EMISSION CHARACTERISTICS OF WASTE COOKING METHYL ESTER IN DI DIESEL ENGINE

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Abstract: The utilization of Recycled Waste Cooking Oil which is proven to be harmful to health is an alternative for petroleum based fuel, due to the fact that it is not environmental friendly to dispose used Cooking oil. The alternative solution for this is to use it for Industrial purposes namely to reproduce it as a Bio Diesel. For this project, The Waste Cooking Oil is collected from Hotels in Chennai to produce Bio Diesel from Waste Cooking Oil and the Bio Diesel is tested in the laboratory to understand its properties. The Bio Diesel extracted from Waste Cooking Oil is blended with diesel oil to get B25, B50, B75, and B100 grades of Bio Diesel. The properties of Bio Diesel meet the American Bio Diesel Standard ASTM 6751. The application of this Bio Diesel has enabled the company to use the Waste Cooking Oil without risks having risks of disposing it and this has save cost to the company. The other advantages are that it has significantly help to preserve environment and as well as conversion of Waste to useful energy. The Bio Diesel plant has also motivated the staff towards about environment and also think of producing sustainable production by concerning environmental factors.

KEYWORDS- **Combustion characteristic, Thermal efficiency, waste cooking oil, Transesterification, Diesel engine, NaOH, B25, B50, B75, B100.**

I. INTRODUCTION

Created in the 1890s by designer Rudolph Diesel, the diesel motor has turned into the motor of decision for power, unwavering quality, and high efficiency, around the world. Early experimenters on vegetable oil fills incorporated the French government and Dr. Diesel himself, who imagined that unadulterated vegetable oils could control early diesel motors for horticulture in remote regions of the world, where oil was not accessible at the time. Present day biodiesel fuel, which is made by changing over vegetable oils into mixes called unsaturated fat methyl esters, has its foundations in investigate led in the 1930s in Belgium, yet the present biodiesel industry was not set up in Europe until the point that the late 1980s.The diesel motor was created out of a want to enhance wasteful, awkward and some of the time unsafe steam motors of the late 1800s. The diesel motor chips away at the vital of pressure start, in which fuel is infused into the motor's barrel after air has been compacted to a high weight and temperature. As the fuel enters the chamber it self-touches off and consumes quickly, compelling the cylinder withdraw and changing over the substance vitality in the fuel into mechanical vitality. Dr. Rudolph Diesel, for which the motor is named, holds the principal patent for the pressure start motor, issued in 1893. Diesel wound up plainly known worldwide for his imaginative motor which could utilize an assortment of powers. With these standards and directions set up, it's justifiable that any feasible oil option would cause a noise. In any case, biodiesel isn't an ideal substitute for fuel. We'll take a gander at its upsides and downsides in the following segments. Today the world is gone up against with twin emergencies of petroleum derivative consumption and condition debasement. The procedure of transesterification expels glycerin from the triglyceride atoms exhibit in vegetable oils and supplant it with liquor utilized as a part of the change procedure.

II. Materials and Methods

2.1. Transesterification

There are four distinctive courses through which non-palatable oils can be changed over into methyl esters are transesterification, mixing, emulsion and pyrolysis out of which transesterification is the most regularly utilized technique. Transesterification is a compound response that happens amongst triglyceride and liquor in nearness of impetus to get methyl ester and glycerol as by product.Transesterification basically relies on the measure of liquor and impetus, weight, time, FFA and measure of water. Oils with expansive measure of free unsaturated fat are hard to go through the change procedure since it will shape cleanser arrangement in nearness of the impetus. This further keeps detachment of methyl ester from glycerol.

2.2. Waste Cooking Oil

Squander cooking oil is utilized as diesel fuel, either as biodiesel, straight in warmed fuel frameworks, or mixed with oil distillates for driving engine vehicles. Biodiesel might be utilized as a part of unadulterated frame in more up to date motors without motor harm and is every now and again joined with non-renewable energy source diesel in proportions changing from 2% to 20% biodiesel. Attributable to the expenses of developing, pulverizing, and refining waste Cooking biodiesel, squander Cooking-got biodiesel from new oil costs more to create than standard diesel fuel.

