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Conversion of Waste Frying Oil into Valuable Product Using Oscillatory Baffled Reactors (OBRs)

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Abstract: ***As supply of fossil fuel is limited whilst energy demand continues to rise, hence alternative renewable fuels have received increasing attention for future utilization. So in this paper transeterification of waste frying oil is studied in Oscillatory baffled reactors. Parameters used for optimization of transeterification are reaction Time, Oil to alcohol ratio and catalyst concentration. The effect of this parameter on viscosity is reported in this paper.***

Key words: Transeterification, Waste Frying Oil, Transeterification

I. INTRODUCTION

The treatment of the waste has become one of the most important concerns of modern society to protect the environment. As global reserve of fossil fuels is limited, great efforts are being made to find ultimate carbon sources for the production of fuels. Since waste cooing oil contains water and free fatty acids, catalytic pyrolysis offers great advantage to eliminate the pre-treatment capital and operating cost. The increasing production of waste frying oils from household and industrial sources is a growing problem all around the world. This residue is regularly poured down the drain, resulting in problem for wastewater treatment plants and energy loss, or is integrated into the food chain through animal feeding, thus becoming a potential cause of human health problems. There are several end uses for this waste, such as the production of soaps or of energy by anaerobic digestion, thermal cracking, catalytic pyrolysis, etc.

Biodiesel is composed of long-chain fatty acids with an alcohol attached, often derived from vegetable oils. It is produced through the reaction of a vegetable oil with methyl alcohol or ethyl alcohol in the presence of catalyst. Chemically, biodiesel is called methyl ester if the alcohol used is methanol. Oscillatory baffled reactors (OBRs) are a form of reactor, in which tubes fitted with orifice plate baffles have an oscillatory motion superimposed upon the net flow of the process fluid. Through the interaction of the baffles with the oscillatory motion of the fluid uniform mixing and enhanced transport rates are achieved, whilst maintaining conditions approximating plug flow.

Oscillatory baffled reactors (OBRs) are a form of plug flow reactor that can be used for long reactions, as the plug flow is not dependent on achievement of a certain velocity in the reactor leading to much more compact designs. One class of long reactions is that of bioreactions/fermentations. Since one major advantage of the OBR is its highly uniform, controllable mixing, which can be used to enhance gas-to-liquid mass transfer, it should be suitable for biological reactions. Biodiesel (fatty acid esters) has a great potential as an alternative diesel fuel. Its fuel properties are quite similar to those of conventional diesel fuels. It can be produced from renewable resources such as vegetable oils and tallow. It also provides environmental benefits especially carbon dioxide saving that prevents the greenhouse effect. Thus, it has become more attractive in many countries, including Thailand (an agricultural-based and diesel-imported country).

The most common way to produce biodiesel is by Transesterification, which refers to a catalyzed chemical reaction involving vegetable oil and an alcohol to yield fatty acid alkyl esters (i.e., biodiesel) and glycerol. Triacylglycerols (triglycerides), as the main component of vegetable oil, consist of three long chain fatty acids esterified to a glycerol backbone. When triacylglycerols react with an alcohol (e.g., methanol), the three fatty acid chains are released from the glycerol skeleton and combine with the alcohol to yield fatty acid alkyl esters (e.g., fatty acid methyl esters or FAME). Glycerol is produced as a by-product. Methanol is the most commonly used alcohol because of its low cost and is the alcohol of choice in the processes developed in this study. In general, a large excess of methanol is used to shift the equilibrium far to the right.

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II. MATERIALS AND METHODS

USED PALM OIL IS USED TWICE FOR FRYING OF VEGETABLES OBTAINED FROM GOKUL RESTAURANT, NAGPUR. LR GRADE SODIUM HYDROXIDE IS USED AS CATALYST FOR THE TRANSETERIFICATION REACTION.

III. EXPERIMENTAL SET

Experimental set up for oscillatory flow biodiesel reactor consists of a hallow pipe of diameter 52mm. Pipe is closed at bottom & open at top. The pipe is fitted with orifice plate baffles, diameter of orifice plate baffles is 50mm.Plates are attached to pair of straight rod at equal distance of about mm. The arrangement is made so that orifice plate will approximately fit the I.D. of pipe. Two rods with orifice plate baffles is attached at the top to the crank mechanism that is simply to the shaft of the motor such that when shaft of the motor rotates in circular direction, orifice plates will move in oscillatory direction that is in upward and downward direction. The motor is fitted at considerable height from the bottom of the reactor so as to match the amplitude of oscillation within the reactor with minimum noise. The speed of revolution of motor shaft is adjusted with the help of dime stat through which electricity is given to the motor. Specified amount of catalyst is dissolved in a methanol completely and then this solution is taken for run. During operation of reactor, mixture of oil and methanol is added to reactor and reactor set for oscillation.

