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GREENER METHOD FOR SYNTHESIS OF BIODIESEL FROM WASTE VEGETABLE OIL

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Abstract:

Biodiesel, a renewable fuel has a great potential in fulfilling an ever-increasing transport fuel demand. Biodiesel has recently received greater concern as one of the reliable and sustainable source of energy. The enzymatic conversion process of feedstock oil to biodiesel is greener when compared to the conventional approach of chemical conversion due to mild reaction conditions and less wastewater generation. Production of biodiesel is hampered by both feedstock availability and catalyst system. In present study, the synthesis of a new greener methodology for bio-diesel has been achieved using Bleaching Earth Clay (pH-12.5) catalyst. The method is simple, efficient and eco-friendly. The catalyst used is economic and recyclable.

Key Words: waste vegetable oil, Bleaching Earth Clay (pH-12.5) catalyst, Methanol

Introduction:

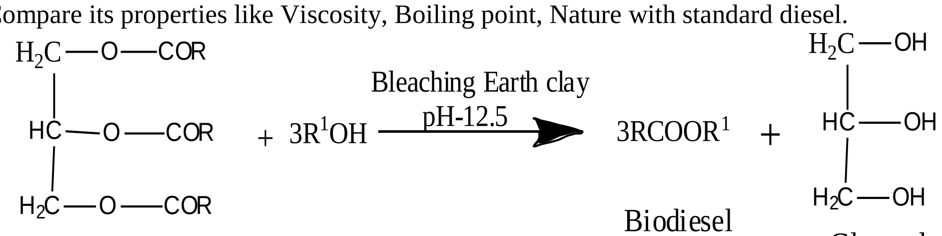
Petroleum based fuel, though the most popular fuel for internal combustion engines. However, such fuel is associated with possible future depletion of reserves worldwide, global warming as a result of toxic exhaust and non-biodegradability[1]To overcome these challenges, biodiesel production has recently received the greater attention as renewable, economically feasible and reliable alternative biofuel to replace conventional fossil fuel.[2] Production of biodiesel at commercial scale remains the major obstacle today. Biodiesel is expensive as compared to petroleum-based fuel, as 60–80% of the cost is associated with the cost of feedstock oils and production (homogeneous catalyst system)[3–5]. Synthesis of biodiesel using enzyme catalysts is attracting interest of researchers and biodiesel producers as it is a green approach of producing renewable fuel by environmental benign biocatalyst. Enzyme catalysis has shown high purity of products. Transesterification reaction of triglycerides (the major component of vegetable oil) with short chain alcohol (methanol) in the presence of catalyst will produce fatty acid methyl ester (FAME) or biodiesel and glycerol as the by-product[6] .Waste cooking oils, soapstock (byproduct of vegetable oil refinery) and non-edible oils, which are available cheaply, are attractive starting materials for biodiesel[7,8]. Currently, most commercial processes used for biodiesel synthesis employ a homogeneous catalyst, such as NaOH or H_2SO_4[9–11].

The increasing production of waste vegetable oil from household and industrial sources is a growing problem in China and around the world[12]. Biodiesel is derived from abundant and renewable substances such as vegetable oils, animal fats, algae, industrial acid oil, and waste cooking oil[13-14]. Biodiesel has recently become an alternative to petroleum-based diesel fuel. It is renewable, biodegradable, non-inflammable, and non-toxic. It also has a favorable combustion emission profile, producing much less carbon monoxide[15]. Bleaching Earth Clay(pH-12.5) is non-toxic, Cheaper and recyclable greener catalyst[16].

Materials and Method:

Experimental Procedure of Bio-Diesel:

Measure 100 ml of waste vegetable oil into the 250ml conical flask.Weigh the flask before and after to determine the mass of oil used. Carefully add 15 ml of Methanol slowly add 1gm of Bleaching Earth clay (ph-12.5) Stir well the mixture for 30 minute. Allow the mixture to stand until it separate into two layers. Carefully remove the top layer by using separating funnel.Lower layer contain glycerol and catalyst it is filtered off. Solid catalyst recovered is again used for next operation.Bio-diesel obtained is purified by distillation method and it is weighed. Compare its properties like Viscosity, Boiling point, Nature with standard diesel.



