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Performance and Emission Characteristics of Biodiesel From Algae in A Diesel Engine

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ABSTRACT
Rapid industrialization and growth in population has resulted in the rapid increase in energy demand. Indiscriminate use of fossil fuels has led to extinction of petroleum sources. Pollutant emissions from diesel engines has caused major impacts in disturbing the ecological system. To overcome these problems, focus is towards alternative sources. Biodiesel, derived from vegetable oils, animal fats and algae is the future prospect. The paper reviews the research on impact of biodiesel on performance. Fuel properties like calorific value, flash point and cetane value of biodiesel and biodiesel blends(B5,B15,B25) were found comparable petroleum diesel. Performance results reveal that most of the biodiesel, give higher brake thermal efficiency and lower brake -specific fuel consumption

Keywords: *Diesel engine, Diesel-biodiesel-bioethanol emulsion fuels, emulsion characteristics, Engine performanc, and Exhaust emission*

INTRODUCTION

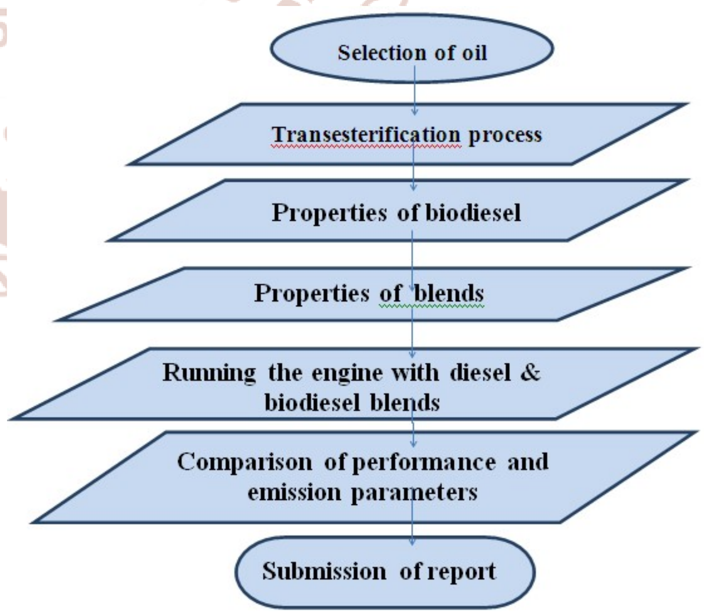
Rapid industrialization and growth in population has resulted in the rapid increase in energy demand. Indiscriminate use of fossil fuels has led to extinction of petroleum sources. Pollutant emissions from diesel engines has caused major impacts in disturbing the ecological system. To overcome these problems, focus is towards alternative sources. Biodiesel, derived from vegetable oils, animal fats and algae is the future prospect. The scope of this work is to reveal microalgae as an alternative energy source for producing biodiesel. In a broad-spectrum shows that microalgae is a sustainable energy source for biodiesel. This present paper evaluates the combustion, performance, and emission characteristics of bio fuel and its blends with diesel. The brake power, torque, specific fuel consumption, thermal efficiency and exhaust emissions are reviewed.

PROBLEM IDENTIFICATION

1. The unburnt fuel particle create high degree exhaust gas temperature which create harmful effect in ozone layer.
2. The transesterification procedure cannot be successful when the FFA (Free fatty acid) content is more than 3%.
3. There is a drastic increase in smoke emission.

METHODOLOGY

The various research methodologies of our project is shown in the figure



Flowchart Research Methodology

PROPERTIES OF FUELS

Table 4.1 Properties Of Fuels

S.NO	FUELS	DENSITY(ρ) kg/m^3	CALORIFIC VALUE (kJ/kg)	KINEMATIC VISCOSITY in centistoke
1.	DIESEL	860	43500	3.56
2.	ALGAE OIL	926	43120	3.4
3.	B5	870	42150	4.12
4.	B15	889	41837	5.5
5.	B25	895	41432	6.61

Table 4.2 Flash And Fire Point

S.NO	FUEL BLENDS	FLASH POINT ^oC	FIRE POINT ^oC
1.	DIESEL	62^{o}C	65^{o}C
2.	ALGAE OIL	74^{o}C	76^{o}C
3.	B5	58^{o}C	60^{o}C
4.	B15	68^{o}C	70^{o}C
5.	B25	76^{o}C	78^{o}C

Table 5.1 specifications of the engine

Specification of the test engine type	Vertical, water cooled, four stroke
Number of cylinder	One
Bore	87.5mm
Stroke	110mm
Compression ratio	16.7:1
Maximum power	3.7kW
Speed	1500rpm
Dynamometer	Eddy current dynamometer
Injection timing	23° before TDC
Injector opening pressure	200kg/cm^2

