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Experimental Investigation on Diesel Engine using Methyl Fish Oil and its Diesel Blends

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Abstract – **The world is on the brink of energy crisis. The limited fossil fuels sources are unable to provide for the continuously increasing demand of energy. This demand has forced a search for an alternative source of energy, which is renewable, safe and non-polluting. Since vegetable oils and animal fats satisfy the major requirements, of C.I. engine fuel, they can be used as fuels alternative to diesel fuel. Fish oil is one of the sources for alternative fuels. From Hydrolysates of fish by-products contain a significant amount of oil, which can be extracted and converted into bio-diesel. The objective of this work was to determine the performance characteristics and emissions of a single cylinder, direct injection C.I. engine using methyl fish oil and their blends with diesel in varying proportions. These results were compared with the pure Diesel.**

Keywords – **Diesel Engine, Fish Oil, Hydrolysates, Brake Thermal Efficiency, Engine Combustion.**

I. Introduction

In this modern world of industries and technology the diesel engine plays a major role in various fields. It may be transportation (or) production e.t.c., with the increase of various applications to the diesel resources effects on the environment leading to effect like green house(3). Higher fuel efficiency in the diesel engine is achieved due to the high compression ratios along with relatively high oxygen concentration in the combustion chamber. However, these same factors results in high emission in diesel engine. The stringent emission norms have been an important driving force to develop the internal combustion engines more environment friendly (12). The main pollutants from diesel engines are Carbon Monoxide and Hydro Carbons.

The use of fish oil as an alternative to diesel fuel is a new concept. In fact early engines were demonstrated with vegetable oils. In a developing country such as India where mass transportation plays a key role, the suitability of alternate fuels for a diesel engine likes cetane number and calorific value similar to diesel(7). They have heat contents approximately 80-90% of diesel fuel.

One of the beauties of fish oil is that it requires minimal processing to be made usable as fuel. At a cost of 25 cents per gallon for fish oil compared to $1.19 per gallon for diesel fuel, it is easy to see why fish biodiesel blend make good economic sense (8). Future efforts will focus on assessing, the long-term effects of fish oil fuel blends on the equipment, the suitability of methyl fish oil blends for use in the most common engines in the region, and the amount of fish oil available for processing into methyl fish oil blends. Locally produced fish oil biodiesel blend fuels have the potential to create a sustainable energy supply for use in remote regions of Alaska, yielding dramatic cost savings and reducing dependence on imported petroleum products(4). Easy to manufacture, cleaner-burning fish oil biodiesel blends could potentially replace millions of gallons of traditional diesel fuel now used in rural Alaska.

The use of fish oil as fuel in a large stationary diesel engine .Halifax stirred up a brew of 80 percent diesel fuel and 20percent fish oil for its fleet of buses (10) .The Alaska Biodiesel Demonstration Project is showing that biodiesel can be produced from fish oil widely produced as a by-product of the Alaska seafood processing industry. Worldwide commitment to the continuous growth of renewable energy production is giving increasing room for the use of liquid biofuels in internal combustion engines. Heavy-duty medium speed diesel engines are best suited to burn low cost liquid biofuels such as some crude vegetable oils, waste oils and biodiesels.

Bio-diesel, which can be used as an alternative diesel fuel, is made from renewable biological sources such as vegetable oil and animal fats. It is biodegradable, non-toxic and possesses low emission profiles(4). Also, the uses of bio-fuels are environmentally beneficial. The objective of this work was to use fish oil biodiesel as a substitute for diesel in compression ignition engine. Fish oil was transesterified to produce biodiesel(11). The properties of the biodiesel were determined using standard methods. The experiments were carried out to investigate the performance, combustion and emission characteristics of fish oil biodiesel and its blends with diesel in varying proportions(5). A single cylinder, water cooled, four stroke diesel engine was used for this work. Experiments were conducted when the engine was fuelled with methyl fish oil and its blends with diesel in proportions of 10:80, 30:70, 50:50 and 70:30 (by volume), which are generally called as B-10, B-30, B-50 and B-70 respectively. Results indicated that methyl fish oil and its diesel blends are suitable substitute for diesel as they produce lesser emissions than diesel and have satisfactory combustion and performance characteristics.

II. Experimental Investigation

The experiments were conducted by considering various parameters. The tests were conducted for fish oil biodiesel with Diesel at different proportions (10%, 30%, 50% and 70%) for conventional engine. The tests were conducted from no load to maximum load conditions. The readings such as time taken to consume 20cc of fuel consumption, speed of the engine, temperatures, etc, were noted. The

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observations were recorded in tabular column and calculations are made using appropriate equations.

