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Research Article

Use of Sulfuric Acid-Impregnated Biochar Catalyst in Making of Biodiesel from Waste Cooking Oil via Leaching Method

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SUPPORTING INFORMATION

The method consisted of catalyst preparation and characterization followed by biodiesel synthesis and characterization. For the catalyst preparation scheme can be depicted in the Figure A:

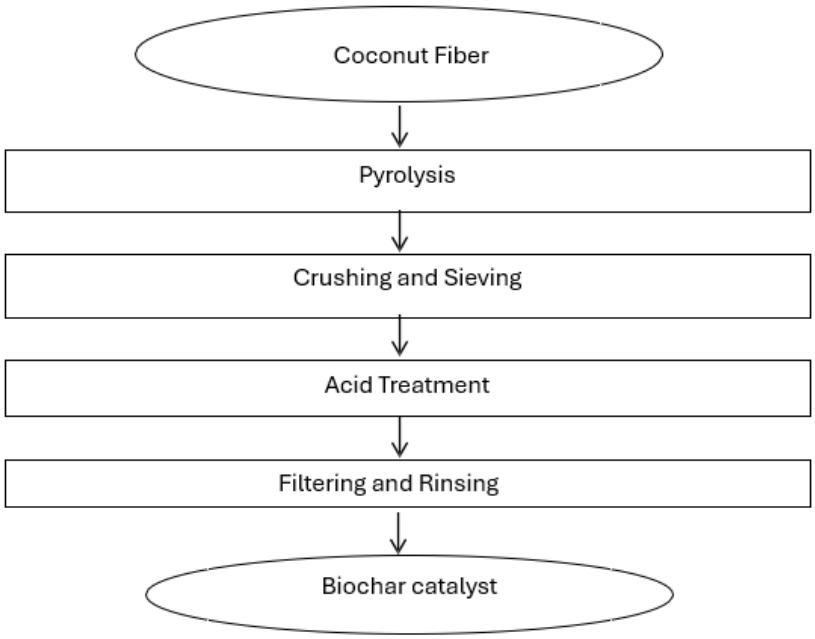

Figure A. Scheme of Catalyst Preparation

The coconut fiber is ground into short pieces, placed within a jacket made of stainless steel and subjected to pyrolysis for 2 hours at 700 °C, then crushed using a mortar and sieved using a sieve shaker with a size

of 250 μm. The resulting biochar was added to 100 mL of 5 N sulfuric acid in an Erlenmeyer flask, then heated to a temperature of 50 °C and stirred for 1 hour. The filtrate was filtered and the residue was rinsed several times until the pH became neutral using distilled water to remove excessive acid content in the residue. The residue was then dried at 70 °C for 2 hours. The results will be used as a catalyst.

We utilized XRD to characterize the catalyst phase. In The XRD results, the degree of crystallinity is calculated based on the formula:

$$Cr.I. = \frac{Ac}{At}\ x\ 100\% \quad (1)$$

Where: A*c* = Crystallinity Area (Integral of Peak)

A*t* = Total Area (Integral of Peak + Amorphous + Background)

In addition, the functional group, composition, surface area, and morphology were characterized using XRF, BET, and SEM-EDS instruments.

The following Figure shows a schematic of the biodiesel synthesis:

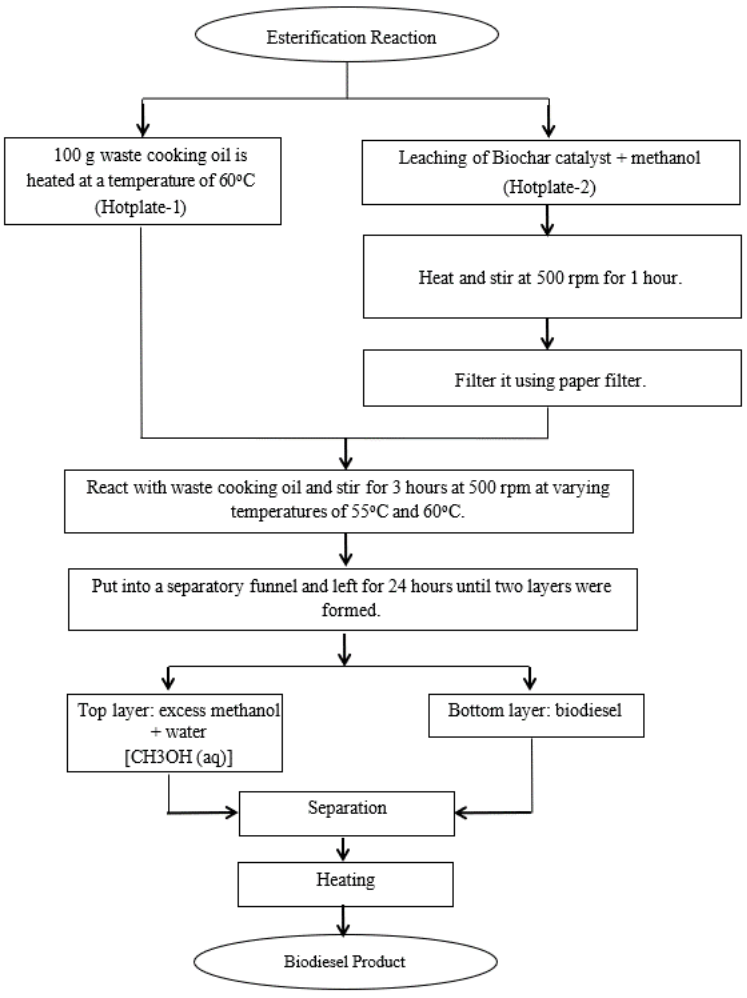

Figure B. Scheme of Biodiesel Synthesis

The esterification reaction was designed using waste cooking oil from previous studies with 3.91 mg KOH/g of acid number, 1208 g/mol of molecular weight, and 1.40 of Free Fatty Acid (FFA) content[5]. For

completeness, waste cooking oil carbon bond distribution data was also characterized by the Gas Chromatography-Flame Ionization Detector (GC-FID) instrument. In the esterification process, 100 g of oil is heated at 60°C using a hot plate. Meanwhile catalysts with variations of 5, 7, and 10wt.%, and methanol with a mole ratio of 1:76 were mixed in a reaction flask, stirred, and heated using a different hot plate and stirred for 1 hour. The catalyst-methanol mixture was filtered using Whatmann 42 paper under vacuum conditions, then the results were directly mixed into waste cooking oil and stirred for 3 hours at at 60°C. The reaction results are put into a separating funnel and left for 24 hours to separate the product and the remaining reactants. The separated biodiesel layer is then heated at 105°C for 10 minutes. Next, the yield calculation is carried out based on the formula:

$$Biodiesel\ Yield = \frac{Weight\ of\ biodiesel}{Weight\ of\ oil}\ x\ 100\% \quad (2)$$

Apart from varying the catalyst weight, mole ratio variations of 1:12, 1:38, and 1:76 and temperature variations of 55 and 60 °C were also carried out. It is to enrich the analysis and look for the most significant biodiesel yield. Then the biodiesel product with the largest calculation results was further identified in two ways, i.e. analytical and characterization. The analytical method is carried out using a Gas Chromatography-Mass Spectroscopy (GC-MS) instrument, while the characterization method is carried out by measuring fuel properties, based on the SNI 7182-2015 procedure with parameter limitations, i.e. density, viscosity, iodine number, and acid number.