PERFORMANCE AND EMISSIONS CHARACTERISTICS OF BIODIESEL FROM WASTE COOKING OIL BLENDED WITH KEROSENE ON DIESEL ENGINE

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ABSTRACT - Due to steady reduction of world petroleum reserves and the influence of environmental pollution there is a serious need for suitable alternative fuels for use in diesel engines. In view of this, waste cooking oil biodiesel blended with kerosene is a promising alternative because it is renewable, environment friendly and produced easily in rural areas, where there is an acute need for modern form of energy. Therefore, during recent years a methodical approach has been made by several researchers to use waste cooking oil biodiesel as a fuel in IC engines.

In this study the waste cooking oil collected from various places such as hotels, food bakery, and chips shop etc., the waste cooking oil was converted into biodiesel through Trans esterification process which is methanol and KOH was used as catalyst. The pure waste cooking oil having high viscosity and calorific value which is performs lower brake thermal efficiency and higher exhaust emission. Here kerosene act as a dilution agent to reduce the viscosity and increase calorific value of waste cooking oil biodiesel.

The kerosene was blended with waste cooking oil biodiesel by various percentages such as 10%, 20% and 50%. The experimental investigations were carried out in single cylinder, water cooled four stroke Kirloskar TV 1 diesel engine and coupled with an eddy current dynamometer as loading device. The performance and emission characteristic were investigated on that test engine with various load condition and minted at constant speed of the engine.

The brake thermal efficiency is increased for maximum concentration of 50% kerosene into waste cooking oil biodiesel (BD50:KE50). It has shown an increase of 2.55% compared to waste cooking oil biodiesel (BD100). The specific fuel consumption is decreased to the blend BD50:KE50 compared to BD100 blend.

The CO, HC, smoke emission, are found to decreases with the blend BD50:KE50 and increases of NO_x emission compared to that of waste cooking oil biodiesel. The decreasing value of CO, HC, smoke, is 20%, 11.5%, 21.5%, respectively and NO_x is slightly increases.

INTRODUCTION

Due to gradual exhaustion of world petroleum reserves and the effect of environmental pollution there is an urgent need for suitable alternative fuels for use in diesel engines. In observation of this, vegetable oil is a promising alternative because it is renewable, environment friendly and produced easily in rural areas, where there is an acute need for modern form of energy. Now day's systematic effort have been made by several research workers to use as fuel engines. It is supposed that energy consumption pattern is an indicator of the socio-economic development of a country. It is also a measure of the quality of life. Energy consumption is rising day by day along with technological development of a country. Although the industrial and developed world consumes most of the energy resources, the demand of energy in the unindustrialized countries has also increased in recent decades due to their economic take off and sustainability. Internal combustion (IC) engines are widely employed in many development activities using greater portion world's energy resources. From the very foundation, the IC engines are being fueled mostly by petroleum products like petrol and diesel. IC engines use only a small fraction of extraction products of crude oils. These crude oils have partial reserves any shortfall of petroleum fuels in the world market will; therefore, have a great impact on the economy of non-oil third world countries. In outlook of growing energy demand of our country, it is thus reasonable to inspect the use of waste cooking oil and kerosene blends are a substitute fuel for IC engine.

Awareness about the environment

Now day's environmental pollution is a much talked issue which has drawn alarming concern worldwide. IC engines release CO_2 which is the main funder to greenhouse effect that leads to global warming, climate change and other adverse effects. The matter of environment protection policies has been taken up in many national and international forums over the years. Today around 80% of the carbon emissions to the atmosphere is due merely to fossil fuel burning and it has become about 0.5% annual growth rate. Future atmospheric concentration of CO_2 will depend on fuel mix and energy demand as they have emotional impact on fossil fuel consumption. So, strong emphasis on the use of non-fossil fuel alternative energy sources is necessary. Vegetable oils may be considered as right alternatives in this regard.

The environmental worries and the fear of energy shortage throughout the world have raised questions on the blind use of conventional fuels. Scientists world over have concentrated their efforts to find out methods and means to produce alternative fuel also known as non-conventional fuel.

