Conversion of Waste Cooking Oil To Biodiesel Using Egg Shell Powder As A Sustainable Catalyst In A Pulverizer System

S. Gowthaman[1], K. Soundhirarajan[2]
[1, 2] Dept of Civil Engineering
[2]Assistant Professor, Dept of Civil Engineering,
[1, 2] Gnanamani College of Technology, Namakkal, Tamil Nadu, India.

Abstract- *Fossil fuels are used now-a-days for energy sectors. But these are non-renewable energy source in present and upcoming generations. So, people want to move sustainable energy source, that their thought happened. That resourceful fuels are cost effective and eco-friendly mode for our day-to-day life conditions. We rectify the problems faced for fossil fuels and make life better movement to future generations and environment. In that we thought that eco- friendly products are using nowadays. Biodiesel is the cheap and cost effective to our people. Hence the financial support is additional strength to lower and middle-class people. The project tells us about how the biodiesel production from waste cooking oil by using egg shell catalyst method is in cost effective manner. Here biodiesel is being prepared by using waste cooking oil, methanol and egg shell powder using so no chemical method. The yield of biodiesel by this method is good and cost effective compared with conventional petrol and diesel. Hence, we recommend this process is viable and practical.*

Keywords- Biodiesel, sustainable energy source, eco-friendly life, waste cooking oil, methanol and eggshell powder.

I. INTRODUCTION

The major problem about fossil fuel like petroleum products, diesel, petrol, kerosene are non-re newable source of energy. It is the unsustainable energy source among others in the world. So, people aware about sustainable energy importance in day today life process. These fuels in the world are adopted with transportation purpose for trade, commerce commercial purpose anything, they use energy sector divisions.

Today many countries produce sustainable energy for the energy sector. They are solar energy, wind energy, tidal energy etc., these are sustainable but enough energy has not produced very much. So, we have to use alternative way to produce large quantity of energy in greenway. That is Biodiesel production.

This is the comfortable way for energy production in this modern era. The process is simple and understandable one. These are the main source of alternate energy from nature in our country. These are waste cooking oil, Methanol and Calcium Oxide as catalyst, even other alkali catalyst also.

The bio diesel is the green and safe fuel for transportation. This is the easiest way for production of biodiesel. The raw materials are cheap cost and most valuable for agriculture sector. It is the indirect income source for farmers and direct income source for commercial shops.

The main characteristics of biodiesel is quick ignition control for engine process. In many countries bio-diesel productions are vast range in their energy sector.

Biodiesel is defined as the mono alkyl esters of long chain fatty acids, derived from renewable vegetable oils or animal fats for use in ignition engines. Vegetable oils which is used in preparing biodiesel is soybean oil, sunflower oil, ground nut oil, canola oil, corn oil, and waste oil which is a mixture of all previous kinds of oil after been utilized (Amit, 2009; Demirbas, 2009).

Biodiesel possesses technical and environmental advantages, low toxicity, derivation from a renewable source, superior flash point than Petro diesel and biodegradability, and lower overall exhaust emissions (Tyson, 2006; Moser, 2009; Isioma *et al*, 2013). Biodiesel's characteristics strongly depend on various plant feed stocks, growing climate conditions, soil type, plant health and plant maturity upon harvest. These parameters affect the physical and chemical properties, which also have direct relationship with performance and emission of the engine (Tesfa *et al.,* 2010).

II. OBJECTIVE

Bio-diesel is a domestically produced, clean-burning, renewable substitute for petroleum and diesel.

Using biodiesel as a vehicle fuel source increases energy saving and security mode, clean environment, improves the air quality and provide safety benefits.

III. PULVERIZER

A pulverizer, also known as a grinder or mill, is used in biodiesel production to grind and pulverize materials into a fine powder. Here are some specific uses of a pulverizer in biodiesel production.

3.1.USES OF PULVERIZER IN BIODIESEL PRODUCTION

Benefits of Using a Pulverizer in Biodiesel Production:

Increased surface area:
Pulverizing materials increases their surface area, which can improve their reactivity and Efficiency in biodiesel production.

Improved mixing:
Pulverized materials can be mixed more easily and uniformly, which can improve the quality and consistency of biodiesel.

Increased yield:
Pulverizing materials can increase the yield of biodiesel by improving the efficiency of the trans- esterification reaction.

Reduced energy consumption:
Pulverizing materials can reduce the energy required for biodiesel production by improving the efficiency of the transesterification reaction

Figure: Pulverizer

IV. METHODOLOGY

4.1. Collection

Waste Cooking Oil: Collect waste cooking oil from restaurants, food establishments, and households. Ensure the oil is free from contaminants and food particles.

