FUEL PERFORMANCE AND CHARACTERISTICS ANALYSIS OF BIO DIESEL BLENDS ON I.C. ENGINE

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Abstract : Technology up gradation in different areas has raised up the living standards of human beings, currently I.C engines plays an important role in the areas of transportation power generation aerospace, etc. The emission procedure by I.C engines during the different processes emits harmful gases like CO2, SO2, NO2, etc. These emissions of exhaust gases take a share of about 24% in transportation and 48% in industrial production in overall air pollution by only usage of I.C engines.

The problem of this gas emission has raised a concern in society on environmental change, to overcome this problem many researchers are currently working on alternative fuel resources which can provide the similar performance when compared to diesel with a lesser emission of gases. In a "present research work fuel analysis report on bio-diesel blends, we are making bio-diesel made up waste vegetable oil with an objective of preparing blends (B15, B25, B35 & B45) in order to compare its fuel properties and to know it performance analysis on I.C Engines when this blends are used in place of diesel.

For preparation of biodiesel we have collected waste vegetable oil from hotel and chemical treatment is applied to it. The blend B10 is later produced by mixing of diesel and biodiesel which is tested on single cylinder I.C Engine for performance analysis. To understand the fuel properties of diesel and blend B10, the various kinds of test are conducted for knowing flash point, fire point, viscosity and Calorific value.

The various graphs and tables are plotted which shows the variation at brake power Total fuel consumption (TFC), Specific fuel consumption (SFC) and thermal efficiency when diesel and biodiesel are used.

I. INTRODUCTION

Biodiesel, a diesel fuel substitute that can be made from a variety of oils, fats, and greases, is of interest to farmers for a number of reasons: It can provide an additional market for vegetable oils and animal fats; it can allow farmers to grow the fuel they need for farm machinery; and it can decrease U.S. dependence on imported oil since fuel feedstocks can be grown domestically.

Biodiesel is a renewable source of energy that can help reduce greenhouse gas emissions and minimize the "carbon footprint" of agriculture. It contributes less to global warming because the carbon in the fuel was removed from the air by the plant feedstock.

In addition, biodiesel produces less air pollution (exhaust emissions) than diesel made from fossil fuels. A 1998 study by the USDA and US DOE found that using pure biodiesel in urban buses "results in substantial reductions in life cycle emissions of total particulate matter, carbon monoxide and sulfur oxides (32%, 35% and 8% reductions, respectively, relative to petroleum diesel's life cycle)." (Sheehan et al., 1998)

- To manufacturing the Biodiesel from waste vegetable oil.
- Comparing the fuel properties of Biodiesel B15, B25, B35 & B45 with Diesel.
- Operating the four-stroke engine with Biodiesel B15, B25, B35 & B45
- Comparing performance and emissions of Biodiesel B15, B25, B35 & B45 with Diesel.

II. LITERATURE REVIEW

Various method for the production of biodiesel from vegetable oil were reviewed. Such as direct use and blending, micro emulsion, pyrolysis and transesterification. The advantages and disadvantages of the different biodiesel-production methods are also discussed. Finally, the economics of biodiesel production was discussed using Malaysia as a case study. **[1]**

Fossil fuel resources are decreasing daily. Biodiesel fuels are attracting increasing attention worldwide as blending components or direct replacements for diesel fuel in vehicle engines. Biodiesel fuel typically comprises lower alkyl fatty acid (chain length C_{14}–C_{22}), esters of short-chain alcohols, primarily, methanol or ethanol. Various methods have been reported for the production of biodiesel from vegetable oil, such as direct use and blending, micro emulsification, pyrolysis, and transesterification. Among these, transesterification is an attractive and widely accepted technique. The purpose of the transesterification process is to lower the viscosity of the oil. **[2]**