The experiments were conducted on a single cylinder Alamgir four stroke diesel engine. The general specifications of the engine are given in Table-1. By taking the engine performance and plot the graphs.

"Alamgir" engines for generating sets are fuel efficient, with the lube oil consumption less than 1% of S.C.F. lowest among the comparable brands. They are equipped with heavy flywheels incorporating 4% governing on the fuel injection equipment.

This complete avoids voltage functions. In case of emergency, the unique overload stop feature safeguards equipments by shutting down the engine automatically

Table 1: Engine specifications.

Item	Specifications
Engine power	6.6 kW
Cylinder bore	102 mm
Stroke length	110 mm
Connecting Rod Length	234 mm
Engine speed	1500 rpm
Compression ratio	17.5

Table 2: Properties of Diesel and Fish oil

Properties	Diesel	Fish Oil Biodiesel
Kinematic viscosity at 40 [degrees] C	3.52CST	4.03CST
Density at 15 [degrees] C (kg/m3)	830	843
Flash point ([degrees] C)	49	158
Cetane number	50	51
Calorific value (kJ/kg)	42000	40800
Total sulphur (% by mass)	0.01	0.05
Ash (% by mass)	0.01	Nil

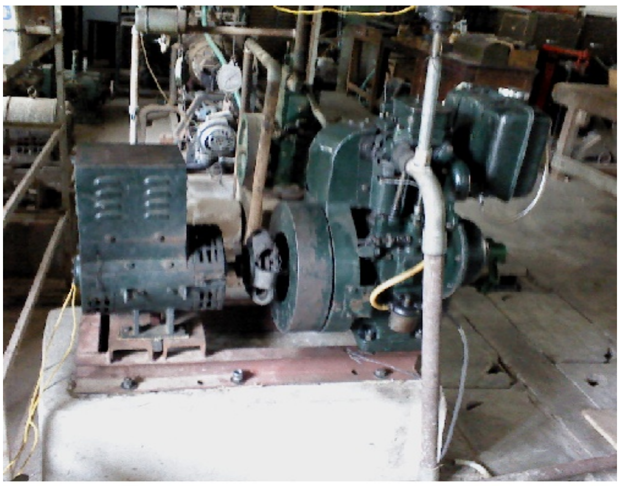
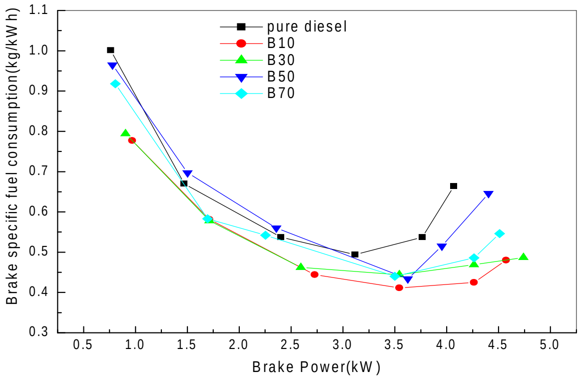


Fig.1. Alamgir engine

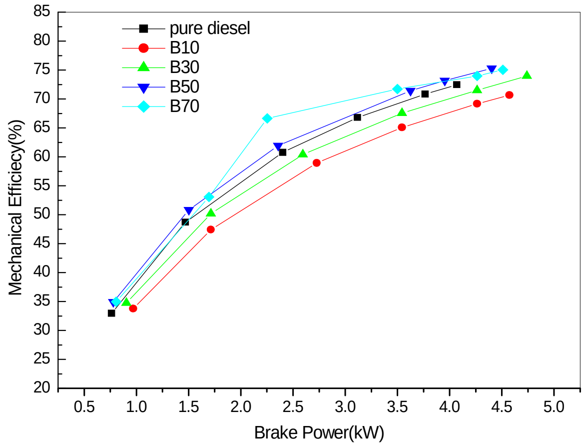
Fig.2. Load indicator

III. Results and Discussions



Graph 1: Brake Specific Fuel Consumption Vs Brake Power

The result for the variations in the brake specific fuel consumption (BSFC) is presented in the Graph 1. For all the fuels the BSFC falls with increasing load. The differences of BSFC are very small when using different fuels. The maximum BSFC values are 0.91 kg/kW hr for diesel, 0.77 kg/kW hr for B-10, 0.79 kg/kW hr for B-30, 0.91 kg/kW hr for B-50and 0.96kg/kW hr. The higher BSFC values in the case of pure methyl Fish oil are due to their low energy content.