PERFORMANCE CHARACTERISTICS FOR DIESEL

Table 6.1 Performance Characteristics Of Diesel

S.No	Load (kg)	Time taken for 10cc of fuel (sec)	BP (kW)	BMEP (bar)	TFC (kg/h)	SFC (kg/kW-h)	η_{Bte} (%)
1.	0	93.42	0	0	0.327	0	0
2.	2	74.91	2	1.13	0.408	0.480	14
3.	4	58.5	4	2.295	0.523	0.379	22
4.	6	50.6	6	3.34	0.604	0.292	29

Table 6.2 Performance Characteristics Of B5

S.No	Load (kg)	Time taken for 10cc of fuel (sec)	BP (kW)	FP (kW)	TFC (kg/h)	SFC (kg/kW-h)	η_{Bte} (%)
1.	0	67.5	0	2	0.457	0	0
2.	2	58.5	2	2	0.529	0.2645	32.23
3.	4	54.5	4	2	0.568	0.142	60.14
4.	6	46.5	6	2	0.665	0.110	77.06

The table 6.3 shows that performance characteristics of B15 fuel. The fuel B15 contain 15% of bio-fuel and 85% of diesel. The B15 is give the higher thermal efficiency compare with other bio-diesel. But less thermal efficiency to the diesel.

Table 6.3 Performance Characteristics Of B15

S.No	Load (kg)	Time taken for 10cc of fuel (sec)	BP (kW)	FP (kW)	TFC (kg/h)	BSFC (kg/kW-h)	η_{Bte} (%)
1.	0	68.5	0	1.8	0.452	0	0
2.	2	58	2	1.8	0.533	0.267	32.31
3.	4	53	4	1.8	0.584	0.146	61.9
4.	6	47	6	1.8	0.6587	0.109	78.38

Table 6.4 Performance Characteristics Of B25

S.No	Load (kg)	Time taken for 10cc of fuel (sec)	BP (kW)	FP (kW)	TFC (kg/h)	BSFC (kg/kW-h)	η_{Bte} (%)
1.	0	76	0	1.6	0.407	0	0
2.	2	62.5	2	1.6	0.487	0.256	33.2
3.	4	55.5	4	1.6	0.557	0.134	62.63
4.	6	48.5	6	1.6	0.638	0.11	79.96

The table 6.4 shows that performance characteristics of B25 fuel. The fuel B25 contain 25% of bio-fuel and 75% of diesel. The B25 is give the higher thermal efficiency compare with other bio-diesel. But less thermal efficiency to the diesel.

6.1.5 BRAKE THERMAL EFFICIENCY (BTE)

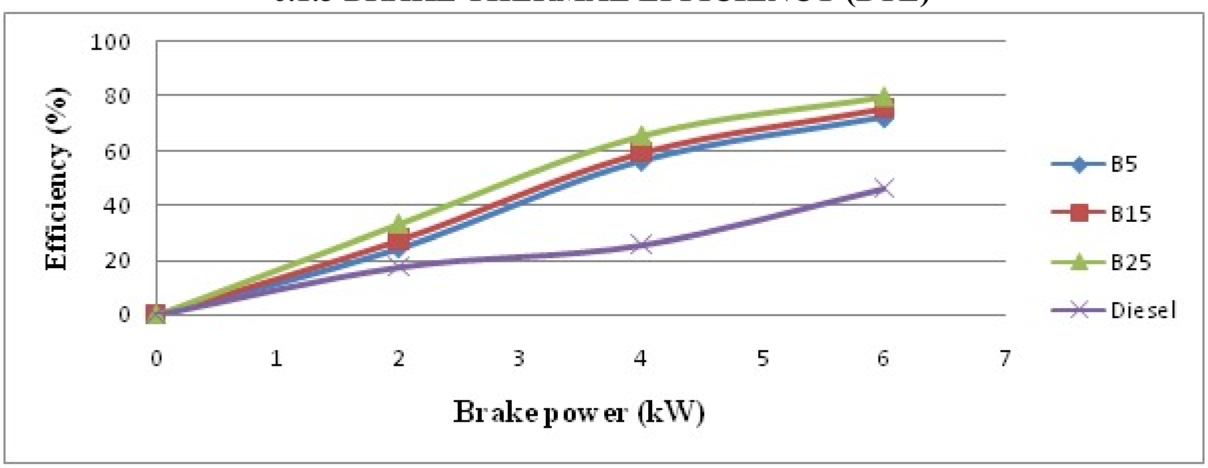


Figure 6.1 Comparison Of Brake Thermal Efficiency

The figure 6.1 is show the thermal efficiency of fuels. Brake power is taken in x-axis and thermal efficiency should be taken in y-axis. the thermal efficiency of the blends has been compared with diesel fuel at various loads and it is shown in figure 6.1. It is observed that the thermal efficiency for B25 is higher than all blends and also with diesel.