Search for alternative fuels

Alternative fuel‖ means the term refers to substances (excluding conventional fuels like gasoline or diesel) which can be recycled as fuels. Due to the energy crisis, the following factors have led to the increasing need for finding a feasible fuel alternative to conservative sources:

- Fossil sources are 2limited; it will eventually get used up.
- Only few countries have usable fossil investments. It forces other nations to depend on them for energy.
- Countries want energy safety and independence.
- Combustion of carbon-rich fuels clues to emissions like CO and CO_2, which are harmful to the environment.
- More and more people are becoming environmentally-conscious and need a fossil fuel alternative.

The pressing need for a solution to the world‘s environmental and energy problems has directed to a lot research to find a fossil fuel alternative. Alcohol-fuels alike ethanol and methanol based substances are easy to produce. They are made from crops like corn, which is fermented to harvest alcohol. But alcohols are highly destructive, and require expensive metal, plastic and rubber replacements for existing parts to be used in cars.

Biodiesels state to non-petroleum based substances which powers a diesel engine. Vegetable oils and used-fry-oil (waste cooking oil) have been used as biodiesels, after being subject to some processing. They are effective alternatives to petro diesel, producing like amounts of energy with lesser emissions. However, biodiesels are significantly more expensive than petro diesel, freeze solid in cold weather, and cannot be produced in sufficient quantities to happen global demand.

Objective

The objective of the present work is to identify suitable non eatable oil to extract biodiesel. To avoid the waste cooking oil disposal to open land and reduce the greenhouse gas emission.

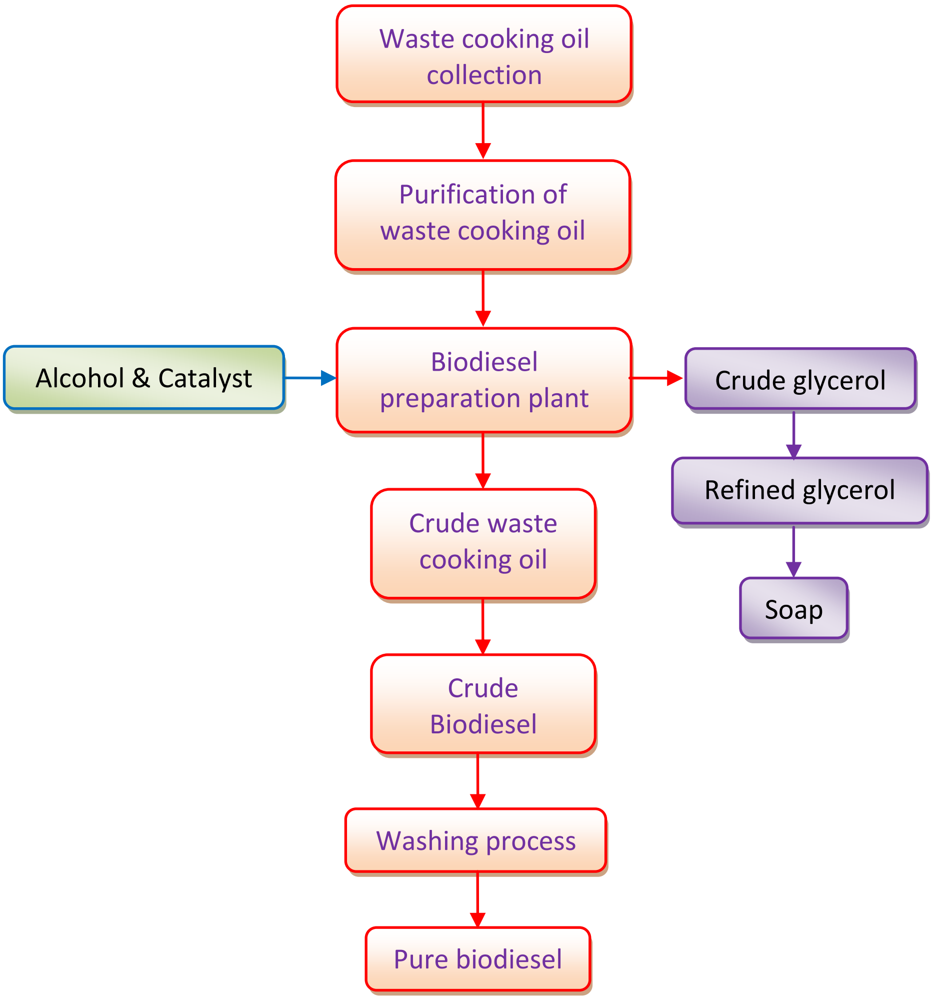
- Selecting the suitable non edible oil to make the biodiesel.
- To select the kerosene as alternate fuel for C.I. engine.
- To select the appropriate method for biofuel production.
- To select the right blending proportions of kerosene and biodiesel for enhance the performance and emission characteristics.