Eggshells Powder: Collect eggshells from poultry farms, egg processing plants, and households. Clean and dry the eggshells before grinding them into a fine powder.

Methanol: Source methanol from chemical suppliers or manufacturers. Ensure the methanol meets the required purity standards.

Figure: waste cooking oil

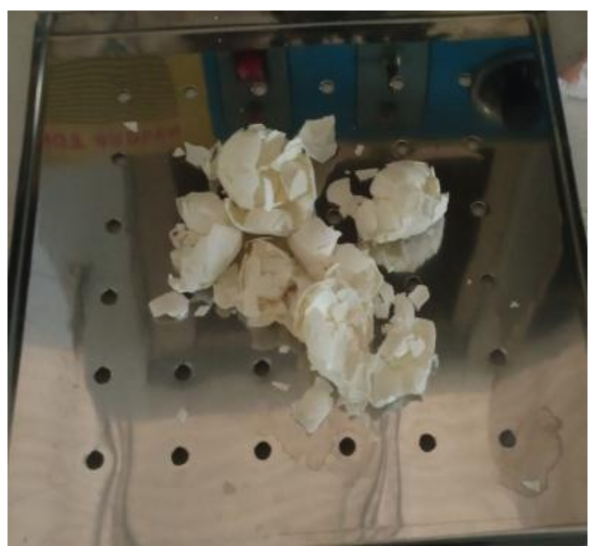


Figure: Egg shell

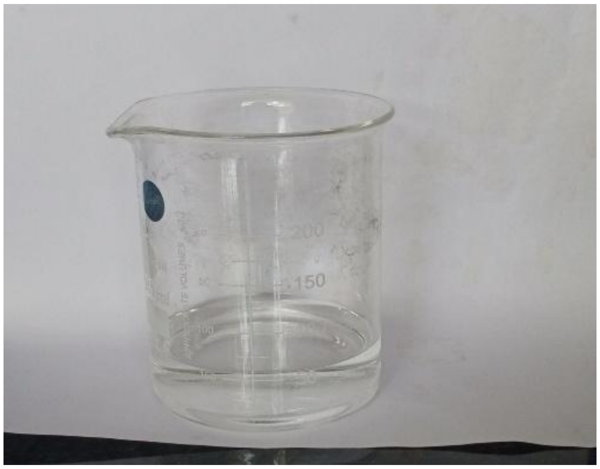


Figure: Methanol

4.2. Storage

Waste Cooking Oil: Store in clean, dry, and secure containers to prevent contamination and leakage.

Eggshells Powder: Store in airtight containers to maintain dryness and prevent moisture absorption.

Methanol: Store in well-ventilated areas, away from heat sources and flammable materials, in approved containers.

4.3. Processing

Pre-treatment: Remove impurities from the waste cooking oil, such as food particles and water.

Transesterification: React the pre-treated waste cooking oil with methanol in the presence of a catalyst (calcium oxide from eggshells powder) to produce biodiesel.

Purification: Distill or filter the biodiesel to remove impurities and improve its quality.

V. MIX PROPORTION

5.1. Mixing Proportions for Biodiesel Production

The mixing proportions for biodiesel production involve combining waste cooking oil (WCO), methanol (CH3OH), a catalyst (eggshells powder), and calcium oxide (CaO) in specific ratios.

5.2. Waste Cooking Oil (WCO)

Volume: 100% (by volume)
Function: Feedstock for biodiesel production

5.3. Methanol (CH3OH)

Volume: 20-25% (by volume) of WCO
Function: Reactant for transesterification reaction

5.4. Catalyst (Eggshells Powder)

Weight: 1-2% (by weight) of WCO
Function: Catalyst for transesterification reaction

5.5. Calcium Oxide (CaO)

Weight: 1-2% (by weight) of WCO (derived from eggshells powder) Function: Catalyst support and activator

5.6. Transesterification Reaction

The transesterification reaction involves reacting WCO with CH3OH in the presence of the catalyst (eggshells powder) and CaO to produce biodiesel and glycerol.

Reaction Equation

WCO + CH3OH → Biodiesel + Glycerol

Notes

Optimization: The exact mixing proportions may vary depending on the specific feedstock, catalyst, and reaction conditions. It's essential to optimize the mixing proportions to achieve high conversion rates, yield, and quality of biodiesel.

Catalyst Adjustment: The catalyst and CaO can be adjusted to optimize the reaction rate and yield.