Biodiesel is a renewable transportation fuel consisting of fatty acid methyl esters (FAME), generally produced by transesterification of vegetable oils and animal fats. In this review, the fatty acid (FA) profiles of 12 common biodiesel feedstock's were summarized. Considerable compositional variability exists across the range of feedstock's. For example, coconut, palm and tallow contain high amounts of saturated FA; while corn, rapeseed, safflower, soy, and sunflower are dominated by unsaturated FA. Much less information is available regarding the FA profiles of algal lipids that could serve as biodiesel feedstock's. However, some algal species contain considerably higher levels of poly-unsaturated FA than is typically found in vegetable oils. **[3]**

Biodiesel defined as mono-alkyl esters of vegetable oils and animal fats, has had a considerable development and great acceptance as an alternative fuel for diesel engines. Density and viscosity are two important physical properties to affect the utilization of biodiesel as fuel. In this work, mixtures of biodiesel and ultra low sulphur diesel (ULSD) were used to study the variation of density (ρ) and kinematic viscosity (η) as a function of percent volume (V) and temperature (T), experimental measurements were carried out for six biodiesel blends at nine temperatures in the range of 293.15–373.15 K. Both, density and viscosity increases because of the increase in the concentration of biodiesel in the blend, and both of them decrease as temperature increases. **[4]**

Biodiesel, Combustion modelling, Critical properties, Heat of vaporization, Liquid density, Methyl ester, Physical as the use of biodiesel becomes more widespread, researchers have shown a strong interest in modelling the combustion processes in the engine in order to understand the fundamental characteristics of biodiesel combustion. In the early phase of the simulation, accurate prediction of the physical properties of biodiesel is critical in the representation of spray, atomization, and combustion events in the combustion chamber. The objective of this article is to present methods for predicting key physical properties including critical properties, vapour pressure, latent heat of vaporization, density, surface tension, and liquid viscosity for biodiesel that can be used for combustion modelling. Predicted results were compared with published data where available, and for some properties, errors were less than 1%. These models could be used in a detailed combustion model such as KIVA to make relative comparisons between fuels. **[5]**

To optimize biodiesel manufacturing, many reported studies have built simulation models to quantify the relationship between operating conditions and process performance. For mass and energy balance simulations, it is essential to know the four fundamental thermo physical properties of the feed oil: liquid density (ρ_L), vapour pressure (P_{vap}), liquid heat capacity (C_P^L), and heat of vaporization .Additionally, to characterize the fuel qualities, it is critical to develop quantitative correlations to predict three biodiesel properties, namely, viscosity, cetane number, and flash point. This article presents the results from a comprehensive evaluation of the methods for predicting these four essential feed oil properties and six key biodiesel fuel properties. We compare the predictions to reported experimental data and recommend the appropriate prediction methods for each property based on accuracy, consistency, and generality. **[6]**

Viscosity is one of the most significant properties to affect the utilization of biodiesel fuels. This paper presents a method, which has been verified experimentally, for predicting the viscosities of biodiesel fuels from the knowledge of their fatty acid composition. The viscosities of fifteen biodiesel types were then predicted based on their fatty acid composition as published in the literature and were found to vary as much as 100% This is most likely a principal contributing factor to the variation in performance of some biodiesel fuel types. The viscosity of biodiesel fuels reduce considerably with increase in unsaturation. Contamination with small amounts of glycerides significantly affects the viscosity of biodiesel fuels. **[7]**

In the present work, a group of contribution model is proposed for estimating the dynamic viscosity fatty compounds. For the major components involved in the vegetable oil industry, the optimized are reported. In order to improve the data bank gathered from the literature, viscosity data were measured as a function of temperature for three saturated and three unsaturated fatty esters, one unsaturated fatty acid, and unsaturated triacylglycerol. These last two are unavailable data in the literature. A simple method of calculation is also proposed to predict the dynamic viscosity of vegetable oils as an extended applicability of our equation. The model can be a valuable tool for designing processes and equipment for the oil industry, including edible and no edible compounds, such as bio-diesel. **[8]**