Methodology

- The waste cooking oil is converted into biodiesel through Trans esterification process.
- The kerosene was blended with biodiesel by several percentages such as 10%, 20% and 50%.
- The physical properties of kerosene waste cooking oil blends are tested through ASTM standards.
- The preparation of kerosene and waste cooking oil biofuel blends stimulated with magnetic stirrer.
- The experimental surveys has been carried out in Kirloskar TV 1, single cylinder four stroke, water cooled diesel engine coupled with an eddy current dynamometer with all necessary equipment and studied the engine performance and emission characteristics.
- Running the engine with different blends of kerosene and waste cooking oil biodiesel blends (10%, 20% and 50%) at varying load conditions by keeping the engine speed at constant.

Biofuel production process from waste cooking oil

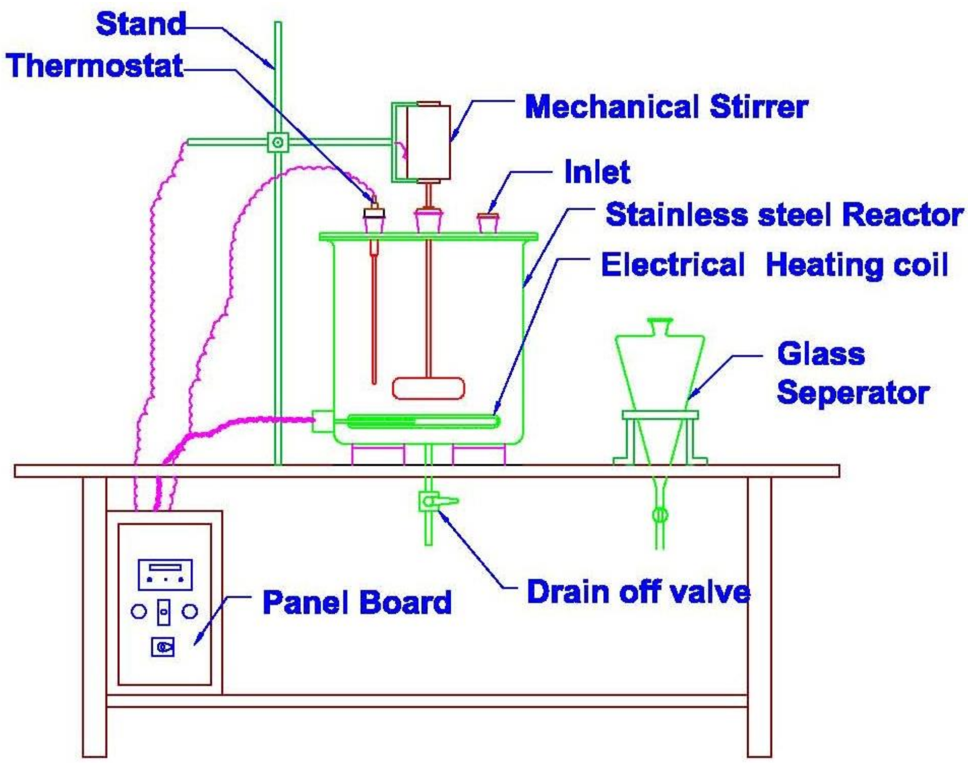
The procedure flow diagram for production of biofuel through trans esterification from the waste cooking oil is presented in Figure 4.3.



