INVESTIGATION ON PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL ENGINE USING VARIOUS BIODIESELS

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Abstract

The population expansion and fast industrialization have caused a sharp rise in energy consumption. Petroleum sources are now extinct as a result of the careless use of fossil fuels. The ecological system has been seriously impacted by the pollution discharged from diesel engines. Focus is being placed on finding solutions to these issues. Future prospects include the production of biodiesel from algae, animal fats, and vegetable oils. The study on how biodiesel affects the efficiency and emission characteristics of diesel engines is reviewed in this publication. The main issue with using various oils directly in engines is their higher viscosity, which may be solved by turning them into biodiesel through a Tran's esterification reaction. The calorific value, flash point, and viscosity of biodiesel and diesel fuel were determined to be equivalent to those of petroleum diesel. With regard to engine performance parameters such as brake power (BP), brake thermal efficiency, brake specific fuel consumption (BSFC), and engine effects on emission of carbon monoxide (CO), carbon dioxide (CO2), hydrocarbons (HC), nitrogen oxides (Nox), sulphur oxides (Sox), etc., various graphs have been plotted during the experimental investigation of a diesel engine running at variable loads and constant RPM.

Key words: Biodiesels, Diesel Engine, BTE, BSFC, Emission, Tran's esterification

1. Introduction:

To meet their energy needs, almost all nations rely on petroleum fuel. Subterranean fossil fuel supplies have been impacted by an increase in energy demand brought on by population expansion. Researchers are exploring alternate energy sources to address this issue. Given that biodiesel's qualities are quite similar to those of diesel, it is one of the prospective substitutes for petroleum-based diesel. Additionally, the majority of the feedstocks used to make biodiesel are renewable and include both edible and inedible oils as well as animal fats. Making biodiesel from culinary oils including cottonseed oil, sunflower oil, coconut oil, chicken oil, and fish oil has been a major focus in recent years. Non-edible oils are chosen for the manufacturing of biodiesel since using edible oils might have a detrimental impact on agriculture by reducing the availability of food crops. The key benefits of utilising biodiesel are portability, availability, increased lubricating properties, reduced sulphur content, greater cetane number, higher biodegradability, domestic origin, and a higher flash point. Researchers have discovered that when using biodiesel instead of regular diesel fuel, nitrogen oxide (NOX) emissions rise but hydrocarbon (HC), carbon monoxide (CO), and particle matter (PM) emissions fall. Therefore, the current paper's focus is on the emissions produced when diesel engines run on biodiesel.

1.1. Objectives:

1. Preparing biodiesel from waste cocking oil, chicken oil, fish oil.
2. Testing the chemical properties of prepared biodiesels.
3. Comparison between diesel and biodiesels.
4. How to Use of waste cooking oil, chicken oil and fish oil as an alternative fuel for diesel engine.

5.To study Performance and emissions of engine by using biodiesels**.**

1.2.Advantages of Biodiesel over Petroleum:

1. Renewable fuel, obtained from vegetable oils or animal fats
2. Low toxicity, in comparison with diesel fuel.
3. Oxygenated.
4. Biodegradable.
5. Lower emissions of contaminants: carbon monoxide, particulate matter, polycyclic aromatic hydrocarbons, aldehydes.
6. Lower health risk, due to reduced emissions of carcinogenic substances.
7. No sulfur dioxide (SO2) emissions.

8.Higher flash point (100_C minimum).

2. ENGINE SETUP AND ITS SPECIFICATION:

Single-cylinder, four-stroke diesel engines make up the experimental arrangement. The pressure sensor is fixed to the cylinder head, which is exposed to the combustion chamber, and it measures the in-cylinder combustion pressure in relation to the crank angle. To measure the crank angle, an encoder was installed on the crank shaft. For loading the engine, an eddy current dynamometer was employed. The pressure-crank angle data were collected and afterwards analyzed using the data gathering system. Throughout the testing, the engine speed (1500 rpm) and static injection time remained unchanged.