2.3. Fuel Preparation

Squander cooking methyl ester biodiesel was set up through trans esterification process from assault seed oil which was separated from assault seed. The arrangement of methyl ester by transesterification of waste Cooking oil requires crude oil. 15% of methanol and 5% of sodium hydroxide on mass premise. Notwithstanding, the transesterification procedure requires liquor near culmination. A response time of a hour and response temperature of 650C were required to consummation of response and development of ester. The blend was mixed persistently and after that al-lowed to settle down under gravity in the isolating pipe. Two particular layers found after gravity in a making due with 24 hours. The upper layer was of ester and the lower layer was of glycerol. The lower layer was isolated out and the isolated ester was blended with some refined water to expel the impetus display in ester and permit settling under gravity for an additional 24 hours. The impetus not broke up in water, which was isolated and expelled the dampness. The bio-diesel in this manner delivered through the above procedure was mixes with diesel. The fuel mix was arranged just before initiating the examination to guarantee the blend homogeneity.

Table 1. Properties of Diesel and Waste Cooking Methyl Ester and Waste Cooking Oil

Properties	Diesel Fuel	Waste Cooking Oil	Waste Cooking Methyl Ester
Density (kg/m^3)	830	945	920
Calorific Value (kJ/kg)	44,000	35,000	40,000
Kinematic Viscosity @ 20^o C	2.9	8	4
Cetane Number	45-50	55-58	45-55
Flash Point ^{o} C	45	206	105

2.4. Waste Cooking Methyl Ester is a Biodiesel

It is discovered that every one of the properties of the Waste Cooking Methyl ester is inside the cutoff points of the American standard of biodiesel. Therefore we can state that Waste Cooking Methyl Ester is a biodiesel. "Biodiesel" in this report will speak to "Squander Cooking Methyl Ester". The biodiesel mixes can be spoken to as B25 (25%Waste Cooking Methyl Ester + 75% Diesel), B50 (half Waste Cooking Methyl Ester +50% Diesel), B75 (75%Waste Cooking Methyl Ester + 25% Diesel), B100 (100% Biodiesel). Hence the Waste Cooking Methyl Ester can likewise be named as WCME.

III. Testing of Waste Cooking Methyl Ester in a Diesel Engine

The motor was straightforwardly coupled to a whirlpool current dynamometer adaptable coupling. The yield of the whirlpool current dynamometer was settled to a straight check stack cell for estimating the heap connected to the motor. A gas analyzer was utilized for the estimation of carbon monoxide (CO), oxides of nitrogen (NOx), unburned hydrocarbons (HC), oxygen (O2) and carbon dioxide too. CO was estimated as rate volume and NOx, HC was estimated in N-Hexane proportionate, parts per million (ppm). A glass burette was given at fuel tank to the estimation of fuel utilization by volume every moment.

Table 2. Test Engine Descriptions

PARTICULARS	DESCRIPTION
Engine type	Four stroke, single cylinder, vertical water cooled, diesel engine
Bore diameter	80mm
Stroke length	120mm
Compression ratio	16.5:1
Rated power	3.67 KV

Rated speed	1500 rpm
Dynamometer	Eddy current type

IV. RESULT AND DISCUSSION

4.1. Variation of NOx Emission

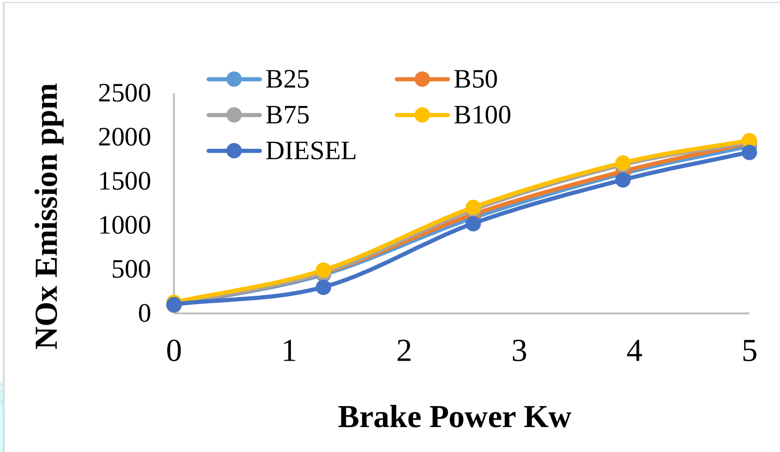

Fig.1: Variation of NO_x Emission

Graph shows the variation of NOx emissions with brake mean effective pressure for the fuels tested. It can be observed that NOx emission increases continually with BP. This is due to the increase in richness of the mixture with increase in BP as result increased fuel injection quantity with constant air supply. It can also be observed that the NOx emission of Waste Cooking Oil Methyl Ester and Waste Cooking Methyl Ester blend is marginally higher by about 16% and 8% respectively compared to diesel. As the BP increases, the mixture strength also increases and the oxygen available in the Waste Cooking Methyl Ester andWaste Cooking Methyl Ester blend improves the combustion process which leads to a higher combustion temperature and hence higher NOx emission.As an oxygenated fuel, Waste Cooking Methyl Ester andWaste Cooking Methyl Ester blend supplies additional oxygen inside the combustion chamber during fuel injection. It increases the availability of free oxygen at higher combustion temperatures to react with nitrogen to form NOx. When compared to Waste Cooking Methyl Ester blend, the oxygen content in Waste Cooking Methyl Ester is higher which leads to a higher NOx emission than Waste Cooking Methyl Ester blend at all BPs.