Process flow diagrams for production of waste cooking oil biodiesel

A laboratory-scale biodiesel production set-up was as shown the Figure 4.4. It consists of a motorized stirrer, straight coil electric heater and stainless steel containers. This system was designed to produce maximum 5 liter of biodiesel. Temperature of the blended triglyceride, methanol and catalyst were maintained at about 60°C.

The method accepted for preparation of biodiesel from waste cooking oil for this work is, Trans esterification which is a process of using methanol (CH_3OH) in the presence of a catalyst, such as potassium hydroxide (KOH), to chemically break the molecule of waste cooking oil into an ester and glycerol. This method is a reaction of the oil with an alcohol to remove the glycerin, which is a by-product of biodiesel production.



Schematic diagram of biodiesel plant (5 litre Capacity)

The procedure done is given below: 1000ml of waste cooking oil is taken in a container. 15 grams of potassium hydroxide alkaline catalyst (KOH) is pondered. 200 ml of methanol is taken is beaker. KOH is mixed with the alcohol and it is stirred until they are properly dissolved. Raw waste cooking oil is engaged in a container and is stirred with a mechanical stirrer and simultaneously heated with the help of a heating coil. The speed of the stirrer should be minimum and when the temperature of the raw oil reaches 60 °C the KOH-alcohol solution is discharged into the raw cooking oil container and the container is closed with an air tight lid. Now the solution is stimulated at high speeds

Sample of blended biodiesel

Impact of Kerosene in waste cooking oil biodiesel and preparation of fuel blend

The main problems of waste cooking oil biodiesel having high kinematic viscosity, lower calorific value, lower density, high flash and fire point. These characteristics are very important factor of atomization and spray combustion quality in internal combustion engines and play a role to determine the droplet size and flash point determines the ignition point of fuel vapor as well as the problems of diesel fuel vehicle operation in cold weather when this conventional diesel/biofuel can gel problem. There are two important cold weather parameters define operability for biodiesel: cloud point (temperature where crystals first appear) and pour point (lowest temperature where fuel is observed to flow). To overcome these problems the waste cooking oil biodiesel is blended with kerosene by 10%, 20% and 50% respectively. The mixing process of kerosene and waste cooking oil blends was made with electric magnetic stirrer. It has been experienced that waste cooking oil has the merits of miscibility with kerosene and the blended fuels do not change the quality of fuel for a long time at any mixed ratio. There is not necessity any modification of the diesel engine to utilize kerosene and waste cooking oil blends.

A kerosene performance as dilution agent to waste cooking oil biodiesel and improves viscosity, calorific value, density; cetane index number etc., one of the important characteristics of a biodiesel fuel is its capacity to auto ignites. A characteristic that is quantified by the fuel's cetane number or index number, a greater cetane number or index means that the fuel ignites more quickly. The cetane number of a fuel indicates the self-igniting capability of the fuel and has a direct impact on ignition interval. The higher cetane , the shorter the ignition delay and vice versa. High cetane number fuel encourages early and uniform ignition of the fuel. Blends of kerosene and biodiesel can be used in unmodified diesel engines and replaced diesel fuel. The objective of this study was to determine the effect of kerosene mixes on diesel engine performance characteristics. Engine performance characteristics are major criteria that govern the suitability of a fuel.

This chapter offerings the detailed discussion of experiments conducted in diesel engine fueled with waste cooking oil biodiesel blended kerosene. The experimental surveys were carried on Kirlosakar TV -1 engine with various load (20%, 40%, 60%, 80% & Full load) conditions and maintained the constant speed 1500 rpm of the engine. The performance and emission characteristic curve are plotted opposing to break power.

