APPLICATION OF MICROWAVE RADIATION TECHNIQUE IN PRODUCTION OF BIODIESEL TO ENHANCE THE PROPERTIES AND ECONOMIZATION OF BIODIESEL

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ABSTRACT

Since the last few years biodiesel has been showing challenging properties in comparison with petro diesel. It is both environmental friendly and can replace petro diesel, in which the later is a major source of environmental pollution. The major hindrance in the commercialization of biodiesel is its high production cost. So it is necessary to reduce the cost of production of biodiesel by reducing the power consumption level for its production from various sources. In the present paper the use of Microwave radiating technique was used which reduced the production cost and time. Also the extracted biodiesel shown good results in practical engine tests. Hence we can say that Microwave radiation technique not only saves power, but it also saves money and environment.

Keywords: Biodiesel, Cost, Carbon Dioxide Emission, Environment Friendly, Microwave Radiation.

I INTRODUCTION

Bio-Diesel is considered as one of the most promising alternative fuel as it is ecofriendly [2-4]. But the primary hindrance to the commercialization of biodiesel is its high of production [5-8]. The transesterification reaction which is the only reaction through which a vegetable oil can be converted to bio diesel undergoes at a temperature of 60˚C to 80˚C.This temperature has to be maintained for about 2 to 3 hours in normal heating conditions which consumes lot of energy and increases the cost of biodiesel. In the present work the same transesterification process was done in a microwave heating conditions, by which the time of heating and the cost of production was reduced as compared to traditional process.

1.1 Materials and Experimental Set-up

1.1.1 Waste cooking oil

Waste cooking oil was collected from an hotel for 20 rupees per liter. Before alkali – catalyzed transesterification the oil is subjected to pretreatment. The oil obtained was filtered and water washed [9]. The removal of impurities such as water, free fatty acid and polymers prior to alkali catalyzed transesterification improves the yield and quality of the esters [12].

1.2 Reactor

The experimental set up consists of a mechanical stirrer and condenser. The stirrer was operated at 600rmp with a motor. The catalyst used was NaOH with 5 minutes heating [14]. A microwave heater, stirrer and a condenser were used for the microwave heating method.The appropriate power dissipation control will result in effective use of microwave energy and reduces the energy requirement [15]. The complete experimental set-up is shown in schematic diagram Fig.1.

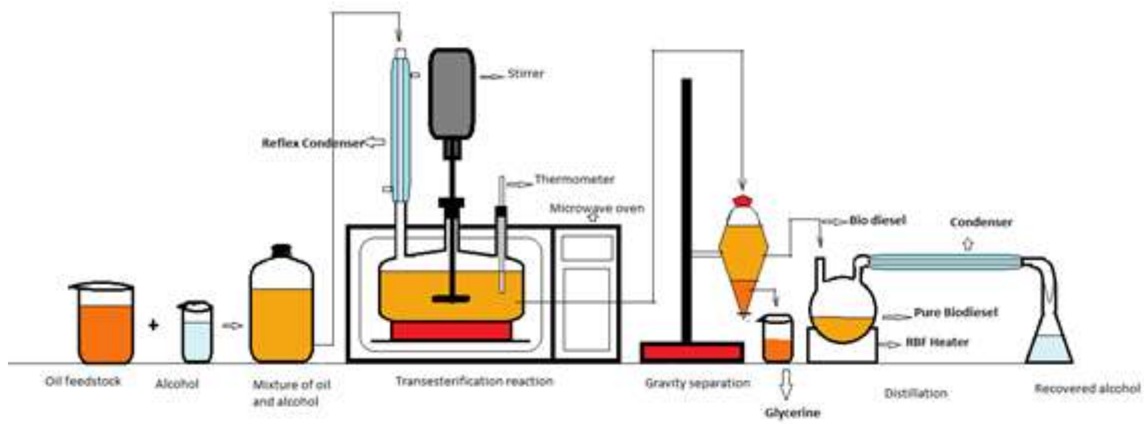

Fig. 1: Schematic Diagram of bio diesel production from waste cooking oil.

1.3 Methodology

1.3.1 Alkali Catalyzed Transesterification

The waste cooking oils are subjected to Tran's esterification; a chemical reaction, involving triglycerides and an alcohol of lower molecular weights using homogeneous or heterogeneous substance as catalyst to yield bio-diesel and glycerol using a fabricated micro-oven reactor. A catalyst is usually used to improve the reaction rate and yield. The sodium methoxide (CH_3 ONa) is used as catalyst in our present work. The oil and the alcohol ratio used here is 1:6, because the reaction is reversible, excess alcohol is used to shift the equilibrium to the products side [10-11]. The reaction is shown in Fig. 2.