Experimental methodology for quantifying the FAMES of biodiesel. New empirical correlations to estimate the physical properties of FAMES from the structural features of molecules. Good agreement between experimental and calculated physical properties. Simple mixing rules based on mass and mole fraction composition to connect the physical properties of individual FAMES according to the biodiesel. **[9]**

Biodiesel is a promising non-toxic and biodegradable alternative fuel used in the transport sector. Nevertheless, the higher viscosity and density of biodiesel poses some acute problems when it is used it in unmodified engine. Taking this into consideration, this study has been focused towards two objectives. The first objective is to identify the effect of temperature on density and viscosity for a variety of biodiesels and also to develop a correlation between density and viscosity for these biodiesels. The second objective is to investigate and quantify the effects of density and viscosity of the biodiesels and their blends on various components of the engine fuel supply system such as fuel pump, fuel filters and fuel injector. **[10]**

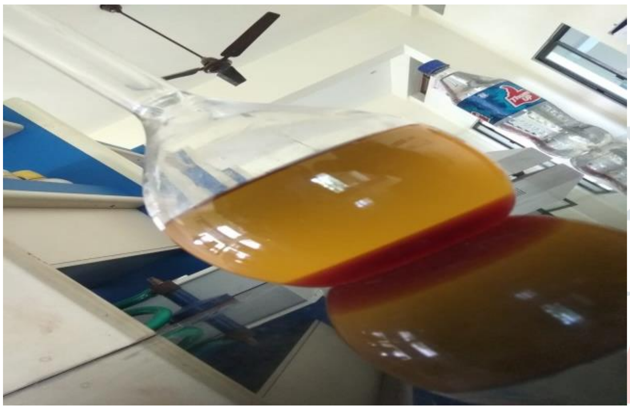
III. MANUFACTURING OF BIODIESEL:-

This fuel can be made in a blender or in a larger mixer. The materials you'll need are used vegetable oil, methanol, and lye. If you are using new vegetable oil, always use 3.5 grams of lye per liter of oil. Since each batch of used cooking oil is different, the amount of lye in each batch of biodiesel will be different. To ensure that you are using the correct amount of lye, make a small test batch of biodiesel in a blender before attempting a reaction in a large mixing tank. This will at least ensure that mixing proportions are correct.

For the test batch, use 100 milliliters of vegetable oil and 20 milliliters of methanol. Mathematical calculations are required to ensure the exact amount of lye needed. If you are using used vegetable oil, use 0.45 grams of lye for the first test batch. If this batch makes biodiesel and glycerin, use the same proportions for the large batch reaction. If the test batch does not form two distinct layers, increase the amount of lye to 0.55 grams and make another test batch. If this batch is unsuccessful, make another batch and increase the amount of lye to 0.65 grams. If that batch is unsuccessful, make another batch with 0.75 grams of lye. Make sure you can make biodiesel on a small scale before attempting a large reaction. Once you have made a successful small test batch of biodiesel, multiply the number of grams of lye you used by ten to see how much lye you will need for each liter of oil in the large reaction. For example, if you used 0.55 grams of lye in the test batch, you will need to use 5.5 grams of lye per liter of used cooking oil for a large reaction. Here is the basic procedure for making biodiesel fuel:

• Purchase or collect used vegetable oil.
• If the oil is used cooking oil, use a restaurant fryer filter to remove burned food bits, etc.
• Purchase some methanol alcohol from a local racetrack or chemical supply store. Ethanol alcohol can also be used, but the process is different.
• Purchase some granulated lye (Red Devil is one brand) or caustic soda sold as a drain cleaner from the hardware or grocery store. It must be pure sodium hydroxide (Noah).
• Measure the amount of vegetable oil you want to use in Liters.
We will call this number V. Pour the vegetable oil into the mixing container.