Brake Thermal Efficiency

Brake thermal efficiency (BTE) is used to estimate the performance of biodiesel fuels, in addition to their heating value. From Figure 6.1, it is clear that BTE somewhat increases with waste cooking oil biodiesel blended with kerosene. Many researchers have reported a minor increase in BTE when using the biodiesel kerosene blends diesel engine. The maximum increase in BTE was found in BD50:KE50 compared with BD100 fuel by about 2.55%. It is due to higher oxygen content present in the biodiesel blend and it tends to better combustion of fuel. An increase of kerosene blend with waste cooking oil biodiesel improves the fuel atomization and the better mixing of fuel with air. From the figure it is found that the BTE increased with the increase of kerosene ratios. Better fuel atomization leads to better utilization of fuel-air mixture and effective combustion can be realized, which results in an increase in BTE. The BTE of BD100, BD90:KE10, BD80:KE20, BD50:KE50 was 25.65%, 26.33%, 27.22% and 28.20% at 220bar (standard) of fuel injection pressures at maximum load, respectively.

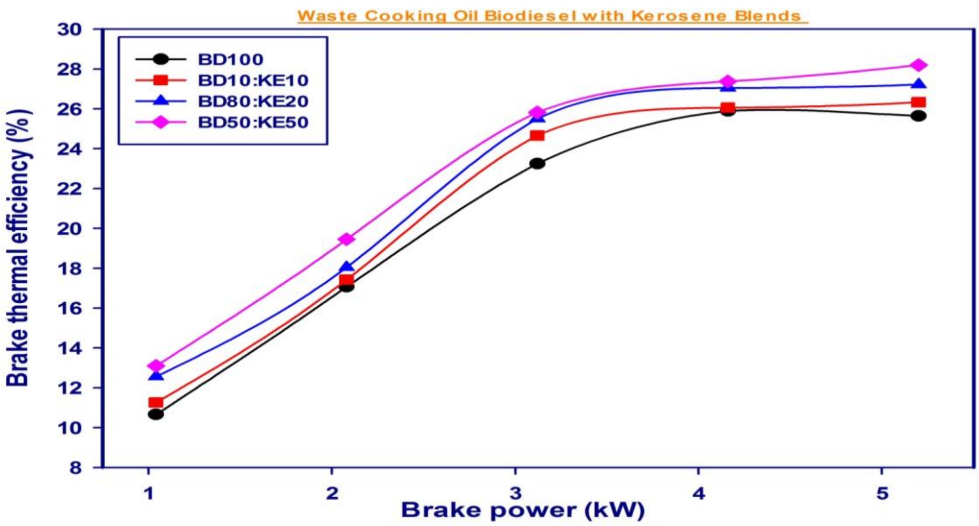


Figure 8.1 Brake thermal efficiency against brake power

Smoke density

The formation of smoke density is mainly dependent on the partial burning of the liquid fuel and incompletely reacted carbon present in the fuel. Figure 6.3 shows the variation in smoke density for the waste cooking oil biodiesel with kerosene blends over the entire range of the brake power. As it is given in the figure, the smoke emission reduced by the addition of kerosene with waste cooking oil biofuel. The blending of waste cooking oil biodiesel with kerosene which is produces locally rich oxygen regions to prevent the crucial smoke formation. The smoke emission over the constant rpm band decreased 21.6% for the BD50:KE50 blend, compared with waste cooking oil biodiesel (BD100%). The increment of kerosene ratio to waste cooking oil biodiesel further reduces the smoke level. This is due to lower kinematic viscosity of kerosene biodiesel blends as well as fine atomization of fuel causes for lower smoke density at maximum load condition. The smoke emission for BD100, BD90:KE10, BD80:KE20, BD50:KE50 is 96.2HSU, 86HSU, 81HSU, 75.4HSU respectively.