Graph 2: Mechanical Efficiency Vs Brake Power

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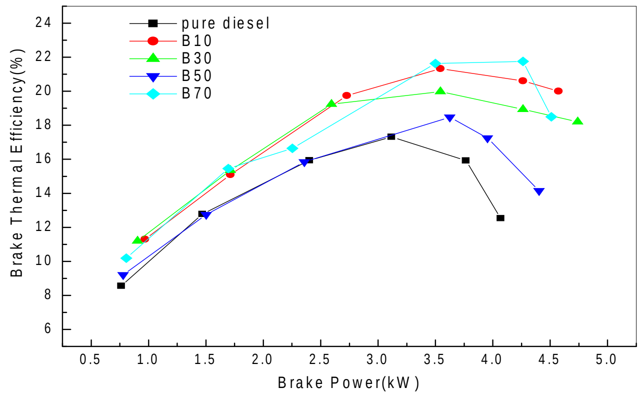
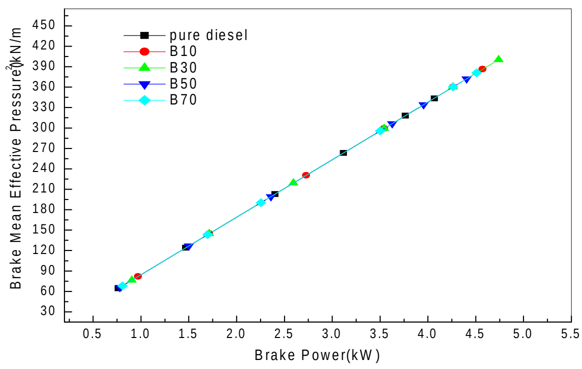
Mechanical efficiency indicates how good an engine is inverting the indicated power to useful power Graph 2shows the mechanical efficiency behind is less than the pure diesel (10). Because higher fuel injection pressures increases the decrease of atomization.The fitness of atomization Reduces ignition lags.



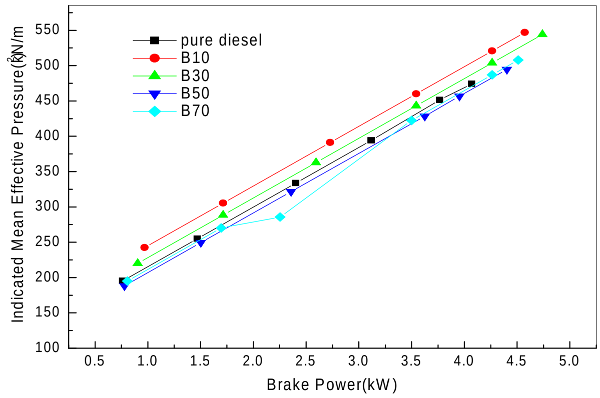
Graph 3: Brake Thermal Efficiency Vs Brake Power

The variation of brake thermal efficiency with load is shown in Graph 3. Brake thermal efficiency gives an idea of the output generated by the engine with respect to heat supplied in the form of fuel. For all the fuels the brake thermal efficiency increases with load. The brake thermal efficiency values at full load are 12.54% for diesel, 20% for B-10, 18.21% for B-30, 14.15 For B-50 and 18.5% for B-70. The brake thermal efficiencies of B-50 are very close to the brake thermal efficiencies of diesel at all loads. This may be due to their low heat input requirement for higher power output at a given load.



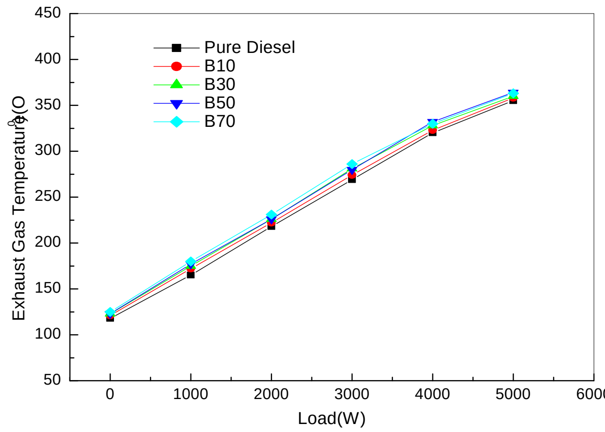
Graph 4: Brake Mean Effective Pressure Vs Brake Power

Graph 4 shows the variation of Brake Mean effective pressure with load. Mean effective Pressure is the average Pressure inside the cylinders of an internal combustion engine based on the measured output (9). From the graph it can be seen that, Brake mean effective values of methyl fish oil and its diesel
Blends are slightly less than diesel.