Reaction Conditions: Temperature, pressure, and reaction time can also be adjusted to optimize the reaction.

Quality Control: Regular quality control checks should be performed to ensure the quality of the biodiesel produced.

VI. MATERIALS MEASUREMENTS

Materials	Waste cooking oil (mL)	Methanal (mL)	Calcium oxide (grams)
Sample test 1 measurements	100	20	1

Sample test 2 measurements	200	40	2
Sample test 3 measurements	400	80	4
Sample test 4 measurements	1000	200	10
Sample test 5 measurements	2000	400	20

6.1 MIXING PROCESS

First, we have taken 100mL of waste cooking oil in beaker.

Take methanol with quantity of 20mL in a beaker.

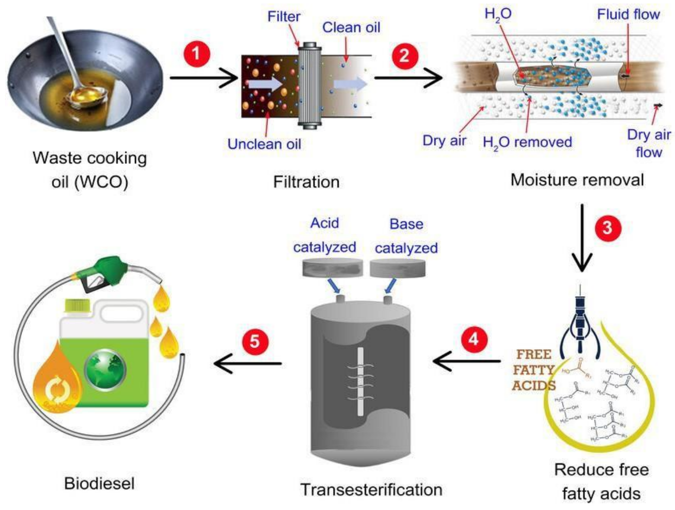
Add pinch of calcium oxide catalyst exactly 1gm.

Mix them in round bottom flask for few minutes.

After repeating this process using the materials and measurements table.

Figure: Mixing process

6.2. TRANS-ESTERIFICATION PROCESS



6.3. APPLICATIONS OF TRANSESTERIFICATION

Transesterification reactions play a crucial role in the synthesis of polyester. Here, di-esters and diols are subjected to transesterification in order to obtain macromolecules. This process is also used in plastic recycling to reduce polyester into its monomers.Biodiesel can be prepared from triglycerides via transesterification.

This reaction is also used in the synthesis of certain derivatives of enols. For example, vinyl ethers can be prepared from vinyl acetate via transesterification

VII. TESTING RESULTS & DISCUSSION

7.1. SEPARATION PROCESS

After the transesterification process, the mix proportion oil are separated into biodiesel, glycerol and egg shell powder using the separation process.

In the separation process, the mix proportion of oil is taken into a plastic cane.

After 1 or two days the egg shell powder and glycerol are settled in the bottom of the cane.

The biodiesel is settled on top of the cane. The above diagram shows the separation of bio- diesel, glycerol and egg shell powder.

After that we have removed glycerol and egg shell powder. Then we collected the biodiesel.

Figure: Separation process

7.2. FLASH POINT

The flash point is the lowest temperature at which a volatile substance evaporates to form an ignitable mixture with air in the presence of an igneous source and continues burning after the trigger source is removed

No of Samples	Flash point (Degree Celsius)
Sample 1	67
Sample 2	75
Sample 3	80
Sample 4	87
Sample 5	101

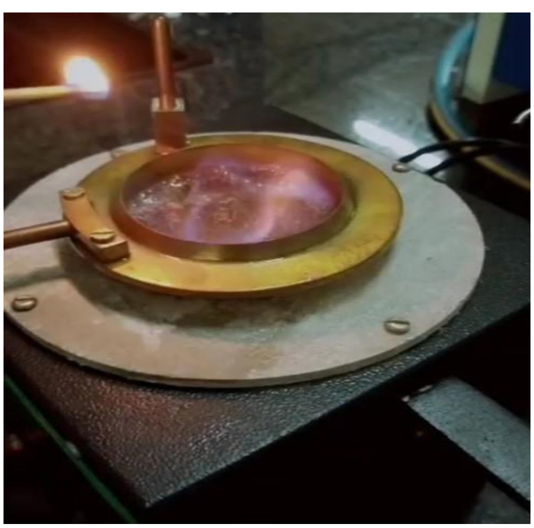


Figure: Flash point

Flash point and fire point apparatus are used to find the flash point of the given samples. The testing sample values are given in the above table.