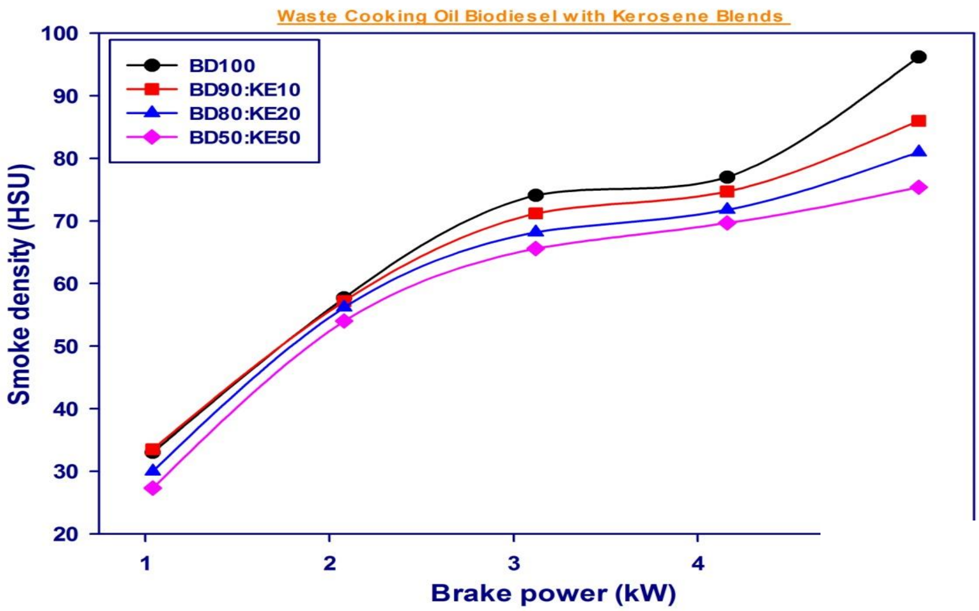


Fig 8.3 Smoke densities against brake power

CONCLUSIONS

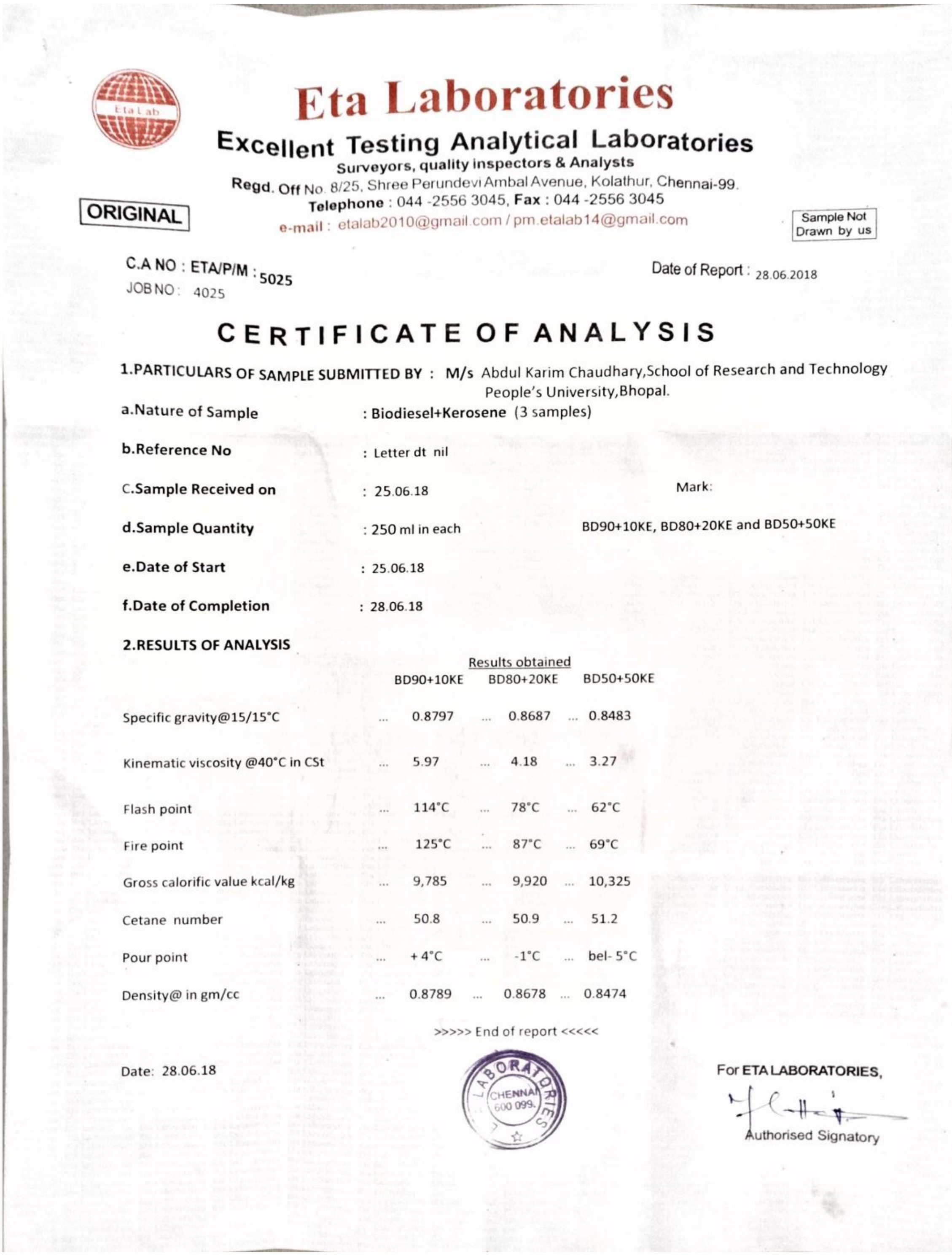
Based on the exhaustive engine test, determined that blending of waste cooking oil with kerosene can be adopted as an alternative fuel for the existing conventional diesel engines by taking care of exhaust emission. On the basis of experimental result with reference to properties of different mixed fuel of kerosene and waste cooking oil, the following conclusions drawn.

