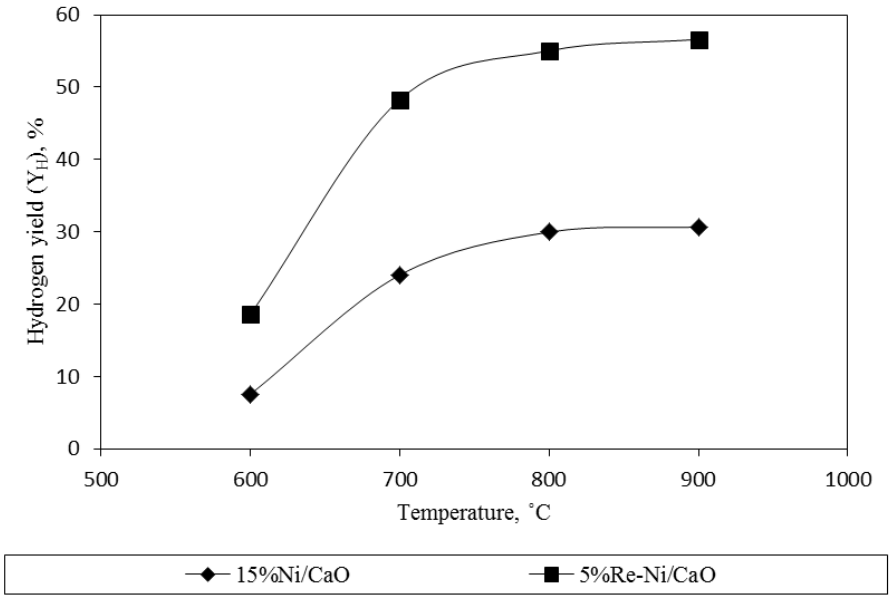

Fig 2: Comparison on hydrogen yield for 15%Ni/CaO and 5%Re-Ni/CaO at different reaction temperatures [Reaction conditions: P_{gly} = 8.41 kPa, CGR=1:1 for Ni/CaO and CGR=3:1 for Re-Ni/CaO, GHSV = 3.6×10^4 ml g_{cat}^{-1} s^{-1}, time = 120 min]

Table 1 Glycerol conversion and gas product yield at different range of GHSV that is manipulated by mass of catalyst from 0.1g to 0.5 g

GHSV (ml g_{cat}^{-1} s^{-1})	Glycerol conversion (X_G), (%)	Yield (%)			
		H_2	CO_2	CO	CH_4
7.2 x10^4	28.49	15.81	8.45	37.20	75.78
3.6 x10^4	60.98	55.55	3.62	73.43	60.51
2.4 x10^4	58.66	50.36	5.53	54.58	48.44
1.8 x10^4	53.20	44.94	5.50	53.89	67.15
1.44 x10^4	44.46	37.09	4.91	47.46	68.03

Acknowledgment

The authors would like to thank Ministry of Higher Education Malaysia for awarding the FRGS research grant (RDU130108) and Universiti Malaysia Pahang for financial support.

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