

## **PREPARASI DAN KARAKTERISASI KATALIS $SO_4/SiO_2$ DAN $KF/SiO_2$ SERTA APLIKASINYA PADA SINTESIS BODIESEL DARI LIMBAH MINYAK SAWIT**

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### **INTISARI**

Preparasi dan karakterisasi katalis asam  $SO_4/SiO_2$  dan katalis basa  $KF/SiO_2$  telah berhasil dilakukan untuk digunakan pada konversi limbah minyak sawit menjadi biodiesel. Penelitian ini bertujuan untuk mempelajari pengaruh penambahan konsentrasi  $H_2SO_4$  dan  $KF$  serta suhu kalsinasi pada sifat keasaman dan kebasaaan material katalis. Selain itu, untuk mempelajari pengaruh sifat keasaman dan kebasaaan katalis pada proses konversi limbah minyak sawit menjadi biodiesel.

Silika dipreparasi melalui metode *sol-gel* menggunakan prekursor tetraetil ortosilikat (TEOS) dan cetakan setiltrimetil amonium bromida (CTAB) dengan metode pemanasan dengan bantuan gelombang mikro (*microwave*) dan konvensional. Katalis asam diperoleh dengan metode impregnasi basah material silika dengan larutan  $H_2SO_4$  (0,5; 1,0; 1,5; 2,0 M). Katalis basa diperoleh dengan metode impregnasi basah material silika dengan larutan  $KF$  (0,5; 1,0; 1,5; 2,0 M). Katalis asam dan basa kemudian dikalsinasi pada variasi suhu 450, 500, 550, 600 °C. Karakterisasi katalis asam dan katalis basa dilakukan dengan instrumen FTIR, XRD, SEM-EDX, SAA, dan TGA-DTA.

Metode pemanasan dengan bantuan gelombang mikro menunjukkan waktu reaksi yang lebih efisien hingga 50% dan menunjukkan luas permukaan yang lebih tinggi yaitu 556,4  $m^2/g$ . Kondisi tersebut lebih baik jika dibandingkan terhadap metode pemanasan konvensional. Kondisi optimum katalis asam dengan nilai keasaman 0,97 mEq KOH/g dicapai oleh  $SO_4/SiO_2$  2,0-550, sedangkan kondisi optimum katalis basa dengan nilai kebasaaan 1,64 mmol HCl/g dicapai oleh  $KF/SiO_2$  2,0-550. Penurunan kadar asam lemak bebas optimum diperoleh pada kondisi reaksi 5% berat katalis, 1:23 rasio mol minyak:metanol, 60 menit waktu reaksi dengan penurunan kadar asam lemak bebas dari 3,6% menjadi 1,62%. Konversi limbah minyak sawit menjadi biodiesel menghasilkan metil ester hingga 54,13% yang dianalisis menggunakan GC-MS.

Kata kunci: katalis asam ( $SO_4/SiO_2$ ), katalis basa ( $KF/SiO_2$ ), gelombang mikro, limbah minyak sawit, biodiesel

## PREPARATION AND CHARACTERIZATION OF $\text{SO}_4/\text{SiO}_2$ AND $\text{KF}/\text{SiO}_2$ CATALYSTS AND ITS APPLICATION IN BIODIESEL SYNTHESIS FROM WASTE OF PALM OIL

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### ABSTRACT

Preparation and characterization of acid catalysts  $\text{SO}_4/\text{SiO}_2$  and base catalysts  $\text{KF}/\text{SiO}_2$  have been successfully conducted to be applied in conversion of waste of palm oil into biodiesel. This research aims to study the effect of  $\text{H}_2\text{SO}_4$  and  $\text{KF}$  concentrations and calcination temperature on the acidity and basicity of the catalyst. Moreover, to study the effect of the acidity and basicity of the catalyst on the conversion process of waste of palm oil into biodiesel.

Silica was prepared through the sol-gel method using a tetraethyl orthosilicate (TEOS) as the precursor and cetyltrimethylammonium bromide (CTAB) as template using microwave and conventional heating methods. The catalysts were prepared by wet impregnation of silica with  $\text{H}_2\text{SO}_4$  (for acid catalysts) and  $\text{KF}$  (for base catalysts) with various concentrations (0.5; 1.0; 1.5; 2.0 M). The acid and base catalysts were then calcined at various temperatures of 450, 500, 550, 600 °C. Characterization of acid and base catalysts were carried out with the instruments of FTIR, XRD, SEM-EDX, SAA, and TGA-DTA.

The microwave heating method reduced up to 50% of reaction time and showed a higher surface area of 556.4  $\text{m}^2/\text{g}$ . These conditions are better compared to conventional heating methods. The optimum condition for acid catalysts with acidity value of 0.97 mEq KOH/g was achieved by  $\text{SO}_4/\text{SiO}_2$  2.0-550, while the optimum condition for base catalysts with basicity value of 1.64 mmol HCl/g was achieved by  $\text{KF}/\text{SiO}_2$  2.0-550. The optimum reduction in free fatty acid levels was obtained under the reaction conditions of 5% by weight of the catalyst, 1:23 mole ratio of oil: methanol, 60 minutes of reaction time with a decrease in the free fatty acid content from 3.6% to 1.62%. The conversion of waste of palm oil into biodiesel produced up to 54.13% of methyl esters which were analyzed using GC-MS.

Keywords: acid catalyst ( $\text{SO}_4/\text{SiO}_2$ ), base catalyst ( $\text{KF}/\text{SiO}_2$ ), microwave, waste of palm oil, biodiesel