Fig 2.1: Four Stroke Single Cylinder Diesel Engine

Table 2.1: Specification of Diesel Engine

Engine	**Kirloskar Diesel engine**
Speed	1500rpm
Number of cylinders	1
Compression ratio	16.5:1
Orifice meter	20mm
Maximum H.P	7H.P
Stroke	110mm
Bore	80mm
Type	Water cooled
Methodofloading	Rope brake

PROPERTY	FISH OIL	CHICKEN FAT OIL	WASTE COOKING OIL	DIESEL
Density at $15^{o}(Kg/M^{3})$	878	926	913	832
Kinematic Viscosity At$40^{o}(Mm^{2}/Sec)$	49.9	38.10	5.03	3.5
Calorific Value (Kj/Kg)	32430	39398	35560	41950
Flash Point(C^{o})	240	267	208	75
Fire Point(C^{o})	266	296	220	82
Specific Gravity	0.878	0.926	0.870	0.832

TABLE 2.2: PROPERTIES OF NEAT OILS

PROPERTY	FISH OIL BIODIESL	CHICKEN FAT BIODIESEL	WASTE COOKING OIL BIODIESEL
Density at 15^o(Kg/M^3)	880	874	885
Kinematic Viscosity At40^o(Mm^2/Sec)	5.27	6.2	5.7
Calorific Value (Kj/Kg)	39174	43780	38650
Flash Point(C^o)	174	164	160
Fire Point(C^o)	190	171	164
Specific Gravity	0.88	0.874	0.885

Table 2.3: PROPERTIES OF OILS OFTER TRANSTERFICATION

3. RESULTSANDDISCUSSION:

Brake power, thermal efficiency, and specific fuel consumption were compared after the performance characteristics investigation of the various fuels had been completed.

3.1 Comparison of the experimental performance characteristics of diesel and various oil methyl esters

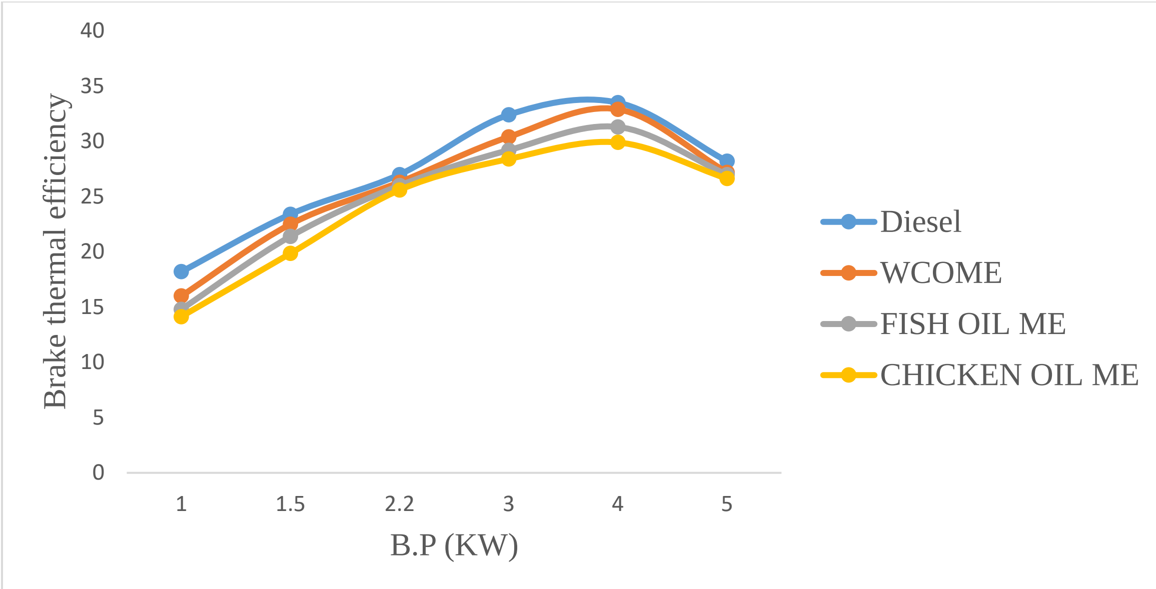

Fig 3.1: Comparisonofbrakethermalefficiencywithrespecttobrakepowerforthree methylestersand dieselby experimental

