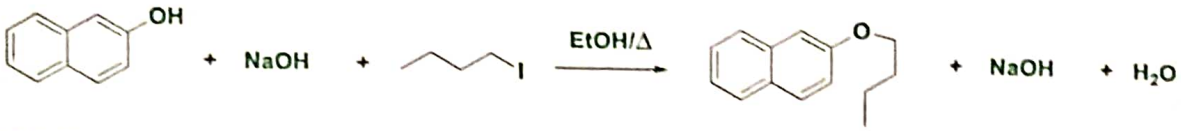
1. Explain the role of Green Chemistry for sustainable development.
2. Discuss any two principles of Green Chemistry that were of particular relevance to the topic that you selected as the basis of your seminar presentation.
3. State two principles of Green Chemistry and discuss their importance in our society.
4. Discuss the following with example based on the principles of Green Chemistry.
   (a) Choice of reaction conditions in chemical reactions.
   (b) Selection of a solvent for a synthesis.
   (c) Atom economy.
   (d) E-factor
5. Discuss the concept of risk. How is it determined? Describe how risk has traditionally been reduced in industry. How does Green Chemistry approach the problem of risk?
6. Discuss the potential of biomass as a source of renewable energy.
7. Discuss the advantages and disadvantages of using supercritical CO_2 as a solvent in place of organic solvents.
8. What is catalysis? How does catalysis contribute to the principles of Green Chemistry? Describe the attributes of the two major groups of catalysts.
9. Write notes on "Green catalyst".
10. What is microwave assisted chemistry? How do microwaves promote chemical reactions? What types of chemical reaction systems are particularly suited to this form of technology?
11. Explain in detail scientific areas for practical applications of Green Chemistry.
12. Define ionic liquids. What are the characteristic properties of ionic liquids?
13. How sonochemistry is associated with Green Chemistry?
14. What are supercritical fluids? Taking CO_2 as example explains it in details.
15. Are supercritical fluids green in nature? Justify your answer with the help of suitable example.
16. What are renewable feed stocks? Explain with the help of a raw material obtained from renewable feed stocks.
17. Explain "minimization of waste" via a greener route of synthesis.
18. Explain the principle "Less hazardous chemical synthesis" giving an example of a greener route of synthesis.
19. Discuss one inherently atom economic reaction.
20. Explain the principle of reduced derivatization in Green Chemistry.
21. Explain the principle of safer chemicals design with examples.
22. What do you mean by green solvents? Explain with examples.
23. Why there is a need to have a green chemistry in industries?
24. Write the greener route to the synthesis of: i) adipic acid, ii) ibuprofen. Write down the conventional route also. What are the drawbacks of the conventional route in terms of Green chemistry?
25. Calculate the % atom economy, reaction efficiency and E-factor for the following reaction



144.17 (1 gm) 40.00 (0.56 gm) 184.02 (1.62 gm) 200.28 (1.29 gm) 149.89 18.02

26. Why is recycling relevant to Green Chemistry?
27. Why are yield and atom economy poor methods for determining the efficiency of Green synthesis?
28. How does microwave irradiation initiates a chemical reaction? Give an example of a microwave irradiation initiated organic reaction.

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EXPERIMENT :

Chemicals and Equipments :

(i) Vegetable oil / Waste cooking oil

(ii) Methanol

(iii) 10(M) NaOH ✓

(iv) A round bottom flask (RB-flask)

(v) Magnetic stirrer ✓

(vi) Stirring bar

and (vii) Reflux condenser.

✓

Procedure :

The catalytic transesterification reaction was carried out under vigorous magnetic stirring in a round-bottomed flask. In a clean, dry round bottom flask 50 ml of waste oil (which is filtered through very fine sieve), 10 ml of methanol (methanol to waste oil molar ratio 6:1) and 2 ml of 10(M) NaOH were added. Then the ~~eq~~ contents of the RB equipped with a reflux condenser were heated by an electromagnetic heater at methanol reflux temp (65°C) for about 10 mins. The two products ~~can also~~ are ~~the~~ separated by gravity using ~~setting~~ settling vessel. The glycerol is drawn off at the bottom of the ~~setting~~ settling vessel and biodiesel is drawn off at the top. The ~~clear~~ layer was ~~of~~ biodiesel which was carefully separated ~~by using a dropper and the lower layer of glycerol and KOH~~ NaOH. ~~Biodiesel~~ was dried over Na_2SO_4 and filtered. Then the volume of the bio-diesel product is measured by using measuring cylinder.

