Preparation of Biodiesel from Palm Oil Catalyzed by Calcium Oxide as Solid Heterogeneous Catalyst

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Transesterification Reaction

\[
\text{CH}_2 - \text{O} - \text{C} - R_1 + 3 \text{CH}_3\text{OH} \rightarrow \text{CH}_3 - \text{O} - \text{C} - R_1 + \text{CH}_2 - \text{OH}
\]

Triglyceride \hspace{1cm} \text{methanol} \hspace{1cm} \text{methyl esters} \hspace{1cm} \text{glycerin}
Esterification Reaction

\[
\begin{align*}
R - C - OH & \quad + \quad R'OH \quad \xrightleftharpoons{H^+} \quad R - C - OR' \quad + \quad H_2O \\
\text{Carboxylic Acid} & \quad \text{Alcohol} \quad & \quad \text{Ester} \quad \text{water} \\
\end{align*}
\]
Catalyst Technology in Biodiesel Production

- Homogeneous Catalyst (Base/Alkaline and Acid)
  - Alkaline: corrosive to equipments, react to FFA, expensive in separation steps (downsteram process), catalyst can not be recycle and reuse
  - Acid: corrosive to equipments, toxic, catalyst can not be recycle and reuse and less or no environment friendly.
  - Lipase: expensive, adenaturate to alcohol and FFA, adsorp of glycerol
- Heterogeneous Catalyst: non-corrosive, non toxic, easy in separation steps, catalyst can be recycle and reuse

Inovation Process and potential for Development process
Biodiesel Production by using Heterogenous Catalyst

- Transesterification of Triglyceride by CaO heterogeneous catalyst
- Liu, et.al (2008), Fuel 87, p1076 - 1082. Transesterification of soybean oil with methanol using CaO (t = 3 hours; 6% CaO, mol ratio 1:25 and T = 60 C) yield 97%.
Transesterification Mechanism

< Step 1>
R-OH → R-O⁻ + H⁺

< Step 2>

< Step 3>
CH₂-O → CH₂-O⁻ + H⁺
Methodology

- **Methanol**
  - Reaction for 30 mnt
  - Varied of Temperature and time
- **CaO**
  - Grinding
- **Palm Oil**
  - Heated at +90°C
- **Product**
  - Rotavapor
  - Biodiesel + CaO + glycerol
  - Settling for ± 8 hrs
  - Separation
    - Biodiesel
    - CaO
    - Glycerol
      - Product Analysis
      - Weighing
      - Weighing
Results

- Process parameter: catalyst dosage, mol ratio, reaction time and temperature
Analysis of product (1)

- Viscosity
Analysis of product (2)

- pH
Analysis of product (3)

- Density
Analysis of product (4)

- Caloric value
Summary

- Transesterification of palm oil with methanol using CaO as heterogenous base catalyst produced biodiesel (methyl esters).
- Optimum parameter for transesterification process consisted of 6% CaO, mol ratio of 1:12, reaction time of 3 hours at 60°C giving yield of 99% of biodiesel.
- Analysis of product indicated that pH, density, flash point, and caloric value fitted to the Standard of Forum Biodiesel Indonesia (FBI-S01-03) as well as European and US standards, whereas viscosity was slightly higher than FBI standard.
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