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SYNTHESIS OF GLYCERIN FROM WASTE COOKING OIL

Mr. Kale Sarthak Jalindar
Department of Chemical Engineering,
Pravara Rural Engineering College,

Mr. Kale Rohit Ramesh
Department of Chemical Engineering
Pravara Rural Engineering College

Mr. Walunj Rushikesh Navnath,
Department of Chemical Engineering
Pravara Rural Engineering College

Mr. Tambe Kartik Rajendra
Department of Chemical Engineering
Pravara Rural Engineering College

MR. R. L. Nibe
Department of Chemical Engineering
Pravara Rural Engineering College, Loni

Abstract

Biodiesel is becoming an important substitute for conventional petroleum-based fuel due to the rapid evolution of the world towards sustainable energy sources, however, the economic success of this change relies solely on how effectively by-products from the production of biodiesel are managed. The most significant by-product created during the synthesis of biodiesel is that of crude glycerol; this material is generated at an average rate of 10% by weight compared to the total amount of biodiesel produced. This study outlines a method for synthesizing and purifying technical grade glycerin created from waste cooking oil (WCO). A typical transesterification reaction uses a reaction volume of 800 mL of WCO, 280 mL of methanol, and 9 g of sodium hydroxide as the catalyst, however, the transesterification process must be optimized to achieve the greatest amount of biodiesel conversion possible. After the transesterification process was completed, the crude glycerol was subjected to a multi-stage purification process to convert the material into technical glycerin (i.e., the glycerol must be converted from the crude state containing 42% glycerol into a final product with >96% glycerol) wherein the purification involved acidification with 17 mL of hydrochloric acid (HCl), dewatering, and decolorizing using 6 g of activated carbon.

.**Important keywords:-** Transesterification, waste cooking oil, purification of glycerine, activated carbon, sustainable chemical engineering, circular economy.

I. INTRODUCTION

The contemporary global energy landscape is characterized by an increasing demand for energy and a simultaneous requirement to mitigate the environmental impacts of fossil fuel consumption. Biodiesel has emerged as a frontrunner in this transition due to its inherent compatibility with existing engine infrastructure and its superior biodegradability.[1] However, the rapid expansion of the biodiesel industry has introduced the challenge of managing the massive overproduction of crude glycerol.[3] For every 10 kg of biodiesel synthesized, approximately 1 kg of crude glycerol is produced as a byproduct.[5]

Waste cooking oil (WCO) serves as the primary feedstock for this investigation. WCO is an abundant waste stream that, if improperly disposed of, leads to significant environmental degradation.[1] Utilizing WCO for chemical synthesis reduces feedstock costs and addresses the "food vs. fuel" debate.[1] Under the guidance of R. L. Nibe at Pravara Rural Engineering College, this study explores the synthesis and purification of glycerin using 800 ml of WCO, 280 ml of methanol, 9 g of NaOH, 17 ml of HCl, and 6 g of activated charcoal to create a roadmap for small-scale chemical refining.[9]

II. MATERIALS AND METHODS

The research methodology lays out the planned experiment based upon established principles in chemical engineering..

2.1 Materials Inventory

Table 1 provides an overview of the materials used in the synthesis and purification of the chemicals to be analyzed. This will assist in standardizing the results from the experiment. All reagents were of laboratory quality.

Material	**Quantity**	**Role**
Waste Cooking Oil (WCO)	800 ml	Feedstock
Methanol	200 ml + 80 ml	Reactant and solvent
Sodium Hydroxide (NaOH)	9 g	Catalyst
Hydrochloric Acid (HCl)	17 ml	Acidification agent

Activated Charcoal	6 g	Adsorbent
Distilled Water	As required	Washing/Solvent

2.2 Synthesis Procedure (Transesterification)

Creating crude glycerin uses a transesterification pathway that is catalyzed by base (a strong alkaline substance). The steps taken to create the crude glycerin are:

1. Steam-clean the oil: Pre-heat 800ml of used cooking oil at 110 degrees Celsius to evaporate any moisture. Allow the oil to cool to 55 degrees Celsius.
2. 2.Creating the catalyst: Mix 9 grams of sodium hydroxide in 200ml of methanol (to create sodium methoxide).
3. Starting the reaction with the catalyst and used cooking oil: Mix sodium methoxide with 800ml of used cooking oil at 55 degrees Celsius for 60 minutes to create biodiesel and crude glycerin.
4. Separating the layers: Allow the biodiesel/crude glycerin mixture to sit for 24 hours in a separating funnel. After 24 hours, remove the layer of biodiesel, but leave the thick .

2.3 Purification Procedure

1. **Evaporation:** The crude glycerol is heated to reduce its volume and remove excess methanol .
2. **Acidification:** 17 ml of HCl is added to the crude glycerol to lower the pH. This converts soaps into free fatty acids and salts .
3. **Phase Separation:** Two layers form; the upper fatty acid layer is removed, leaving the purified glycerol solution at the bottom .
4. **Neutralization:** A small amount of NaOH is added to adjust the pH of the glycerol back to 7.0 .
5. **Decolorising—**6 grams of activated carbon are added to the glycerine (and usually dissolved in the remaining 80 ml of methanol). The mixture is heated to 70 °C or 80 °C for 30 to 60 minutes with constant stirring**.**
6. **Final Filtering**—After filtering out the carbon from solution, the solution is heated to 110 °C (to drive off any absorbed moisture and/or remaining methanol), resulting in technical crystalline glycerin.

III. RESULTS AND DISCUSSION

3.1 Feedstock Characterization

The WCO collected from Loni had a greater acid number than WCOs collected from various other institutions because the oil had thermally degraded over time.

Table 2: Properties of WCO Feedstock

Parameter	**Value**
Density (g/cm³)	0.922
Kinematic Viscosity (mm²/s)	39.4
Acid Value (mg KOH/g)	3.12

3.2 Glycerin Purity Analysis

The use of 17 ml HCl for purification and 6 g of activated charcoal greatly improved the quality of the glycerin produced in the purification process. A table summarising the change of glycerin from crude to purified form can be found in Table 3.

Table 3: The Difference between Crude Glycerin and Purified Glycerin

Parameter	**Crude Glycerin**	**Purified Glycerin**
Glycerol Content (wt%)	42.8%	96.8%
Density at 25°C (g/cm³)	1.15	1.259

pH Value	10.8	7.02
Appearance	Dark Brown	Clear Colorless
Ash Content (wt%)	6.5%	0.38%

3.3 Discussion of Reagent Effectiveness

The 17 ml of HCl was critical for the breakdown of soaps formed during the reaction. Without this acidification step, the glycerin remains contaminated with organic matter non-glycerol (MONG), which prevents it from reaching technical-grade standards.[11] The 6 g of activated charcoal effectively removed the dark pigments and odors. At a dosage of approximately 5% of the glycerol mass, the charcoal adsorbs non-polar organic impurities through van der Waals forces .

IV. CONCLUSION

The synthesis and purification of glycerin from 800 mL of waste cooking oil have been accomplished. A catalyst was needed, using a stoichiometric ratio of 9 g NaOH; 17 mL HCl was also used for the purification process, resulting in a final purity of 96.8%. The use of 6 g activated charcoal yielded the required colorless appearance for industrial-glycerin applications, and thus produced glycerin appropriate for grade II Technical Glycerin. This study also presented a viable means of decentralized waste management/disposal methods and value addition to Biodiesel production processes at Pravara Rural Engineering College.

Appreciation

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