Figure3.1 Waste Vegetable Oil



• When the temperature is below 70°F (21°C), or when the vegetable oil is solid or lumpy, it will be necessary to heat the reactants before, during, and possibly after the mixing. The ideal temperature to attain is 120°F (49°C). A fish tank heater will heat 10 to 30 gallons (40–120 l) of reactants. For larger batches of biodiesel, a water heater element can be mounted in a steel biodiesel mixing tank. Make sure that you follow the manufacturer's directions and safety precautions when adding any electrical device to the system. Be careful when heating vegetable oil in a plastic container. Polyethylene cannot withstand temperatures above 140°F (60°C).

• Multiply V x 0.2. The result will be the amount of methanol you will need in litters We will call this number M.

• To determine how much lye you will need to use for new vegetable oil, multiply V times 3.5 grams. For used vegetable oil, use the number of grams of lye you got in the small test batch. For example, if you used 0.55 grams of lye in the test batch, you will multiply V times 5.5 grams of lye. Call this number L.
• Carefully pour L grams of lye into M liters of methanol.
Stir until the lye is dissolved in them ethanol. Be careful, this creates a toxic substance called sodium methoxide.
• Pour the sodium methoxide into the vegetable oil right away. Stir vigorously for one hour.
• Let the mixture settle for eight hours.
• Pump the biodiesel from the top, or siphon it off with a hand siphon. Or if you are lucky enough to have a container with a spigot, open the spigot and drain the bottom layer of glycerin. The glycerin will be much thicker and darker than the top layer of biodiesel.

Figure3.3 Heating Oil

• Allow the glycerin to sit in the sun for a week. After that, the trace methanol will be evaporated. You have made nice glycerin soap. You can scent it with the fragrance of your choice, add other soap agents as desired, or just use it as it is. This soap is especially good for cleaning grease off your hands and cleaning greasy equipment!

Figure3.5 Bio-Diesel (b)

• Make sure your biodiesel goes through a 5 micron filter before entering your diesel engine.

Waste vegetable oil	Reacted oil with Biodiesel	Bio diesel

Figure3.6 Filtering used oil process to Biodiesel

IV. FUEL TEST

4.1 Fuel Properties:-

- Flash Point
- Fire Point
- Viscosity

4.2 Flash Point

The flash point of a volatile material is the lowest temperature at which vapors' of the material will ignite, when given an ignition source.

The flash point is sometimes confused with the auto ignition temperature, the temperature that results in spontaneous auto ignition. The fire point is the lowest temperature at which vapors of the material will keep burning after the ignition source is removed. The fire point is higher than the flash point, because at the flash point more vapor may not be produced rapidly enough to sustain combustion. Neither flash point nor fire point depends directly on the ignition source temperature, but ignition source temperature is far higher than either the flash or fire point.

4.3 Fire Point

The fire point of a fuel is the lowest temperature at which the vapour that fuel will continue to burn for at least 5 seconds after ignition by an open flame. At the flash point, a lower temperature, a substance will ignite briefly, but vapor might not be produced at a rate to sustain the Most tables of material properties will only list material flash points. Although in general the fire points can be assumed to be about 10 °C higher than the flash points this is no substitute for testing if the fire point is safety critical.

Viscosity

The viscosity of a fluid is a measure of its resistance to gradual deformation by shear stress or tensile stress. For liquids, it corresponds to the informal concept of "thickness": for example, syrup has a higher viscosity than water.

Viscosity can be conceptualized as quantifying the frictional force that arises between two adjacent layers of fluid that are in relative motion. For instance, when a fluid is forced through a tube, the fluid flows more quickly near the tube's axis and more slowly near its walls. In such a case, experiments show that some stress (such as a pressure difference between the two ends of the tube) is needed to sustain the flow through the tube. This is because a force is required to overcome the friction between the layers of the fluid which are in relative motion: the strength of this force is proportional to the viscosity.