4.2. Variation of HC Emission

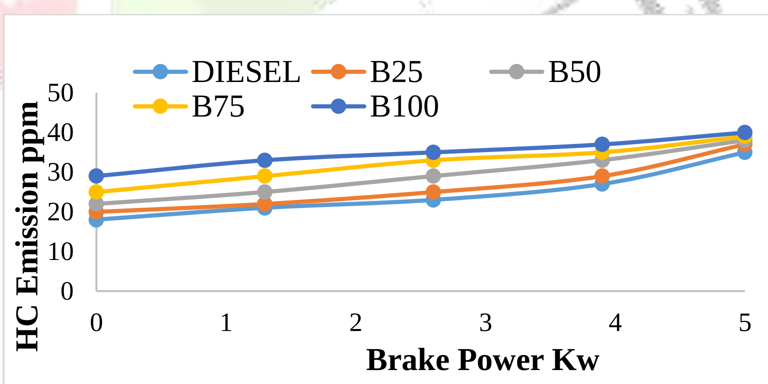

Fig.2: Variation of HC Emission

It can be observed that the HC emission increases as the BP increases. This is may be due to the presence of fuel rich mixture at higher BPs. There is a significant reduction in HC emissions for the fuels tested at all loads compared to diesel. HC emission of Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend is significantly lower by about 50% respectively than that of diesel. As are sultofoxygen present in Waste Cooking Oil Methyl Esterand Waste Cooking Oil Methyl Ester blend, the oxygen availability during the combustion process increases which may result in lean mixture presents in some parts of the combustion chamber and initiates the thermal oxidation reaction. This reaction can been handed by higher combustion temperature at lower BP which may result in a significant reduction in HC emission when compared to maximum BP. Even though the temperature is high at the maximum BP, the presence of rich mixture due to increased quantity of fuel admitted in the combustion chamber increases the formation HC.Waste Cooking Oil Methyl Ester has higher unsaturated fatty acids which promotes oxidation process in the combustion chamber. This results in higher reduction of HC emission for Waste Cooking Oil Methyl Esterand Waste Cooking Oil Methyl Ester blend than diesel. Compares the HC emissions of the blended fuel operation with neat biodiesel in engine. It can be seen that the HC emissions of biodiesel blended fuel operation is lower than that in the case of neat biodiesel operation. This is due to the oxygen content in the blended fuel which can results in more complete combustion, thus reducing the emission of unburned hydrocarbon. The HC emissions are reduced by 5% and 18% corresponding to 10 % and 20 % of Biodiesel blended fuel operation respectively compared to neat biodiesel at the maximum load condition.

4.3. Variation of CO Emission

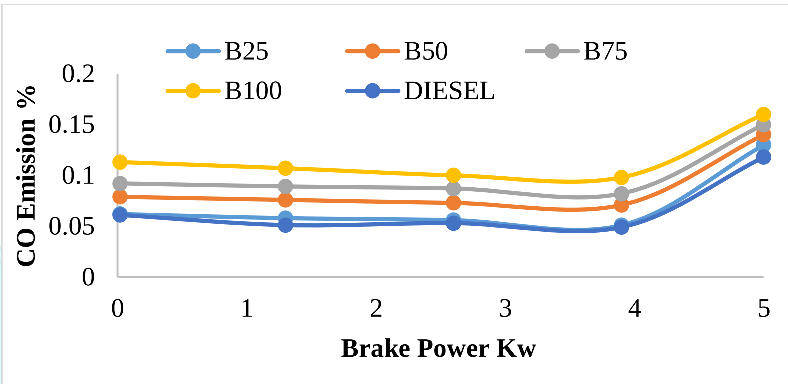

Fig.3: Variation of CO Emission

It can be observed that CO emissions increase with increase in BP. As the air fuel ratio decreases with increase in BP it causes an increase in CO emission. Up to 50 % of maximum BP, the CO emissions are almost same for all the fuels and beyond that CO emissions of Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend are marginally higher than that of diesel. This may be due to the result of thermal oxidation of HC at the later stage of combustion process. During this process the unburned hydrocarbons are burned in the presence of oxidizing species to form gaseous CO or CO2. Higher unsaturated fatty acids present in Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend may enhance the oxidation process and oxidize the HC partially to form gaseous CO. The CO emissions are reduced significantly by 4% and 10% corresponding to 10% and 20% biodiesel blended fuel operation respectively compared to neat biodiesel at maximum load condition. This is due to better combustion of the blended fuel and oxygen concentration of the diethyl ether. At other loads also a similar trend can be noticed.