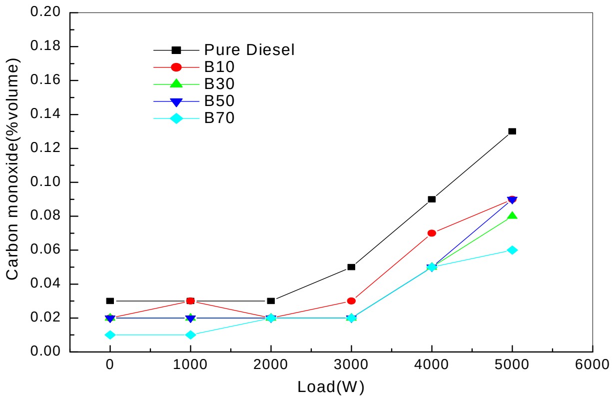
Graph 5: Indicated Mean Effective Pressure Vs Brake Power

Graph 5 shows the variation of Indicated Mean effective pressure with load. Mean effective Pressure is the average Pressure inside the cylinders of an internal combustion engine based on the measured output (13). From the figure it can be seen that, Brake mean effective values of methyl fish oil and its diesel blends of B50and B70 are slightly less than diesel.



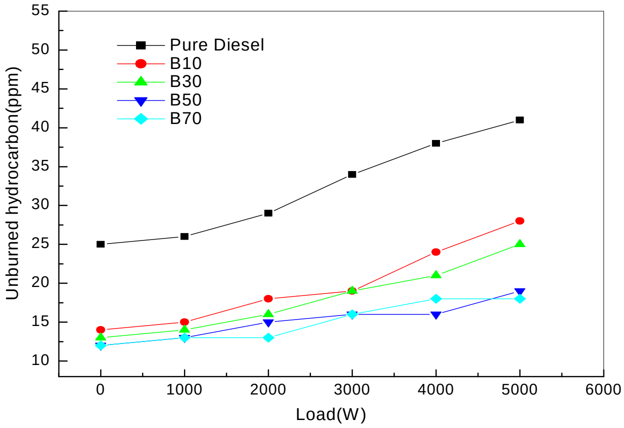
Graph 6: Exhaust Gas temperature Vs Load

Graph 6 shows the variation of exhaust gas temperature with load for various test fuels. It is observed that the exhaust gas temperature increases with load because more fuel is burnt at higher loads to meet the power requirement. It is also observed that the exhaust temperature increases for B-50 and B-70 blends at all loads. This may be due to the oxygen content of the methyl fish oil, which improves combustion and thus may increase the exhaust gas temperature. But the exhaust gas temperatures of B-10 blend and B-30 are very close to the exhaust temperature of diesel.



Graph 7: Carbon Monoxide (%volume) Vs Load

Graph 7 shows the reduction of CO emission with the addition of methyl fish oil to diesel. CO is predominantly formed due to the lack of oxygen. Since biodiesel is an oxygenated fuel, it leads to better combustion of fuel resulting in decrease in CO emission (2). The CO emission is found to be lower for B70.

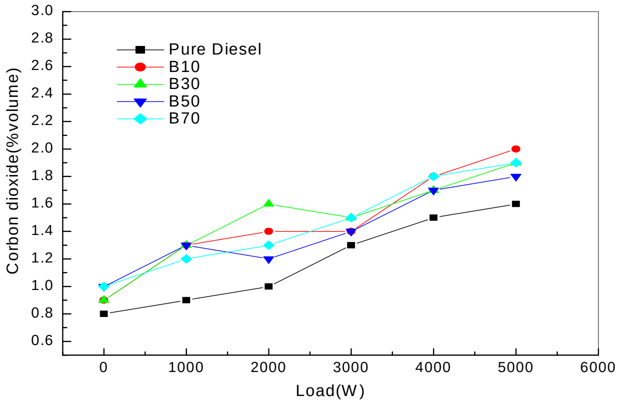


Graph 8: Unburned Hydrocarbons Vs Load

Unburned HC emissions in exhaust gas expresses non-utilizable lost chemical energy as in CO emission.

