Renewable Energy 107 (2017) 223–234

Contents lists available at ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene

Catalytic pyrolysis of glycerol into syngas over ceria-promoted Ni/α-Al_2O_3 catalyst

Mohd Nasir Nor Shahirah [a, b], Jolius Gimbun [a, b], Asmida Ideris [a], Maksudur R. Khan [a], Chin Kui Cheng [a, b, c, *]

[a] Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang, Kuantan, Pahang, Malaysia
[b] Centre of Excellence for Advanced Research in Fluid Flow (CARIFF), Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang, Kuantan, Pahang, Malaysia
[c] Rare Earth Research Centre (RERC), Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang, Kuantan, Pahang, Malaysia

ARTICLE INFO

Article history:
Received 1 September 2016
Received in revised form
1 January 2017
Accepted 2 February 2017
Available online 5 February 2017

Keywords:
Alumina
Ceria
Glycerol
Nickel
Pyrolysis
Syngas

ABSTRACT

This paper reports on the catalytic pyrolysis of glycerol into syngas over a 3 wt%Ce-20 wt%Ni/77 wt% α-Al_2O_3 catalyst and at reaction temperatures of 973 K, 1023 K and 1073 K. NH_3- and CO_2-TPD analyses have revealed that the as-synthesized catalyst was net acidic with acid-to-basic site ratio of 1.24. This provides ideal conditions for chemisorption of glycerol. In addition, the BET specific surface area was 2.89 $m^2\ g^{-1}$. The small surface area can be attributed to the thermally stable α-Al_2O_3 support. In addition, the average crystallite size was 40.22 nm. The catalytic glycerol pyrolysis produced gaseous products that were comprised of H_2, CO, CO_2 and CH_4 only with H_2:CO ratios that were consistently less than 2.0. This ratio is suitable for Fischer-Tropsch synthesis. The yields of CO_2 and CH_4 were several folds lower than the yields of H_2 and CO, indicating that the latter were from primary reaction, viz. glycerol decomposition whilst the former were from secondary competing reactions. In addition, the activation energy obtained via Langmuir-Hinshelwood model was 25.34 kJ mol^{-1}. Used catalyst characterization showed that the carbonaceous deposit was in the forms of whisker-type. This type of carbon deposit would not physically deactivate the catalyst.