The effectiveness of the heat conversion into work described by brake thermal efficiency depends on the fuel type and engine configuration. The brake power-to-fuel energy ratio measures how much braking force is produced. For all fuels, BTE increases as the load increases. **In figure 3.1,** the variation is depicted. A brake power of 4 kW results in the most efficiency. Methyl esters from fish, poultry, waste cooking, and diesel had respective efficiency levels of 31.3%, 29.9%, 32.9%, and 32.9%. Methyl esters' braking thermal efficiency decreased by 1% to 4% as compared to diesel. The high calorific value of these ester oils is what makes them more efficient than diesel. Esters' increased density and viscosity are factors in the lower efficiency.

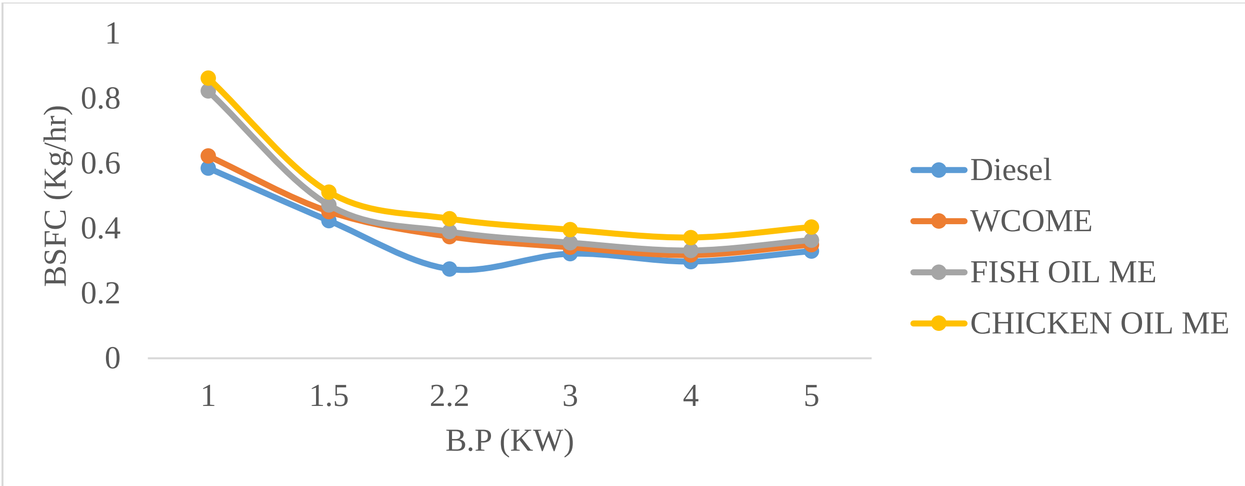

Fig 3.2 : Experimentalb r a k e specificfuelconsumptionforvariousfuelatvariousbrakepower

Brakespecific fuel consumption is determined by dividing the rate of fuel consumption by the am ount of power the engine produces under a certain load.This crucial quantity, which is inversely Related to BTE and indicates engine performance, is vital.The specific fuel consumption of fuel in relation to braking power is shown in **figure 3.2.** With an increase in load, the BSFC rises. The lowest usage was seen at 5 kW of braking power. Diesel's BSFC was less than VOME's. The BSFC of fish oil, chicken oil, waste frying, and diesel was 0.823 kg/kW-hr, 0.868 kg/kW-hr,0.623kg/kWhr,0.586kg/kWhrrespectively.The percentageincrease in BSFC for fish oil, poultr y oil, and cooking waste Methyl esters and diesel comparisonwere, In order 40.6%, 47.2%, 6.3% increased specific energy consumption is the cause of the BSFC of ME increasing. ME increased density and viscosity are factors in the rise in consumption.

