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# Glycerol dry reforming over Ni supported on fibrous ZSM5 and ZY: Correlation of structural properties on $H_2$ production

N. Abdullah [a], N. Ainirazali [a,b,*], N.S.S. Hanafi [a], H.D. Setiabudi [a,b], S.Y. Chin [a,b], A.R. Mohamed [c], A.A. Jalil [d,e]

[a] Faculty of Chemical and Process Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, Kuantan, Pahang 26300, Malaysia
[b] Centre for Research in Advanced Fluid & Processes, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, Kuantan, Pahang 26300, Malaysia
[c] School of Chemical Engineering, Engineering Campus, Universiti Sains Malaysia, Seberang Perai Selatan, Nibong Tebal 14300, Malaysia
[d] School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia (UTM), Johor Bahru 81310, Malaysia
[e] Centre of Hydrogen Energy, Institute of Future Energy, Universiti Teknologi Malaysia (UTM), Johor Bahru 81310, Malaysia

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ABSTRACT

This study investigates fibrous ZSM5 (FZSM5) and Zeolite Y (FZY) as supports for producing hydrogen via glycerol dry reforming. The fibrous ZSM5 and ZY were synthesized hydrothermally with microemulsion and impregnated with 10 wt% Ni via a sonication method. The catalytic test was conducted via a vertical stainless steel fixed-bed rig, at 800°C with a glycerol/$CO_2$ ratio of 1. XRD and $N_2$ sorption revealed the reduced surface area and crystallinity in Ni/FZSM5 compared to Ni/FZY. Ni/FZY catalyst displayed a larger surface area (264 $m^2/g$) and aperture width (6.70 nm) in comparison to Ni/FZSM5, which had a surface area of 238 $m^2/g$ and an aperture width of 3.90 nm. Ni/FZY also had a smaller NiO crystallite size (8.73 nm) than Ni/FZSM5 (9.79 nm), suggesting well-dispersed Ni species on the wrinkle fiber of FZY's surface. Ni/FZY outperformed Ni/FZSM5 with 52.49 % glycerol conversion, 44.87 % $H_2$ yield, 71.31 % CO yield, and only 14.4 % carbon formation, attributed to robust Ni-O-Si contact and larger pore diameter. The discovery highlights the catalytic efficiency of the Ni-loaded fibrous zeolite in GDR, offering versatility for application in energy storage and catalysis.

## 1. Introduction

Rising concerns about global warming and urgent energy security issues have driven the demand for sustainable energy to replace non-renewable fuels. In fact, the preceding several years have shown that human society is overly dependent on the use of fossil fuels (Khor et al., 2022; Martínez et al., 2020). As a result, there has been a rapid rise in serious environmental stress resulting from the mismanaged emission of greenhouse gases (GHGs) with $CO_2$ emissions from fossil fuels burning increased by 1 % globally in 2022 compared to 2021, and 12 million hectares per year of forest destroyed for deforestation (UN-Water, 2021). The world's oil supply situation is likely to reach a critical point, adding to this misery, as the majority of the main oil exploration sites are thought to have been disclosed. Currently, the goal of the global contingency plan is to use synthesis gas (syngas) and $H_2$ as alternative sources of energy.

Most of the research regarding the production of $H_2$ has been concentrated on using simple carbon compounds such as $CH_4$ (Chein and Fung, 2019; Han et al., 2024; Li et al., 2018; Xu et al., 2019). Nonetheless, many scholars are interested in using glycerol as a substrate for

*Abbreviations:* BET, Brunauer Emmett Teller; CC, Cement Clinker; FTIR, Fourier Transform Infrared; FZSM5, Fibrous Zeolite Socony Mobil–5; FZY, Fibrous Zeolite Y; GC-TCD, Gas Chromatography with Thermal Conductivity Detector; GDR, Glycerol Dry Reforming; GHG, Greenhouse Gases; GHSV, Gas Hourly Space Velocity; HFZ, Fibrous Silica ZSM-5 Zeolite; KCC-1, KAUST Catalysis Center; Ni/FZSM5, Nickle loaded on Fibrous Zeolite Socony Mobil–5; Ni/FZY, Nickle loaded on Fibrous Zeolite Y; SBA-15, Santa Barbara Amorphous-15; STP, Standard Temperature and Pressure; TEM, Transmission Electron Microscopy; TGA, Thermogravimetric Analysis; XPS, X-ray Photoelectron Spectroscopy; XRD, X-Ray Diffraction; ZSM5, Zeolite Socony Mobil–5; ZY, Zeolite Y.

* Corresponding author at: Faculty of Chemical and Process Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, Kuantan, Pahang 26300, Malaysia.
*E-mail address:* ainirazali@umpsa.edu.my (N. Ainirazali).

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