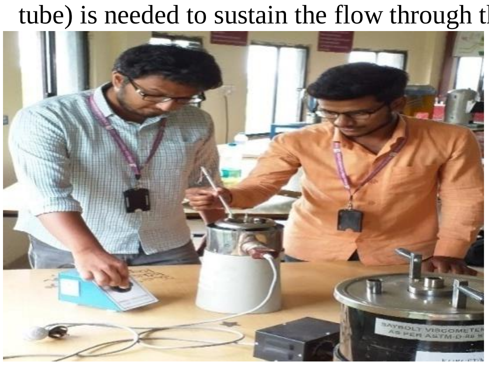


Figure4.2 viscosity

A fluid that has no resistance to shear stress is known as an ideal or in viscid fluid. Zero viscosity is observed only at very low temperatures in super fluids. Otherwise, the second law of thermodynamics requires all fluids to have positive viscosity; such fluids are technically said to be viscous or viscid. A fluid with a relatively high viscosity, such as pitch, may appear to be a solid.

.NO	Type of Fuel	Flash Point	Fire Point	Density	Viscosity	Oil Temp Of (Flash point)	Oil Temp of (Fire point)	Major of Flask with oil
1	Diesel	50	70	0.832kg/f	29.77	50	70	50ml
2	B-15	65	85	0.835kg/f	29.77	65	85	50ml
3	B-25	65	80	0.835kg/f	29.77	65	80	50ml
4	B-35	65	75	0.835kg/f	29.77	65	75	50ml
5	B-45	65	80	0.835kg/f	29.77	65	80	50ml

Table 4.1: Fuel test and differences of Diesel and Biodiesel

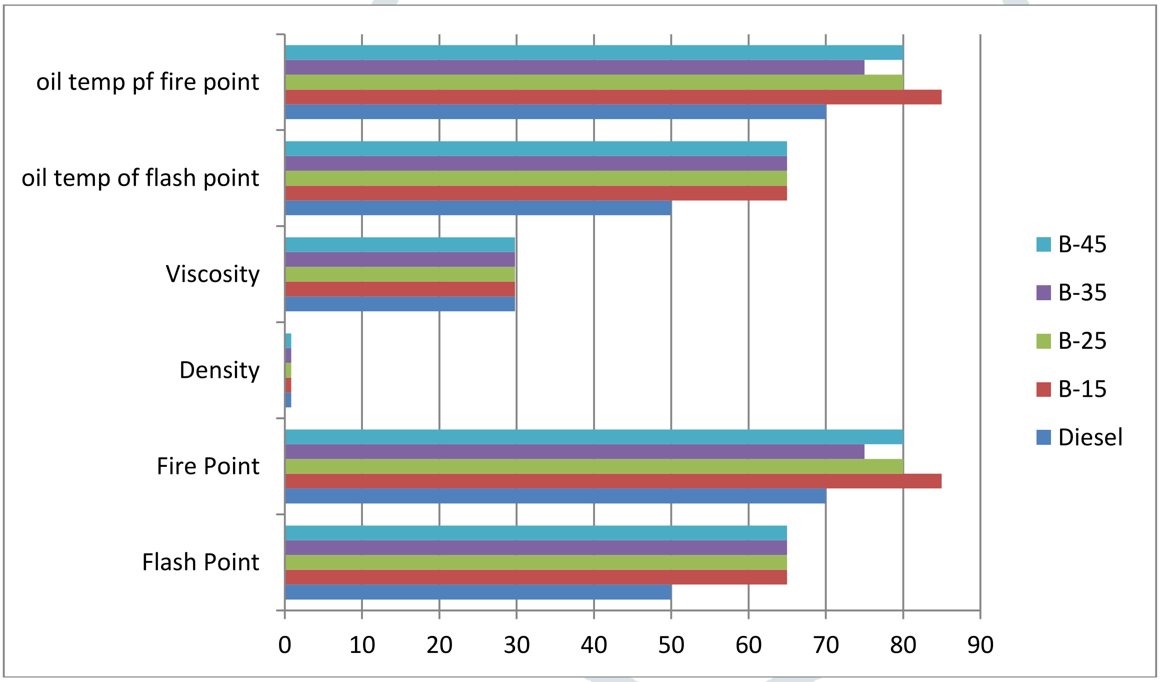


Table 4.2: Fuel characteristic

V. RESULT

5.1 Result:-

Single Cylinder Research Engine Specifications

The scope of supply should include a single cylinder research engine with a modification kit to convert the diesel engine into a GDI / MPFI engine. This shall allow easy switch from diesel engine to gasoline engine testing and vice versa. Provision for gaseous fuel injection to be provided in addition to the conventional liquid injection.

