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# THE PRODUCTION OF BIODIESEL BY TRANSESTERIFICATION PROCESS OF SUNFLOWER OILS AND ETHANOL, USING ALKALI CATALYST

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## ABSTRACT

The transesterification reaction of sunflower oil with ethanol in presence of alkaline catalyst sodium hydroxide was studied. The effect of mass ratio of ethanol to oil, the mass ratio of catalyst to oil and reaction temperature was studied. The optimization of transesterification reaction were done .The optimum condition for transesterification reaction of sunflower oil achieved at ethanol/oil molar ratio 11:1,Catalyst concentration (NaoH) 1% wt/wt and reaction temperature at 950c , the maximum yield of the ethyl ester obtained 81%.

**KEYWORDS**: Sunflower oil, transesterification, ethyl ester, catalyst, glycerin. Sodium hydroxide.

## INTRODUCTION

Nowadays, majority of the worlds energy needs are supplied through petrochemicals sources. All these sources are finite and at current usage rate, it will be consumed shortly. The fast depletion of fossil fuels and the green house gas emissions from fossil fuels are the main reason to develop biofuels.The commercial method used for the biodiesel production is the transesterification process and it also called alcoholysis.The transesterification consists of the reaction of oils with an alcohol of low molecular weight (usually Ethanol or methanol) with the presence of an alkaline catalyst (usually NaOH or KOH) to produce esters and glycerin. Normally, the reaction takes place at atmospheric pressure and $65^0$C temperature. The Constant agitation is continued for several hours. The catalyst used has a significant effect on the reaction rate. It is known that basic catalysts require less times to complete the reaction even at atmospheric temperature, whereas acid catalysts, such as sulfuric acid, require higher temperatures nearly $100^0$c and longer reaction times 3 – 4 hour. The alkalis that are used generally include sodium and potassium hydroxides, carbonates, and alkoxides such as methoxide, ethoxide, propoxide, and butoxide.The alcohols such as methanol, ethanol, and butanol are the most frequently used for process. The selection of the alcohol is based on its cost and performance consideration. Ethanol can be produced from agricultural renewable resources, thereby attaining total independence from petroleum-based alcohols. Also, ethanol, as an extraction solvent, is preferable to methanol because of its much higher dissolving power for oils. For this cause, ethanol is sometimes used as an suitable alcohol for the transesterification process of vegetables oils. Therefore, produced ethyl esters rather than methyl esters are of considerable interest, because, in addition to the entirely agricultural nature of the ethanol, the extra carbon atom provided by the ethanol molecule slightly increases the heat content and the cetane number. The transesterification process consists of three consecutive and reversible reactions. The Stoichiometric ratio for the transesterification reaction is three moles of alcohol and one mole of triglyceride. An extra amount of alcohol is added in the reaction to move the reaction for Ethyl esters formation. Glycerin is also formed as byproduct in the reaction .The by-product, glycerin, has an economical value. The glycerin can be used in manufacturing of hand cream, soap, toothpastes, and lube saponification and free fatty acid neutralization are undesirable side-reactions. These side reactions consume the catalyst. As result, it reduced the production of biodiesel. The purification and separation steps become more complicated. The triglyceride reacts with the basic catalyst with formation of soap and water (saponification reaction).

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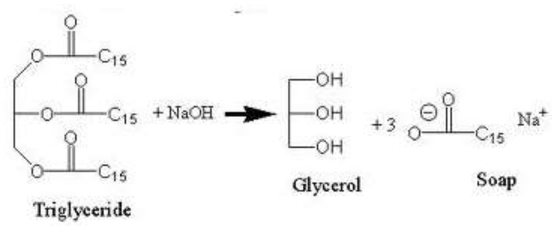


The saponification takes place only in the presence of hydroxide group (OH). It occurs when catalyst is potassium or sodium hydroxide. The soap formation can be avoided by using an acid catalyst. The presence of water or free fatty acid favors the formation of soap. For this reason the oils and alcohols have to be essentially anhydrides. The water can be removed by evaporation, before the transesterification process.

## MATERIAL AND METHOD

***Transesterification Procedure***

The transesterification reactions were carried out in a reactor, provided with a heating arrangement, mechanical stirring, sampling outlet, and condensation system. The reactor was preheated to 75 °C, to remove the moisture, and then sunflower oil was added in the reactor. When the reactor reached the temperature required for the reaction, the ethanol and the catalyst were added and stirring were continued. After the reaction. The transesterification product was taken in a separating funnel for glycerol separation by addition of pure glycerol The emulsions formed in the case of the ethanolysis products, glycerol was not separated only by gravity, and in order to separate it from the ethyl ester phase, pure glycerol was added to the transesterification product, and the separating funnel was shaken vigorously, the product was allowed to stand. The glycerol layer was separated from the ester layer within an hour. The addition of pure glycerol to the mixtures, removes the residual catalyst and the soaps which have been formed during the transesterification reaction, thus creating a difference in the density between the two phases, and in this way making it easier for their separation by gravity. After separation of the two layers, crude ethyl esters were washed several times with hot distilled water until neutral pH. Finally, the water present was eliminated by heating at 110 °C.