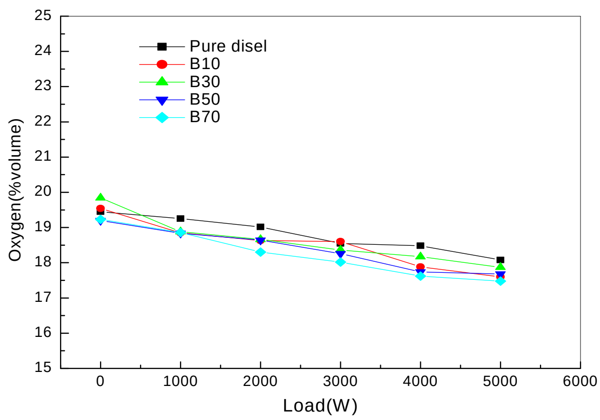
The reason of HC among combustion products are disability to reach the ignition temperature or disability of fuel to be oxidized because of lack of oxygen and semi oxidation the main reason of reduction in HC emission shows that oxygen in methyl fish oil supplies is sufficient for oxidation in mixture parts of rich air–fuel. Graph 8 shows that The HC emissions Resulted from methyl fish oil and its blends were lower than that of diesel fuel. The lowest HC emissions were observed for B70, while the higher Ones were obtained for diesel. With the increase in the amount of methyl fish oil that of containing blends HC emissions decreased accordingly.

The reason for the HC decrease for biodiesel and its blends is that biodiesel contains extra oxygen which helps to improve combustion.



Graph 9: Carbon dioxides Vs Load

One of the main factors of global warming, and the most important environmental problem of the world is the increase of CO2 emission which eliminates greenhouse effect in the atmosphere (6). Some researchers think that CO2emission released into the atmosphere with the use of biodiesel combines with photosynthesis cycle CO2 existing among exhaust products is an important parameter for expressing the complete combustion. When the engine load increases, in Graph 9, it has been thought that oxygen in fish oil contributes significantly to reactions of oxygen-fuel in engine cylinder. The CO2 emissions of the diesel engine fuelled with the fish oil and its blend fuels and pure diesel fuel are shown in Graph 9, CO2 emissions resulting from fish oil and diesel blends were lower than that of diesel. The lowest CO2 emissions were found for B70.



Graph 10: Oxygen Vs Load

Graph 10shows the O2emissions of the diesel fuel, methyl fish oil another blends operation at different engine loads. When compared with diesel fuel. The higher oxygen amount of fish oil helps to improve combustion of fuels and it takes part in complete combustion. The exceeded oxygen is swept away from the engine cylinder with the exhaust process. The same results can be seen in Graph 10. Therefore, the oxygen emissions from fish oil and blend fuels was considerably higher than that of diesel fuel. In diesel engines, excess air was naturally aspirated into the combustion chamber to mix with the atomized fish oil (7). The chemically bound oxygen in the biodiesel

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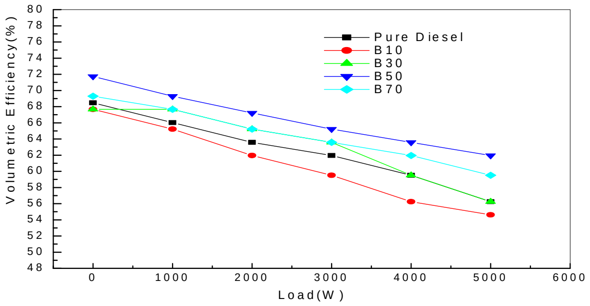
provided another excess source of the oxygen component, which added excess inlet air to the reactant mixture. Hence, burning of the methyl fish oil and its blends produced more residual oxygen missions than did burning the pure diesel.



Graph 11: Volumetric Efficiency Vs Load

The Graph 11 shows the variation of volumetric efficiency with load for various blends. Volumetric efficiency is a measure of success with which the air supply, and thus the charge, is inducted in to the engine. It indicates the breathing capacity of the engine. From the figure it is evident that the volumetric efficiency values of B-30, B-50 and B-70 are exceeding the volumetric efficiency values of diesel at all loads.5

IV. Conclusions

Following are the conclusions based on the experimental results obtained while operating single cylinder air cooled diesel engine fuelled with methyl fish oil and its diesel blends.

- Methyl Fish oil and its diesel blends can be directly used in diesel engines without any modifications.
- Brake specific fuel consumption values of methyl fish oil and its diesel blends are slightly higher than diesel.
- Brake thermal efficiency of B50 blend is very close to the brake thermal efficiency of diesel at all loads.
- Volumetric efficiency values of fish oil biodiesel and its diesel blends are exceeding the volumetric efficiency values of diesel at all loads.
- CO emission decrease with increase in percentage of methyl fish oil in the fuel.
- CO_2 emissions of methyl fish oil and its diesel blends are slightly lower than that of diesel.
- HC emissions of methyl fish oil and its diesel blends are lower than that of diesel.
- O_2 emissions of methyl fish oil and its diesel blends are slightly higher than that of diesel.
- From the above analysis the main conclusion is methyl fish oil and its diesel blends are suitable substitute for diesel as they produce lesser emissions than diesel and have satisfactory combustion and performance characteristic.

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