Diesel Engine mode

- Displacement approximately1 litres.
- Max. speed 4000 rpm
- Approximate engine power rating to be mentioned. [XX kW].
- Max. firing pressure 180 bar
- Compression ratio 15-22 (adjustable)

Figure5.1 Single Cylinder 4-Stroke Diesel Engine

The Sub components to include but not limited to

- CR Fuel Injector, solenoid magnetic type,max.1800 bar
- High Pressure Fuel Pump, integrated into timing belt drive
- Fuel Rail with Pressure Sensor and Pressure Control Valve
- Safety Over pressure Valve
- Wiring harness and Sensors.
- Fully open electronic fuel injection system.
- Provision for creation and modification of load/speed maps via ECU application system
- Interface.

Control of fuel injection, rail pressure, and ignition and cam phases should be supported. At least, up to 4 injection events per cycle e.g. two pre-injections, one main-injection and one post injection shall be possible

Single Cylinder SI Engine:

- Displacement Volume approximately 0.5 liters
- Max. speed 6000 rpm
- Rated power: approx. 20 kW (natural aspirated)
- Low rotation inertia (less 0.75 kgm2)
- Combustion concept Homogeneous; Lambda1
- Cylinder Pressure PFP 120 bar

Figure5.2 Testing of biodiesel

	S.NO	Weight in Kg's	RPM (N) m/sec	O/P (BP)	Time taken for 10cc in 10 sec	TFC in kg/hr	SFC in kg/hr	Brake Thermal efficiency
DIESEL	1	2	2186	1.4696	40	0.747	0.5117	15.416%
B-10	2	2	2021	1.34	51	0.58	0.482	18%
B-20	3	2	2006	1.33	57	0.52	0.6901	20%
B-30	4	2	2053	1.38	59	0.50	0.675	21%
B-40	5	2	2067	1.37	60	0.49	0.673	23%

	Volumetric efficiency	Mechanical efficiency (B.P/I.P)
DIESEL	28.9%	75.05 %
B-15	29.7%	75.2%
B-25	30.2%	75.3%
B-35	27.6%	75.4%
B-45	27.3%	75.2%

