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Optimization on Glycerol and Acetic acid Molar Ratio for Conversion of Glycerol into Acetin

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Structured Abstract

Background: The abundance of glycerol by-product from biodiesel synthesis contributed to an oversupply in global market with a decline in its market price. Considering glycerol as valuable resource, it is necessary to utilize glycerol into valuable derivatives through several processes. This study utilized glycerol into its derivatives, acetin through esterification reaction. Among acetin mixture, triacetin is considered as the most valuable product compared to monoacetin and diacetin due to polarity. However, achieving high triacetin selectivity from the reaction can be a challenged. To add, selecting molar ratio of glycerol to acetic acid for esterification is crucial to achieve optimum value for high glycerol conversion. This study aims to obtain the highest glycerol conversion and triacetin selectivity by optimizing the reactant molar ratio.

Methods: Sulfonated polydivinylbezene catalyst (PDVB-SO_3H) which used to facilitate the esterification of glycerol and acetic acid is prepared by mixing azobisisobutyronitrile (AIBN) with mixture of tetrahydrofuran (THF), deionized water and divinylbenzene (DVB) which then hydrothermally treated in an oven. PDVB sulfonation is carried out to introduce sulfonic acid groups (-SO_3H) onto polymer backbone before PDVB-SO_3H is used in esterification process. Total Acid Content, CHNS Elemental Analyser, Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR), X-Ray Diffraction (XRD), Thermogravimetric analysis (TGA), and Brunauer-Emmett-Teller (BET) analysis are used to characterize PDVB-SO_3H to determine its physical and chemical properties. Esterification of glycerol and acetic acid is further conducted using fixed temperature, 115 °C and reaction time of 3 hours at different molar ratio of 1:3, 1:6, 1:9 and 1:12.

Results: The result of Total Acid Content and CHNS analysis showed the presence of -SO_3H group in PDVB-SO_3H and absence in PDVB suggested that sulfonation process has introduced -SO_3H group into PDVB polymer. Product analysis by Gas Chromatography-Mass Spectrometry (GC-MS) showed highest triacetin selectivity (43.5%) and glycerol conversion (100%) at 1:9 molar ratio with the aid of 2.0% (wt/wt%) PDVB-SO_3H catalyst.

Conclusion: In conclusion, there is considerable potential in further optimizing the reaction to achieve higher product of acetin. Utilizing glycerol into acetin can offer significant market opportunity and benefit the economies as triacetin is useful in applications of cosmetic production or in fuel additives.

Keywords: Polydivinylbenzene, Sulfonated polydivinylbenzene, Acetin

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