3.2 COMPARISONOFEXPERIMENTALEMISSIONCHARACTERISTICSOFVEGETABLEOILMETHYLESTERSWITHDIESEL

3.2.1: Carbon Monoxide (CO)Emissions:

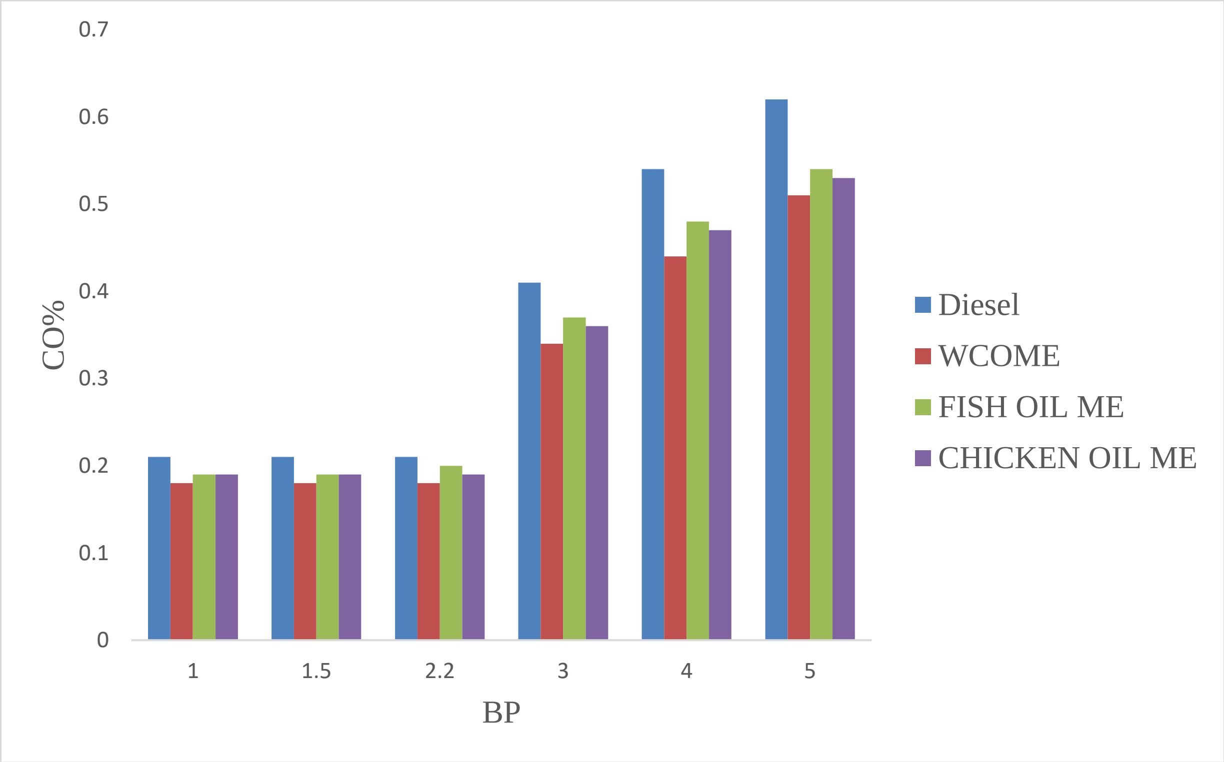

Fig 3.3: Experimentalcarbon monoxideemissionofusingfivefuelsatvariousbrakepowerindieselengine

Carbon monoxide emissions for all fuels and loads are depicted in **figure 7.3.** With more braking force, the emissions rise. The CO emissions for diesel, used cooking oil, fish oil, and chicken oil at 5 kW of braking power there were three methyl esters: 0.5, 0.4, and 0.44. When compared to diesel, the CO emissions for the aforementioned four ME decreased by 20%, 16%, and 12%, respectively. Incomplete combustion results in the generation of CO, which is dependent on the rate of combustion of the fuel-air combination and the amount of carbon in the fuel. Carbon is transformed into carbon monoxide when it cannot create carbon dioxide. The cetane number and oxygen concentration of ME are both high. Combustion is caused by the elevated oxygen level. Full combustion fuel is produced by the promoter. Therefore ME reduces CO a byproduct of incomplete combustion.