Table 5.1: Diesel and Biodiesel Result

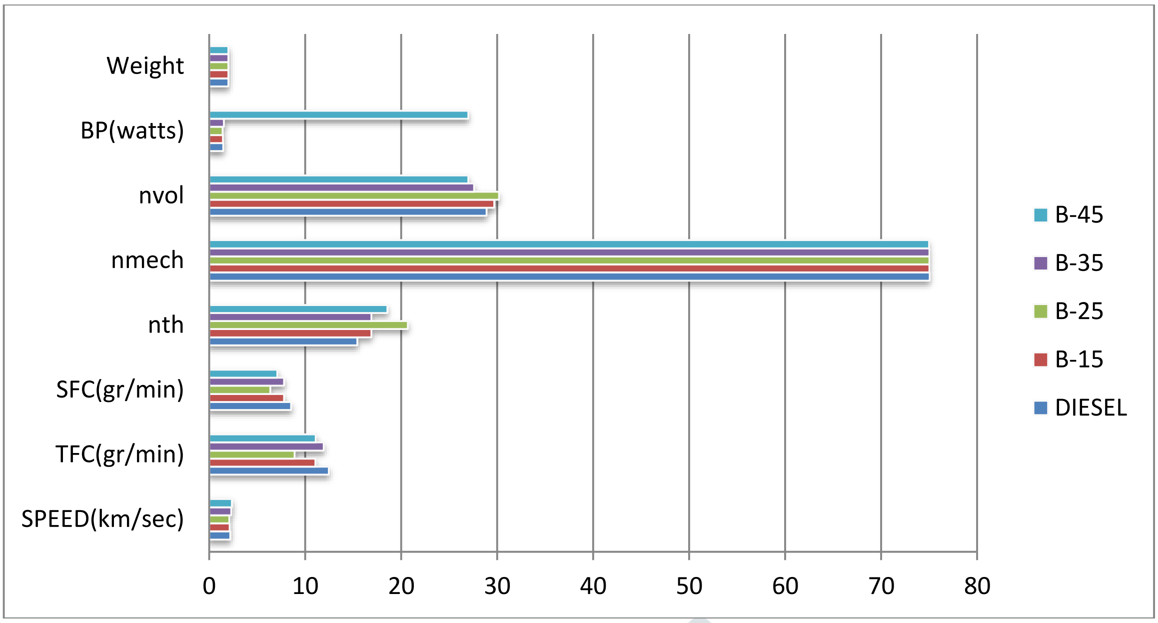


Table 5.2: Graph of Diesel and Biodiesel

5.2 Discussion:-

The above shows the result of performance test done on diesel and bio diesel {B15, B25, B35&B45} on the single cylinder 4 stroke water cooled I.C Engine. Here in this performance test we have took two different type of fuels, one a normal type ofdiesel used regularly in automobile and second one biodiesel blend B15,B25,B35&B45 made up of diesel and biodiesel (15%::85% proportion for B15) (25%::75% proportion for B25) (35%::65% proportion for B35) and (45%::55% proportion for B45) mixture. This B15, B25, B35&B45 are produced by doing chemical treatment on waste vegetable oil.
The parameters which are considered in analysis are Brake power, TFC, SFC, mechanical efficiency, volumetric efficiency, thermal efficiency. From the above graph we can say that that there is a decrease of 5-8% in output power, increase of 30-35% in both SFC & TFC, 30-50% increase thermal efficiency when we use biodiesel blends, but at a same point we could not find any amount of growth or change in volumetric efficiency which shows that if we use biodiesel blends in place of diesel the performance parameters will decrease and the mechanical efficiency values are negligible or remains constant.

When we have compared fuel properties of diesel to bio diesel blend we have found that viscosity and density of both the fuel is similar but there is an 10^0 c temperature variation in the values of flash point and fire point of biodiesel blends to diesel.

VI. CONCLUSION AND FUTURE WORK

6.1 Conclusion:-

The results obtain on performance and characteristics test of biodiesel shows a decrease of 5-8% in output power, increase of 30-35% in both SFC & TFC, 30-50% increase thermal efficiency over the values obtained by regular diesel, but at a same point we have found a negligible amount of change in volumetric and mechanical efficiency. From fuel properties of diesel to bio diesel blend we have found that viscosity and density of both the fuel is similar but there is a 10^0 c temperature variation in the values of flash point and fire point of biodiesel blends to diesel.
The above results satisfies the objective of our present research work from this we can say that performance of I.C Engine can be affected in areas of output and fuel consumption but at a same time we will have huge amount change in efficiency which shows on the cost of efficiency, output and fuel consumption change can satisfy our requirement and here we doesn't have any variation in fuel characteristics so from this we can conclude that our biodiesel blends can be used in place of diesel which will satisfy our all requirement of diesel as fuel with its properties and performance.

6.2 Future Scope:-

In our present research of fuel analysis of blends on I C Engine. We have done fuel analysis on biodiesel blends B15, B25, B35 & B45 which are made up of waste vegetable oil. In future it can be moved forward by analyzing B55, B65, B75 & B85 etc. which can be either manufactured by materials like sunflower oil, tallow oil, alcohol and other alternative energy resources.

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