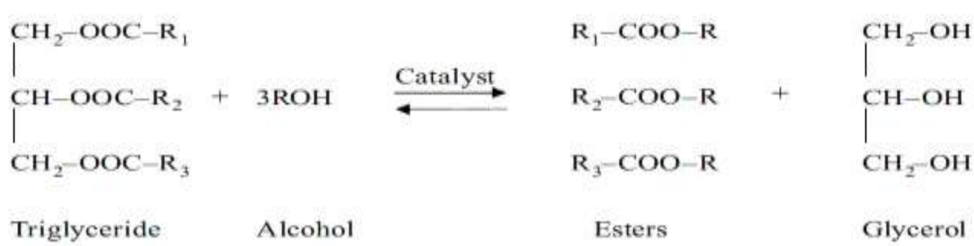

Fig.2: Transesterification Reaction

1.3.2 Downstream processing of Bio-Diesel

Once the reaction is completed biodiesel needs to be processed from the reaction mixture for which separation and purification processes are carried out.

1.3.3 Separation of Bio-diesel

After the transesterification reaction, bio-diesel is a mixture of excess methanol catalyst and glycerol. As a rule, difference in specific gravity of 0.1 in a mixture of compounds will result in phase separation by gravity. Gravity separation is suitable to recover bio-diesel from the process by products.

1.3.4 Purification of bio-diesel

This process is meant to remove impurities from bio-diesel after it is separated from the glycerol layer. These include alcohol, catalyst, entrained glycerol, soap and other impurities [16]. In order to obtain a final bio-diesel product adhering to specification, distillation has been used as the final purification step for bio-diesel production to remove the impurities and unpleasant odor.

II RESULTS AND DISCUSSIONS

The heating was carried out at 65^{O}C with a methanol to oil molar ratio of 6 and 0.75 wt% NaOH. The maximum yield of bio-diesel made from Waste cooking oil under conventional heating was 85% but by microwave heating is 90%. Gas chromatography analysis (Fig.3) precisely measures the percent of free glycerin, mono, di and tri glycerides. Average conversion factors are applied to the mono di and triglycerides to calculate the bonded glycerin content of the sample retention time changes indicate instrument states.

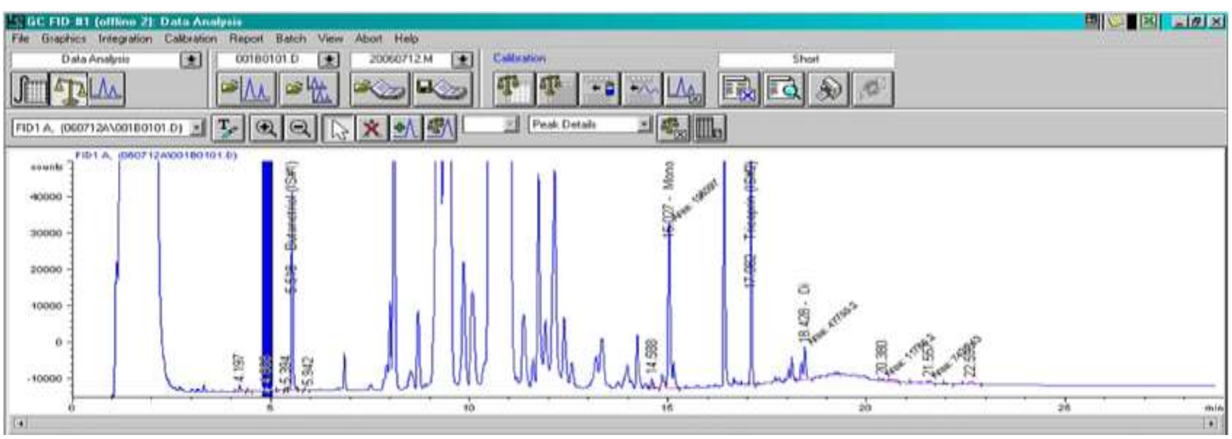

Fig.3: Analysis of Chromatogram

The economic feasibility of biodiesel depends on the price of crude oil and the cost of transporting diesel long distances to remote markets [4]. Cost was analyzed for the production of 1liter of biodiesel from the waste cooking oil and the expected cost of Biodiesel if extracted from Waste cooking Oil on small scale will be approximately Rs. 50/- per liter. But if the production is taken at a large scale the catalyst and the alcohol can be recovered and reused for several times and thus the cost of production of bio diesel can be further reduces. The properties of Biodiesel extracted from the waste cooking are mentioned in Table 1 and compared to Petro-diesel and the complete process shown in Fig.4.