3.2.2: Hydrocarbon(HC)Emissions:

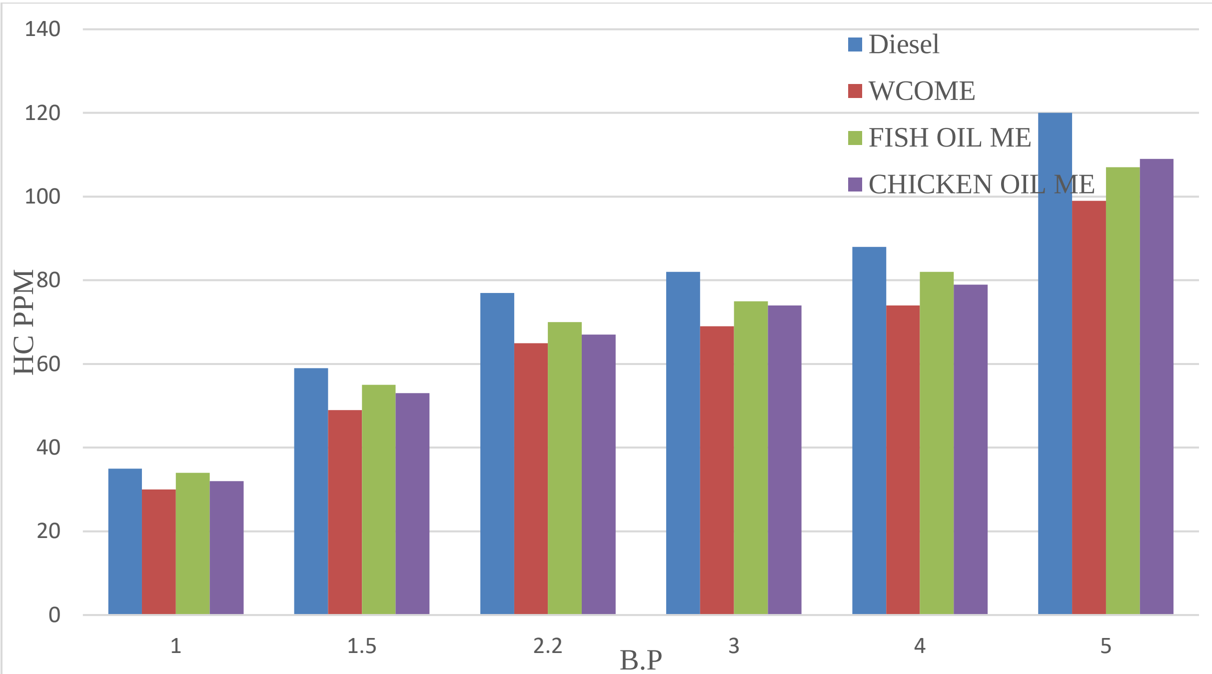

Fig 3.4: Experimentalhydro carbonemissionofusingfivefuelsatvariousbrakepowerindieselengine

The emission of hydrocarbons for each of the four fuels in relation to braking power is shown in **figure 3.4.** As braking power increases, emissions rise. Diesel, used cooking oil, fish oil, and methyl esters of chicken and fish oils all had HC emission levels that were, respectively, 88 PPM, 72 PPM, 75 PPM, and 76 PPM. Methyl esters of waste cooking oil, fish oil, and chicken oil had lower hydrocarbon emission rates than diesel at 18.18%, 14.8%, and 13.64 percent, respectively. Because of incomplete combustion, there are emissions. Only until the fuel correctly atomizes and combines with the air can efficient combustion take place, which in turn depends on the viscosity and surface tension of the fuel. Methyl esters burn more efficiently than diesel due to their characteristics as a fuel. Because biodiesel has a greater cetane number than diesel, it displays shotter ignition delay time.

These assist in lowering the hydrocarbon emissions from methyl esters.