## RESULT AND DISCUSSION

The Transesteriication reaction carried out at $80^0$c and ethanol/oil molar ratio taken as 11;1.The Figure 1,shows the effect of catalyst (NaoH) concentration on ethyl ester production with respect to time.The best result obtained at 1% concentration,for higher value of catalyst more than 1% concentration ,NaoH yied of ethyl ester lower.The optimum concentration catalyst obtained at 1%wt/wt . The addition of an excessive amount of catalyst, however, gives rise to the formation of an emulsion, which increases the viscosity and leads to the formation of gels. These hinder the glycerol separation and, hence, reduce the apparent ester yield.

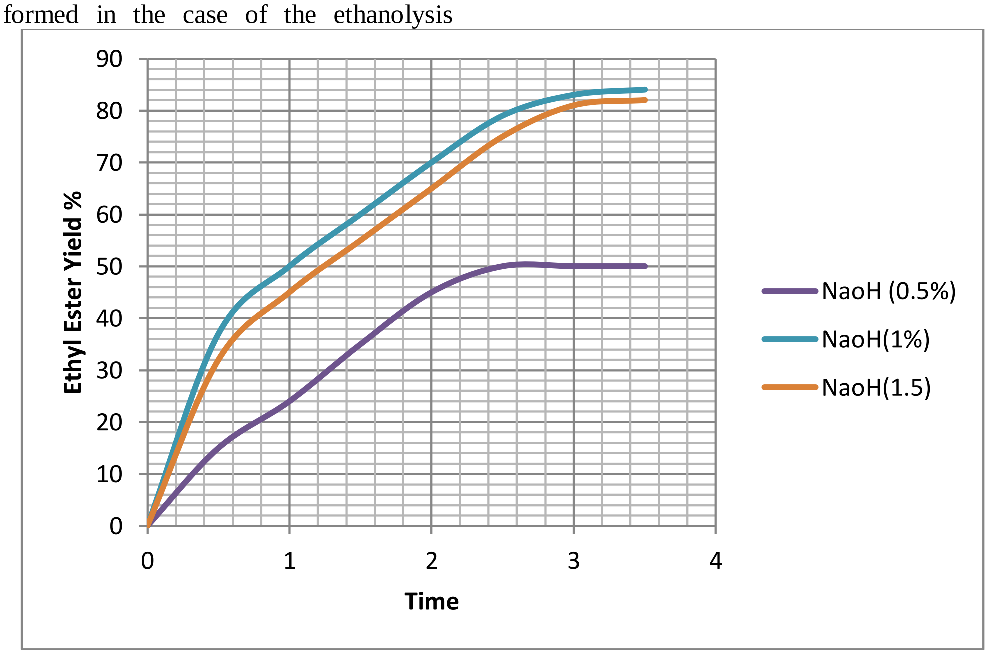


***Figure 1.Effect of catalyst concentration on the ethyl ester yield with respect to time.***

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Figure 2, shows effect of reaction temperature on ethyl ester Yield, it found that at $40^0$c the ethyl ester yield obtained 49% after 3 hrs, whereas at the same time period, at reaction temperature $95^0$c ,the ethyl ester yield obtained 83%.it showed that increased in reaction temperature ,ethyl ester yield increased.