Table 1: Comparison of Fuel Properties of Extracted Biodiesel with Petro-diesel

Property	Petro-diesel	Bio-diesel
Carbon, Wt. %	86.8	76.2
Hydrogen, wt.%	13.2	12.6
Oxygen, wt.%	0.0	11.2
Sulphur, wt.%	0.0015	0.0
Specific Gravity 0.85 0.88	0.85	0.88
Viscosity, mm2/s @	2-3	4-5
Energy content	43	39
Flash Point in ℃	60-80	130-170
Cetane No	40-55	47-65
Lubricity	2000 grams	>7000 grams
Carbon residue	0.2%	0.7%

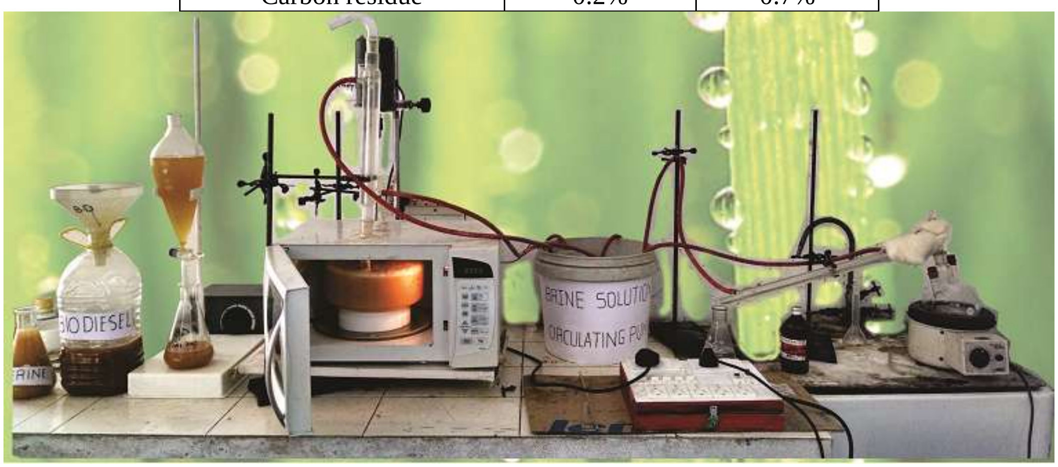

Fig.4: Experimental Process for bio diesel production from waste cooking oil.

III MECHANISM OF MICROWAVE TRANS ESTERIFICATION

The highly effective trans esterification by the microware heating system is attributed to the direct adsorption of the radiation by the OH group of the reactant. Microwave heating can be more energy efficient than conventional heating because the alchol and oil mixture gets heated faster and the energy heats only the mixture, not the whole oven compartment. Microwave heating does not reduce the nutritional value of the mixture more than conventional heating. In fact, alchol and oil mixture heated in a microwave heater may keep more of their nutritional values, because microwave heater can heat more quickly and without adding any solvent. Microwaves are produced inside the oven by an electron tube called a magnetron. The microwaves are reflected within the metal interior of the oven where they are absorbed by solution in the container. Microwaves cause liquid molecules present in the solution to vibrate, which heats the solution. The microwave energy is changed to heat as it is absorbed by solution, and does not make solution “radioactive” or "contaminated."

IV CONCLUSION

Bio-diesel as an alternate fuel for diesel engines has become increasingly important due to environmental consequences of petroleum resources. The main challenges are its cost and availability of raw material. By using the waste cooking oil and converting it to bio-diesel, its cost can be significantly lowered and the negative impact of disposing used cooking oil to environment reduce. The maximum yield of bio-diesel made from Waste cooking oil under conventional heating was 85% but by microwave heating is 90%.

The quality of bio-diesel is most important for engine parts. Hence various downstream processing - separation of bio-diesel from glycerol, purification to recover alcohol, bio-diesel washing, drying and where specified distillation are carried out.

To check the quality of bio-diesel various standards have been specified. As per the analytical methods reported in literature, gas chromatography method has been widely used. The bio-diesel was characterized by determining its density, viscosity, calorific value, cetane number , flash point, cloud and pour points. The characteristic properties of bio-diesel are same as that produced from virgin oil and are generally similar to those of petroleum diesel fuel. The fuel properties of bio-diesel derived from used cooking oil all met the various rational bio-diesel standards.

The bio-diesel produced from used cooking oil can be used in diesel engine without any engine modification. Hence the cost of production of the biodiesel which was the major hindrance for the commercialization of the biodiesel can be reduced by the use of microwave heating technique and increasing the yield of biodiesel production from 85% to 90% and by reducing the power consumption cost.

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