7.3. FIRE POINT

Fire point of a fuel is the lowest temperature at which the vapor of that fuel will continue to burn for at least five seconds after ignition by an open flame of standard dimension. At the flash point, a lower temperature, a substance will ignite briefly, but vapor might not be produced at a rate to sustain the fire. Most tables of material properties will only list material flash points. In general the fire point can be assumed to be about 10°C higher than the flash point, although this is no substitute for testing if the fire point is safety critical.

No of Samples	Fire point (Degree Celsius)
Sample 1	76
Sample 2	83
Sample 3	90
Sample 4	100
Sample 5	111

Flash point and fire point apparatus are used to find the fire point of the given samples. The testing sample values are given in the above table.

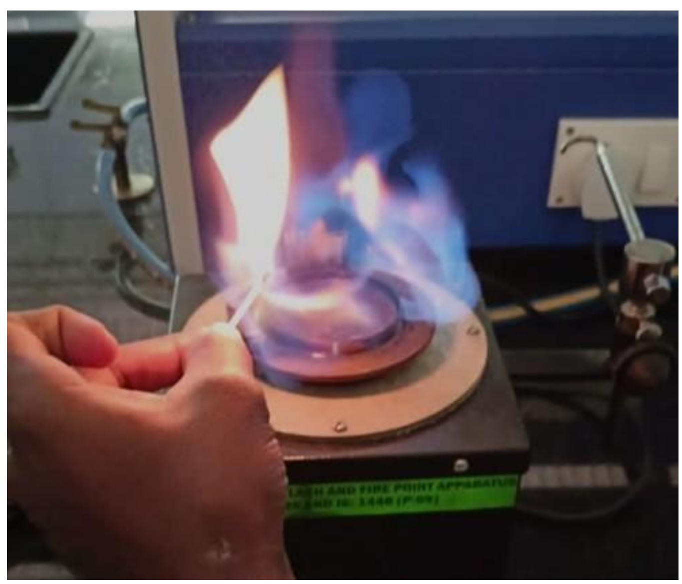


Figure: Fire point

7.4. POUR POINT

The pour point of a crude oil, or a petroleum fraction, is the lowest temperature at which the oil will pour or flow when it is cooled, without stirring, under standard cooling conditions. Pour point represents the lowest temperature at which oil is capable of flowing under gravity.

No of Samples	Pour point (Degree Celsius)
Sample 1	3
Sample 2	1
Sample 3	-2
Sample 4	-5
Sample 5	-9

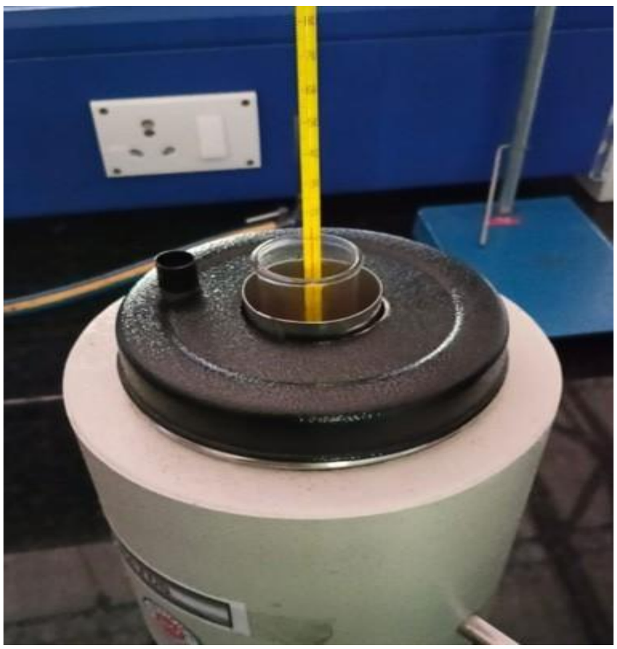


Figure: Pour point

Pour point and cloud point apparatus are used to find the pour point of the given samples. The testing sample values are given in the above table.

7.5. CLOUD POINT

Cloud point is the temperature at which wax (paraffin) begins to separate when oil is chilled to a low temperature, and it serves as an important indicator of practical performance in automotive applications in low temperatures. (Fig: Cloud point figure)

No of Samples	Cloud point (Degree Celsius)
Sample 1	5
Sample 2	3
Sample 3	1
Sample 4	-2
Sample 5	-3

Figure: Could point

Pour point and cloud point apparatus are used to find the cloud point of the given samples. The testing sample values are given in the above table. Concentration of catalyst depends on nature of catalyst used: either heterogeneous or homogenous.