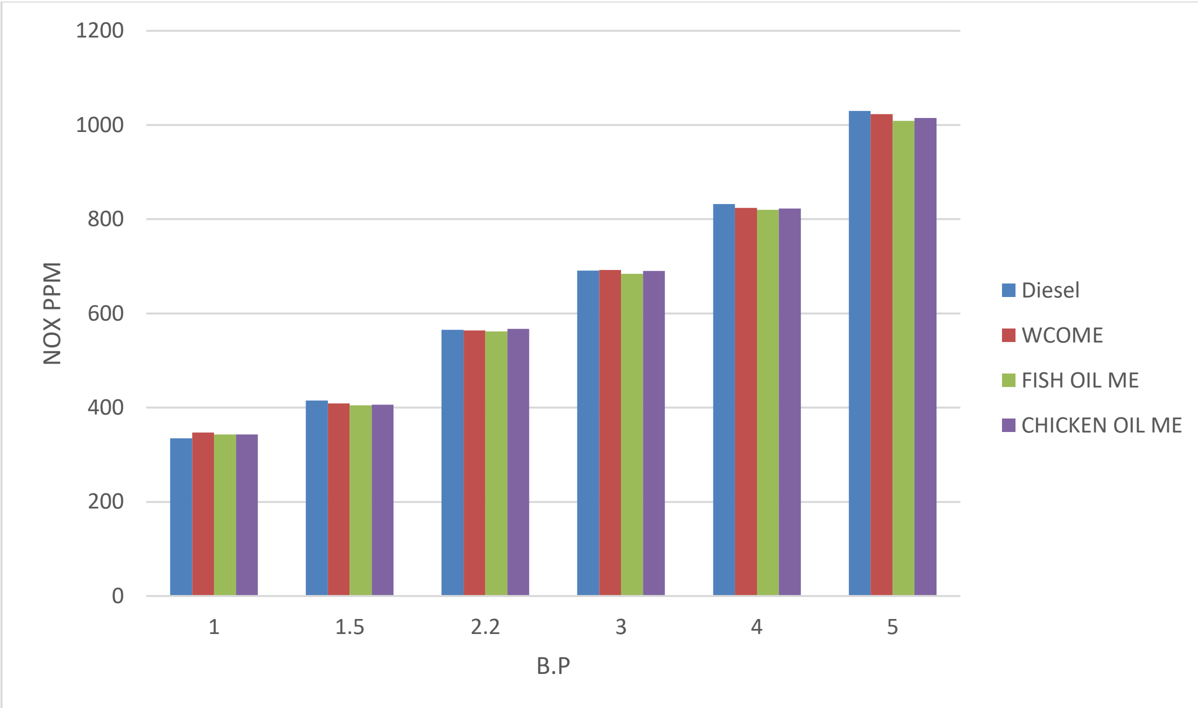

Fig 3.5: Experimentalnitric oxideemissionofusingfivefuelsatvariousbrakepowerindieselengine

The figure 3.5 shows the emission of nitric oxide for all the four fuels with respect to brake power. The emission increases with brake power. The emission of Nox for diesel, waste cooking oil, fish oil, and chicken oil methyl esters were 832PPM, 821PPM, 815PPM and 813PPM respectively. The decrease in NOx emission waste cooking oil, fish oil, and chicken oil methyl esters 1.3%, 1.7%, and 2.3%, than diesel respectively. NOx emission depends on oxygen content adiabatic flame temperature and spray properties. Spray characters is based upon droplet size, momentum, degree of mixing with air and penetration rate. The nitrogen content of the fuel also contribute to NOx production.

4. CONCLUSION

1. When compared to Diesel, Brake Thermal Efficiency is decreased by around 1.6% for fish oil 3% for chicken waste oil, and 0.6% for waste cooking oil.
2. When compared to diesel, the consumption of brake-specific fuel increased for fish oil by 40%, waste chicken oil by 48.1%, waste cooking oil.
3. When compared to diesel, the carbonmonoxideemissions of are respectively reduced by waste cooking oil, fish oil, chicken waste oil by 20%, 16%, 14% .

4. The emission of Hydrocarbon is decreased by 18%,16%,15%,13% for waste cooking oil, fish oil, chicken waste oilrespectively when compared with diesel
5. When compared to diesel, the emission of nitrogenoxide is reduced by 11.4%, 10%, 8.5% for waste cooking oil, fish oil chicken waste oil respectively.

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