IV. RESULTS AND DISCUSSION

A Effect of Reaction Time Vs Viscosity:

From figure 1, it is observed that the viscosity of FAME decrease as the time passes from 10min to 20min and after 20 min the viscosity is approximately constant. So 20 Min is considered as optimum time for carrying out further experiment

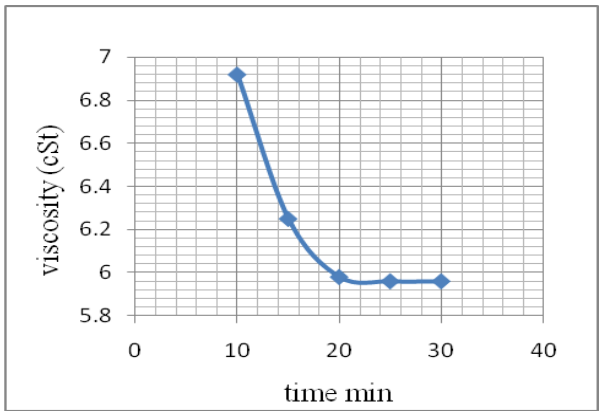

Fig 1: Effect of Time Vs Viscosity

B Effect of Molar ratio on Viscosity

From the Figure 2 minimum viscosity of FAME is Observed at 1:9 molar ratio. The experiment was carried out for 20 min.

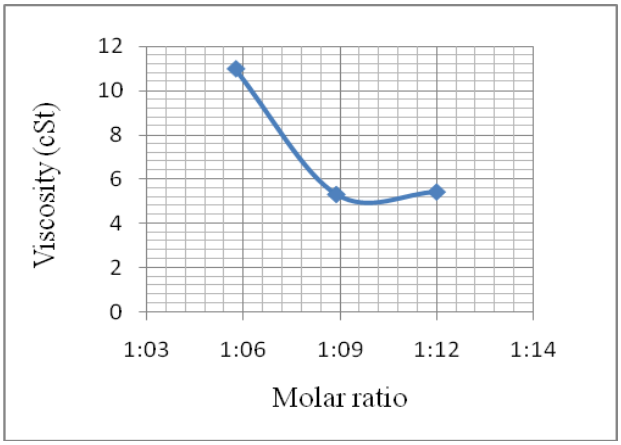

Fig 2: Effect of Molar Ratio Vs Viscosity

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C. Effect of Catalyst Concentration on Viscosity

From figure 3, it is observed that viscosity of FAME decreases from 0.5 wt % of Catalyst to 1 wt% of catalyst. Further increases in catalyst concentration viscosity also increases.

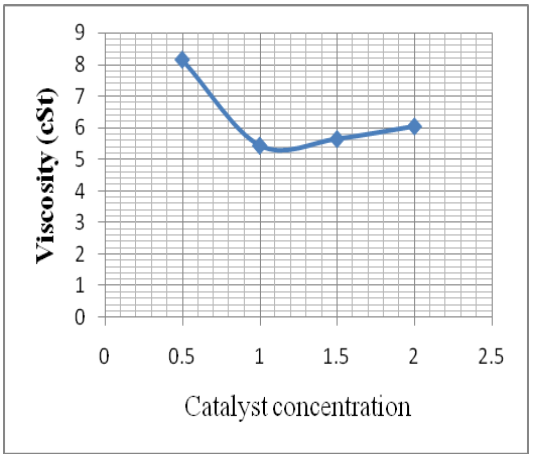

Fig 3: Effect of Catalyst Concentration Vs Viscosity

V. CONCLUSION

From above discussion one can conclude that, waste frying oil can be converted into FAME using OBR. Because of increasing waste frying oil day by day, this is one of the promising ways to utilize waste to convert into valuable product. The optimum conditions for carrying out transeterification reaction of frying oil in OBR are

Molar ratio (oil: alcohol) = 1:9

1. Reaction time = 20 min.
2. Catalyst concentration = 1% (by weight)

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