CALCULATION :

Calculation of yield :

50 ml of ~~fresh~~ waste oil gave ....V.... ml of bio-diesel.

$$\therefore \%\ \text{yield} = \frac{\text{Volume of Bio-diesel produced}}{\text{Volume of oil taken}} \times 100$$

$$= \frac{\text{V mL}}{\text{50 mL}} \times 100 = \quad \%$$

E-Lab.

Date:19-05-2020

Experiment No. 6: Alternative Source of Energy:

Photo-reduction of Benzophenone to Benzopinacol in presence of Sunlight

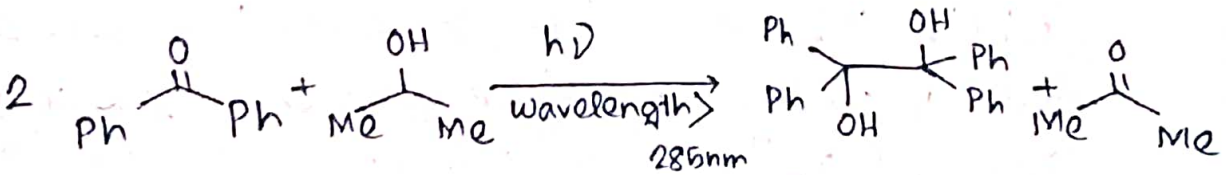
Introduction:.....write introduction

This is Green Chemistry lab., so you should write its background i,e,; Introduction

Basic Principle:

In green approach, benzopinacol is synthesized by photo-reduction of benzophenone in presence of isopropanol and one drop glacial acetic acid under solar energy. In this reaction, hydrogen abstraction by initially formed photoexcited benzophenone from isopropyl alcohol followed by radical couplings yields benzopinacol & acetone as stable products. Benzopinacol can be easily isolated as crystalline white solid compound from the reaction mixture.

Chemical Reaction:



Benzophenone.

Benzopinacol

Chemicals & Equipments:

i) Isopropanol
ii) Benzophenone
iii) Glacial Acetic Acid
iv) Benzene
v) Round-bottom flask
vi) Parafilm
vii) Suction filtering flask
viii) Buchner funnel
ix) Filter paper
x) 250ml beaker
xi) Digital Electric Balance
xii) Melting point apparatus

Experimental Procedure:

A mixture of 2.5g (0.0137 mole) of benzophenone and about 10ml of isopropanol in a 100 ml round-bottom flask is warmed over a beaker of warm water (~45°c) to dissolve the solids. When the solids are dissolved, one drop of glacial acetic acid is added to the flask. The flask then is closed tightly with rubber stopper, sealed with a strip of parafilm and shaken well. The flask is taken to a open space and exposed to direct sunlight. After 3-5 hours of bright sunshine crystals of benzopinacol begin to appear; after five or six day of exposure, depending upon the intensity of the sunlight, the flask is found to be filled with white crystals of benzopinacol. The solution is chilled in ice and after scratching the inner side wall of the flask by a spatula, the crystalline product has obtained is filtered through suction using Buchner funnel, washed with a small quantity of isopropanol and allowed to dry in the air.

~~The filtrate may be reserved for subsequent reductions~~. The dried product is weighed and the percentage yield is determined.

On the left side of the one page write the mechanism of the reaction.

Determination of Percentage Yield:

Weight of the crude product = 2·30 g

$$\% \text{ Yield} = \left(\frac{\text{Experimental quantity of benzopinacol produced}}{\text{Theoretical quantity of the benzopinacol expected to be formed}} \right) \times 100$$

Experimental quantity of benzopinacol product = 2·30 g

Quantity of benzophenone taken = 2·5 g

$$= \frac{2 \cdot 5}{182 \cdot 22} \text{ moles}$$

$$= 0 \cdot 0137 \text{ moles.}$$

Theoretical quantity of benzopinacol = (No. of moles x it's Molecular weight)

Theoretical no. of moles of benzopinacol expected to be formed = $\frac{0 \cdot 0137}{2}$ moles.

∴ Therefore, theoretical quantity of benzopinacol = $\left(\frac{0 \cdot 0137}{2} \right) \times 366 \cdot 46 = 2 \cdot 51$ g.

∴ Therefore, % Yield = $\left(\frac{2 \cdot 30}{2 \cdot 51} \times 100 \right) = 91 \cdot 6\%$.

Determination of Melting Point:

Don't write m. pt. just leave it blank now.