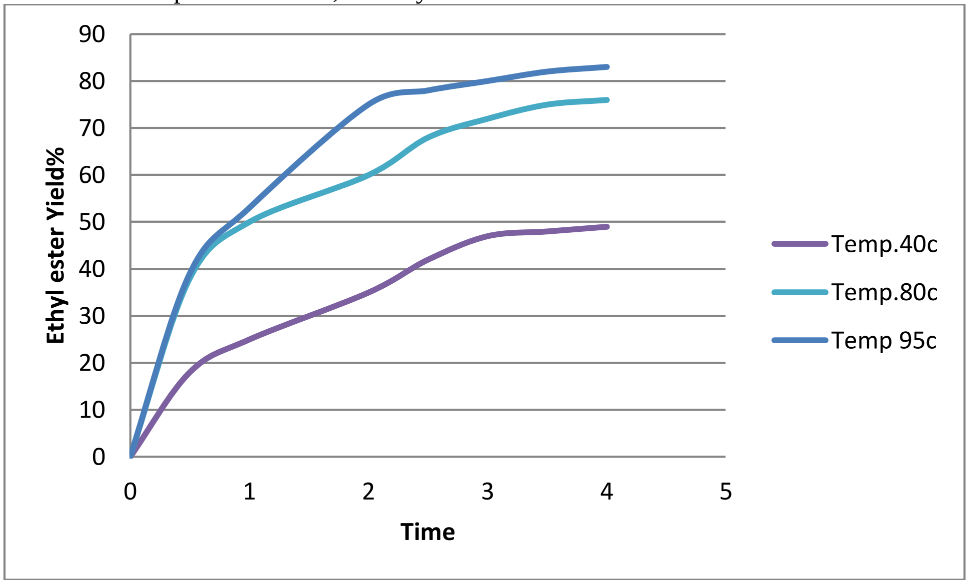


*Figure 2. Effect of reaction temperature on ethyl ester yield with respect to time.*

The experiments were performed by varying the ethanol/oil molar ratio 7:1, 9:1, 11:1 and 13:1. The catalyst concentration was kept on 1wt/wt.The temperature was fixed on $80^0$c.The figure 3.shows the effect of molar ratio of ethanol/oil on ethyl ester yield with respect to time. It is found that with molar ratio 7:1, the conversion of ethyl ester after 3 hour 65%.The ethyl ester production increased with increased in molar ratio of ethanol/oil. The best result found at 11;1 molar ratio. With molar ratio 11:1, the conversion of ethyl ester after 3hours 81%.The later increased in molar ratio, it did not increase the yield of ethyl ester. This was because of higher molar ratio the separation of glycerol become difficult, as ethanol excess hinder the decantation by gravity sothat the apparent yield of ester decreases, since the part of glycerol remains in the biodiesel phase.

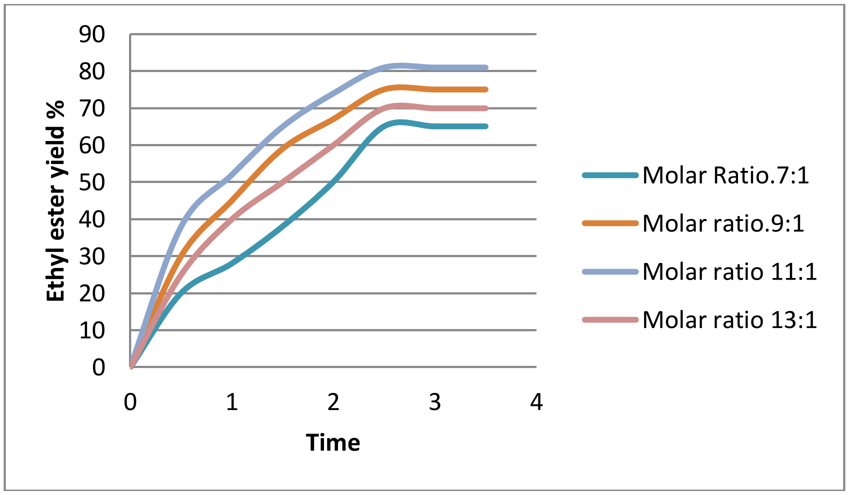


*Figure 3.Effect of molar ratio of ethanol/oil on ethyl ester yield with respect to time.*

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In transesterification reaction of sunflower oil, the excess of alcohol seems to favor conversion of di- to monoglycerides, but there is also a slight recombination of esters and glycerol to monoglycerides since their concentration keeps increasing during the course of the reaction, in contrast with reactions conducted with low molar ratios It is observed that when glycerol remains in solution it helps to drive the equilibrium back to the left, lowering the esters yield. In consequence, the alcohol/oil molar ratio is one of the most important variables affecting the esters yield, and although the stoichiometric ratio for transesterification requires three moles of alcohol and one mol of triglyceride, an excess of alcohol is used in practice. Hence, the alcohol molar/oil ratio is a variable that must be always optimized.

## CONCLUSION

In order to obtain the higher yield of biodiesel, for transesterification reaction of sunflower oil with ethanol and sodium hydroxide as catalyst. The reaction condition was varied, such as catalyst concentration, ethanol/oil molar ratio and reaction temperature. The optimization of reaction was done and the optimum condition was found at ethanol/oil molar ratio11:1, reaction temperature $95^0$c and catalyst concentration at 1%wt/wt, at this reaction condition yield of ethyl ester obtained maximum.

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