Waste Vegetable oil   Biodiesel   Glycerol

Optimization of Catalytic Activity:

The optimization of catalytic activity of the bleaching earth clay (pH 12.5) catalyst was evaluated by transesterification of waste vegetable oil using methanol and catalyst was arranged three sets of reaction in 250 ml conical flask. In each conical flask,100 ml of waste vegetable oil, 15 ml methanol and different quantity of the bleaching earth clay (pH 12.5) catalyst such as 0,0.5,1,1.5& 2 gmof were added respectively. Stir well the mixture for 30 minute. Allow the mixture to stand until it separate into two layers. Carefully remove the top layer by using separating funnel.Lower layer contain glycerol and catalyst it is filtered off. Solid catalyst recovered is again recycled for next operation. Bio-diesel obtained is purified by distillation method and it is weighed. In the conclusion of optimization of Catalytic activity, we found that the weight of 1 gm of catalyst which is used in transesterfication is most suitable quantity giving higher yield of the product compare to other quantity of the catalyst taken for optimization.

Characterization of Biodiesel:

Samples of biodiesel were subjected to series of tests in order to determine if the biodiesel produced met the specification standards.

- **Kinematic viscosity at 40ºC:** Kinematicviscosity of biodiesel corresponds to its informal conception of thickness. Kinematic viscosity of prepared biodiesel was measured with the help of viscometer. The kinematic viscosity of biodiesel was measured 6.7 (gm/cm^3). The viscosity value for biodiesel ranges from 4.9 to 6.0 (gm/cm^3)
- **Density at 15ºC:** The density of biodiesel produce from the waste vegetable oil which is the mass of the biodiesel compared to water at constant temperature of 15 ºC. The density of sample of biodiesel was measured with hydrometer. The density of biodiesel was measured 0.85cSt. According to the ASTM standard, the value of density for biodiesel is 0.875 cSt. These values of prepared biodiesel meet the density value of the pure biodiesel.
- **Flash point (°C):**The flash point of biodiesel was determined by open cup flash point test method. The flash point of biodiesel was measured 110˚C comparable to ASTM standard which is 100 to 170 ˚C

Result and Discussion:

Properties of Waste Vegetable Oil:

The properties of waste vegetable oil used were identified and are tabulated. The saponification and the acid values are 187.2 mg/gand 11.0 mg/g, respectively. The average molecular weight of waste vegetable oil was calculated as 898.9 g/mol. The content of free fatty acids was found to be 5.5% w/w, which is in the higher range, and therefore, not recommended for the use in homogeneous catalyst system due to the high free fatty acids. Therefore, a solid base catalyst is more suitable to use in the waste vegetable oil.

Table 1: Characterization of Physical Properties of Synthesized Biodiesel

S.No	Properties	Biodiesel Standard	Synthesized Biodiesel	Diesel Standard
1	Kinematic Viscosity (gm/cm3) at 40°C	4.9-6.0	6.7	2.3-4.6
2	Density (cSt) at 15°C	0.87	0.852	0.825
3	Flash point (°C)	100 to 170	110	60 to 80
4	Moisture content (%)	0.05% max.	0.07	0.161
6	Nature	Neutral	Neutral	Neutral

Table 2:Optimization of catalyst bleaching earth clay (pH 12.5)

Wt. of catalyst (gm)	Time of reaction	Product Yield (%)
0.0	30	00
0.5	30	73
1.0	30	91
1.5	30	84
2.0	30	76

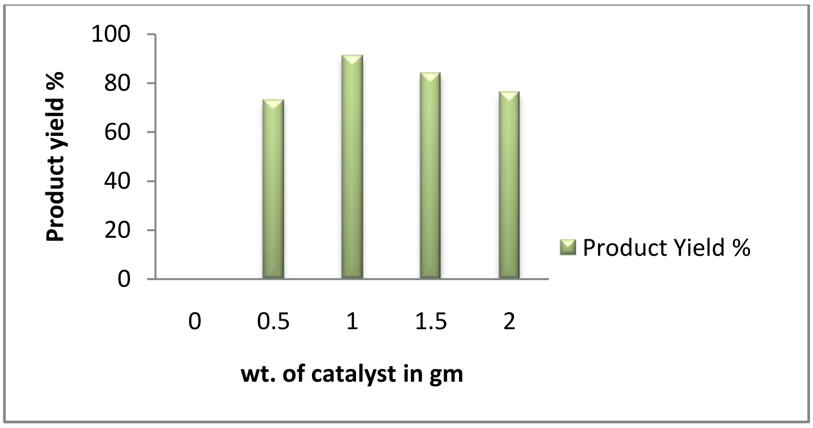


Figure 1: Optimization of catalyst and product yield in %

Conclusion:

In summary, the synthesis of bio-diesel has been achieved using Bleaching Earth Clay (pH-12.5) catalyst as new greener methodology. The method is simple, efficient and eco-friendly. The catalyst used is economic and recyclable. Optimisation of catalyst and characterisation of biodiesel attempt in good yield of the products.

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