Observed melting point of benzopinacol : ..... °C

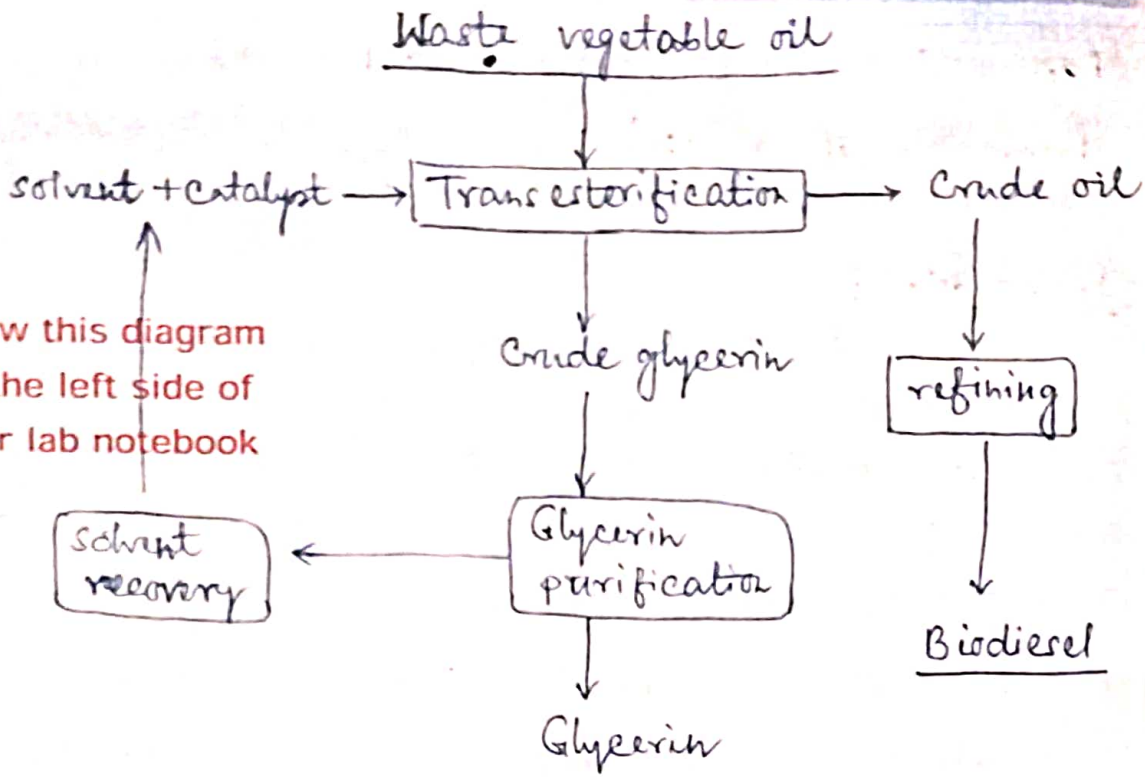
Observed melting point of benzopinacol = 185°C

(Literature m.pt. = 185-186 °C)

Experiment No. 2 : Using Renewable Resources :
Preparation of Biodiesel from Vegetable/Waste Cooking Oil

Introduction :

The technical definition of bio-diesel is 'the mono alkyl esters of long fatty acids derived from renewable lipid feedstock such as vegetable-oils or animal fats for use in compression ignition engines. In simple terms, biodiesel is a renewable fuel manufactured from alcohol (mostly from methanol or ethanol) and vegetable oil, animal fats and reuyeled cooking oils. Waste cooking oil is easy to collect from other industries such as domestic usage and restaurant and also cheaper than other oils(refine oils). Hence, by using ~~this~~ these oils as the raw material, we can reduce the cost in biodiesel production. The adevantages of using waste cooking oils to produce biodiesel are the low cost and prevention of environmental pollution. A laboratory experiment by transesterification reaction using the principles of Green Chemistry from waste cooking oil is desined to ~~study~~ describe the study of biodiesel production. These oils need to be treating before dispose to the environment to prevent pollution. Due to the high cost of disposal, many individuals dispose waste cooking oils directly to the environment especially in rural area. So that, the use of waste cooking oils is an effective way to reduce the cost of biodiesel production.



Show this diagram on the left side of your lab notebook

Fig.-1 : Flow diagram for the production of biodiesel

Basic Principle :

The most common way to produce biodiesel is the transesterification method which is found in the textbooks of Org. Chemistry. It is the process of exchanging the organic group R of an ester with the org. group R' of an alcohol. These reactions are often catalysed by the addition of an acid or base catalyst (KOH or NaOH). In the production of biodiesel, the triglycerides in the fats and oils react with methanol to make fatty acid methyl esters (biodiesel) with glycerine as by-product and in the presence of the basic catalyst as depicted described below.

Chemical Reaction :