4.4. Variation of Smoke %

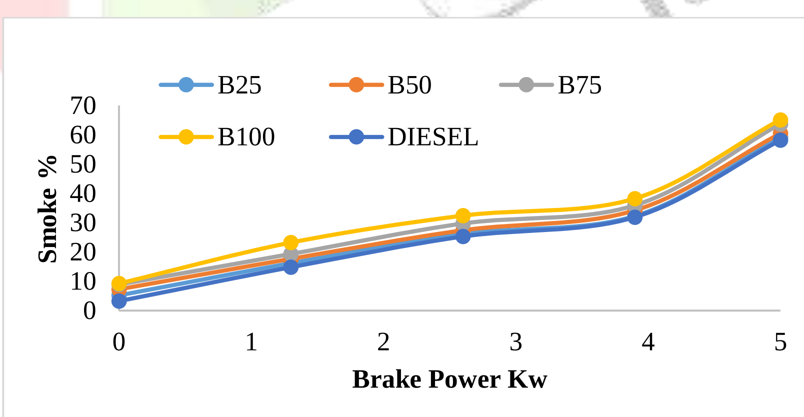

Fig.4: Variation of smoke %

The amount of smoke produced by using smoke meter. The smoke meter will find the amount of smoke produced by passing the light through from one end to another end. The receiver in other end will capture all the light on other, by comparing initial and final value the smoke is found in percentage as shown in graph. From the graph above we can able to find that for pure diesel the smoke emission is low when compared to other blends with the Waste CookingOil Methyl Ester blend. As the blend increases (B20-B100) the emission of smoke will also increase at the range of 65%-70%. From this we can say that the as the composition of the biodiesel increases the smoke production gradually increases and the load increases the smoke production will increase about 60-65% for 1/4 increase in load of engine. It is highest for pure biodiesel because of high viscosity, low volatility, and high density, low heat content and heavy molecular structure in comparison to that of diesel which may cause incomplete combustion because of lack of oxygen at highest load.

V. CONCLUSION

From the performance, emission and combustion characteristics of diesel, Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend it is inferred that

1. The combustion characteristics of Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend are comparable with those of diesel and the following are observed when compared with diesel. Ignition Delay of Rape-seed Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend is shorter than diesel and among the three; Waste Cooking Oil Methyl Ester has the shortest delay period. Heat release rate of diesel is higher than that of Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend and Waste Cooking Oil Methyl Ester has the lowest heat release rate.
2. Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend show reduced HC emission, smoke density and marginally higher CO emission when compared with diesel.
3. NOx emission of Waste Cooking Oil Methyl Ester is higher than that of diesel and Waste Cooking Oil Methyl Ester blend and diesel shows the lowest NOx emission.
4. Thermal efficiencies of Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend are lower compared to diesel Waste Cooking Oil Methyl Ester shows the lowest thermal efficiency.
5. Waste Cooking Oil Methyl Ester shows higher reduction in smoke density than Waste Cooking Oil Methyl Ester blend with marginal increase in NOx emission when employed in a stationary engine.
6. It is desirable to use Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend as a fuel for stationary engine respectively. It is also observed that Waste Cooking Oil Methyl Ester and Waste Cooking Oil Methyl Ester blend has the ability to replace diesel and a method to reduce the NOx emission with lesser sacrifice on smoke density and thermal efficiency.
7. Introducing Biodiesel as an alternative to conventional diesel fuel made from renewable resources, such as non-edible vegetable oils are a promising fuel in future. The fuel extracted from oilseeds (e.g., Rape Seed Oil) are commonly referred to as "Biodiesel." No major engine modifications are required to use biodiesel in place of petroleum-based diesel.
8. In future there will be scarcity of diesel that are used in daily commercial uses. So government should encourage the production and use of biodiesel in commercial vehicles (DI Diesel engine vehicles).The cost of biodiesel is higher than diesel but on considering the future benefit we should encourage the use of biodiesel. Thus we suggest the use of biodiesel in the commercial vehicles to prevent the decrease in level of Diesel.

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