The main conclusions of this study are;

- Heating value (calorific value) of the waste cooking oil biodiesel (BD100) is much lower than the biodiesel kerosene blend (BD50:KE50). So when waste cooking biodiesel is used in a diesel engine reduce the power output of the engine.
- High viscosity is identified as a main problem of using the considered waste cooking oil biodiesel directly in diesel engine. However, when this oil is volumetrically blended with kerosene; viscosity values decreased that required by the diesel engine. Therefore, 20% to 50% waste cooking oil biodiesel can be blended with kerosene as substitute fuel of diesel.
- The physical properties of the biodiesel produced from waste cooking oil through trans-esterification is measured and compared to that of diesel fuel.
- The brake thermal efficiency of the waste cooking oil kerosene blend (BD50:KE50) is 2.55% higher than biodiesel (BD100).
- The SFC is decreases for the blend BD50:KE50 compared to other cases.

- The CO, HC, smoke emission, are found to decreases with the blend BD50:KE50 and increases of NOx emission compared to that of waste cooking oil biodiesel. The decreasing value of CO, HC, smoke, is 20%, 11.5%, 21.5%, respectively and NOx is slightly increased.

- The NOx emission for bio-diesel kerosene blend is significantly raised. In future in order to reduce the NOx emission, EGR, SCR and catalytic converter may be employed to attain the desired result.



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ORIGINAL

Sample Not Drawn by us

C.A NO : ETA/P/M : 5025
JOB NO : 4025

Date of Report : 28.06.2018

CERTIFICATE OF ANALYSIS

1.PARTICULARS OF SAMPLE SUBMITTED BY : M/s Abdul Karim Chaudhary,School of Research and Technology People's University,Bhopal.

a.Nature of Sample : Biodiesel+Kerosene (3 samples)

b.Reference No : Letter dt nil

c.Sample Received on : 25.06.18

Mark:

d.Sample Quantity : 250 ml in each

BD90+10KE, BD80+20KE and BD50+50KE

e.Date of Start : 25.06.18

f.Date of Completion : 28.06.18

2.RESULTS OF ANALYSIS

	Results obtained		
	BD90+10KE	BD80+20KE	BD50+50KE
Specific gravity@15/15°C	0.8797	0.8687	0.8483
Kinematic viscosity @40°C in CSt	5.97	4.18	3.27
Flash point	114°C	78°C	62°C
Fire point	125°C	87°C	69°C
Gross calorific value kcal/kg	9,785	9,920	10,325
Cetane number	50.8	50.9	51.2
Pour point	+ 4°C	-1°C	bel- 5°C
Density@ in gm/cc	0.8789	0.8678	0.8474

>>>>> End of report <<<<<

Date: 28.06.18

LABORATORIES CHENNAI 600 099.

For ETA LABORATORIES,

Authorised Signatory

Certificate for blended biodiesel with kerosene

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