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Aqueous Phase Reforming of Sorbitol Over Sonosynthesized Ca-Doped Ni Supported On Al_2o_3 and Tio_2 for Production of Value Added Chemicals

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EXTENDED ABSTRACT

Production of value added chemicals derived from renewable carbohydrate such as sorbitol through the aqueous phase reforming is a promising technology. Aqueous phase reforming for industrial without highly effective and efficient catalyst in term of its operational lifetime and catalytic activity. Supported nickel catalyst has been identified have good selectivity of alcohols for aqueous phase reforming of sorbitol, and support such as Al_2O_3 and TiO_2 has been identified as support which has good surface area and active sites. In this work, the effect of introducing the varying percentage of Ca (0%, 0.5%, 3% and 5%) as promoter onto 10% Ni supported on two potential catalyst support, TiO_2 and Al_2O_3 have been investigated. The catalysts are prepared via the sonochemical method, where the catalysts are synthesized under ultrasonic irradiation for 45 minutes using ultrasonic probe at 90W using methods by Abdollahifar, et al. [1], where sonochemical method has discovered to enhance the dispersion of particles, improve surface area and increase the performance. The sonosynthesized catalysts were then subjected for characterization by using Thermogravimetric Analysis (TGA), Scanning Electron Microscopy (SEM), Xray Powder Diffractometer (XRD), H2-Temperature Programmed Reduction (H2-TPR) and Brunauer–Emmett–Teller (BET) in order to investigate the physicochemical and morphological characteristic of the catalysts. The experimental work was carried out in a batch reactor (230˚C, 20 bar, 1 hour) to evaluate the performance of every catalyst for aqueous phase reforming. The liquid products obtained were analyzed by using HPLC analysis in order to determine the type of products formed. Based on the findings, TiO_2 supported catalyst is discovered to have far more superior performance in terms of particle dispersion, surface area and crystallinity compared to Al_2O_3 supported catalyst. Congruently, the addition of Ca as a promoter has shown remarkable effect on the catalysts as it increases selectivity of 1,3-propanediol for most of the catalysts, one of the notable value-added chemicals commonly produced from glycerol [2], especially at 5% Ca + 10% Ni/TiO_2, where the yield of the 1,3-propanediol is 0.674 mol. In general, Ni/Al2O3 and Ca-doped Ni/Al2O3 tends to favour production of C4-C5 alcohols and diols such as pentanol and 1,4-butanediol while Ni/TiO2 and Ca-doped Ni/TiO2 tends to favour production of C2-C3 alcohols and diols such as 1,3 propanediol and ethylene glycol. In addition, sonochemical synthesis method is also proven to improve dispersion of Ni and Ca particles and surface area even at high percentage of Ca doping. Detailed analysis of the liquid products formed shows the production of various types of valuable liquid chemicals such as ethylene glycol, propionaldehyde, pentanol, 1,4 butanediol and 1, 3 propanediol at different percentage of Ca can be observed on Fig. 1, where those products are at

relatively high yield, which is among the possible 43 products to be produced by aqueous phase reforming of sorbitol [3].

Keywords: Aqueous phase reforming; Sorbitol; Nickel; Calcium; Sonosynthesis
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