Stirrer speed helps to enhance rate of reaction. In most cases, optimum speed of stirrer was maintained in the range of 200–250 rpm.

VIII. RESULT & DISCUSSION

- Biodiesel is A clean-burning, renewable fuel that can be used in diesel engines.
- Glycerol A byproduct of the transesterification reaction that can be used in various applications, such as soap production and pharmaceuticals.
- Eggshells Powder Can be used as a catalyst in the transesterification reaction, reducing the need for synthetic catalysts.
- Overall, the collection, storage, and processing of waste cooking oil, eggshells powder, and methanol can produce high-quality biodiesel and other valuable products while promoting sustainability and reducing waste
- High fatty acid content in waste cooking oil could be reduced by pretreating waste cooking oil with acid catalyst.
- Water produced during the esterification process can inhibit acid catalyst, and this can be eliminated by stepwise reaction mechanism.

- Methanol is the most suitable alcohol because of its low cost and easy separation from biofuel.
- Methanol to oil ratio for the acid-catalyzed reaction depends on amount of free fatty acid. For base-catalyzed reaction,6:1 is optimum ratio for transesterification reaction.
- Concentration of catalyst depends on nature of catalyst used: either heterogeneous or homogenous.
- Stirrer speed helps to enhance rate of reaction. In most cases, optimum speed of stirrer was maintained in the range of 200–250 rpm.

REFERENCES

[1] Hossain, A.B.,and Salleh,M.A.(2008, July).” Biodiesel Production from Waste Cooking Oil: A Review.” Bio resource Technology, 99(11), 3629-3636.

[2] Raheman, H., and Phadatare, A. G. (2004, April). “Diesel Engine Performance and Emission Characteristics of Biodiesel Produced from Mahua(Madhucaindica)Oil.” Bioresource Technology,92(3),255-262.

[3] Shahid, E. M., and Jamal, Y. (2012, March). “Biodiesel Production from Non-Edible Oils: A Review. “Renewable and Sustainable Energy Reviews, 16(3), 1887-1898.

[4] Zhang, Y., Dube, M. A., McLean, D. D., and Kates, M. (2003, November). “Biodiesel Production from Waste Cooking Oil: 1. Process Design and Technological Assessment.” Bioresource Technology,89(1),

[5] Demirbas,A.,and Balat,M.(2011,January).”Progress and Recent Trends in Biodiesel Fuels.” Energy, 36(4), 2100-2108.

[6] Mittelbach,M.,and Remschmidt,C.(2004,December). “Biodiesel: The Comprehensive Handbook.” Springer-Verlag, 2nd Edition, 39-58.

[7] Knothe, G., and Steidley, K. R. (2010, May). “Biodiesel Fuel Production from Algae Oil Using Supercritical Methanol.” Bioresource Technology, 101(5), 1253-1260.

[8] Demirbas,A.(2009,January).”Biodiesel:A Realistic Fuel Alternative for Diesel Engines.” Energy Sources, 31(14), 1360-1368.
Knothe,G.,and Gerpen,J.V.(2006,June).”The BiodieselHandbook.” AOCSPress,1stEdition,10-22.

[9] Schwab, A. W., Bagby, M. O., and Freedman, B. (1987, December). “Preparation and Properties of Diesel Fuels from Vegetable Oils.” Fuel, 66(10), 1372-1378.

[10] Baskar, S., Rengaraj, S., and Karthikeyan, P. (2014, August). “A Reviewon Production of Biodiesel from Different Feedstocks.”Renewable and Sustainable Energy Reviews, 33(2), 698-712.

[11] Lapuerta,M.,Fernández,J.,andRodríguez,J.(2008,February).”Effect of Biodiesel Fuels on Diesel Engine Emissions.” Progress in Energy and Combustion Science, 34(3), 362-391.

[12] Kumar, A., and Bansal, R. C. (2011, July). “Use of Biodiesel as an Alternative Fuel in Diesel Engines: A Review.”Renewable and Sustainable Energy Reviews, 15(7), 2920-2927.

[13] Zubair, S. M., and Mehmood, M. (2013, March). “Optimization of Biodiesel Production from Jatropha Oil Using KOH Catalyst.” Energy Conversion and Management, 65(3), 297-303.

[14] Abed,S.R.,Al-Shammari,H.A.,and Jassim,N.A.(2015,June). “Study of Biodiesel Production