SPECIFIC FUEL CONSUMPTION

In the graph, brake power is taken in x-axis and is taken Specific Fuel Consumption(SFC) in y-axis. The SFC of the blends ha sbeen compared with diesel fuel at varios loads and it is shown in figure 6.2. it is observed that the SFC is same as the bio-fuels for the entire range of load.

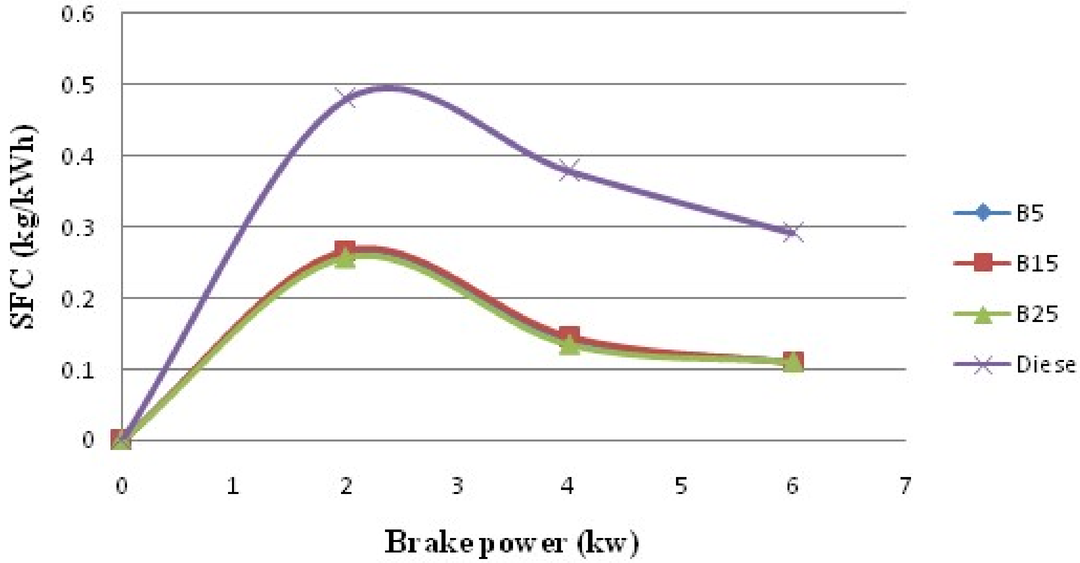


Figure 6.2 Comparison Of SFC

S. no	Load (amps)	Voltage (V)	Speed(rpm)	Time (sec)	CO (%)	HC (ppm)	CO_2 (%)	O_2 (%)	NO_X (ppm)
1	0	230	1500	55	0.03	11	0.80	19.93	12
2	2	230	1500	54	0.03	10	0.70	19.84	20
3	4	230	1500	49.5	0.02	9	0.90	19.70	24
4	6	230	1500	47.5	0.02	10	1.10	19.36	32

Table 6.5 Emission Characteristics Of Diesel

EMISSION CHARACTERISTICS OF DIESEL

Table 6.6 Emission Characteristics Of B5

S.no	Load (Amps)	Voltage (V)	Speed (rpm)	Time (sec)	CO (%)	HC (ppm)	CO_2 (%)	O_2 (%)	NO_X (ppm)
1	0	230	1500	67.5	0.01	6	0.10	20.74	3
2	2	230	1500	58.5	0.01	1	0.30	20.55	8
3	4	230	1500	54.5	0.03	8	1.30	19.42	19
4	6	230	1500	46.5	0.03	64	1.8	18.43	68

Table 6.7 Emission Characteristics Of B15

S.no	Load (Amps)	Voltage (V)	Speed (rpm)	Time (sec)	CO (%)	HC (ppm)	CO_2 (%)	O_2 (%)	NO_X (ppm)
1	0	230	1500	68.5	0.04	20	0.90	19.63	15
2	2	230	1500	58	0.02	16	1..10	19.15	34
3	4	230	1500	53	0.02	10	1.30	19.06	40
4	6	230	1500	47	0.02	9	1.50	18.72	60

Table 6.8 Emission Characteristics Of B25

S.no	Load (Amps)	Voltage (V)	Speed (rpm)	Time (sec)	CO (%)	HC (ppm)	CO_2 (%)	O_2 (%)	NO_X (ppm)
1	0	230	1500	76	0.03	10	0.70	20	14
2	2	230	1500	63.5	0.03	10	1	19.50	28
3	4	230	1500	55.5	0.02	7	1	19.50	37
4	6	230	1500	48.5	0.03	11	1.40	18.93	59

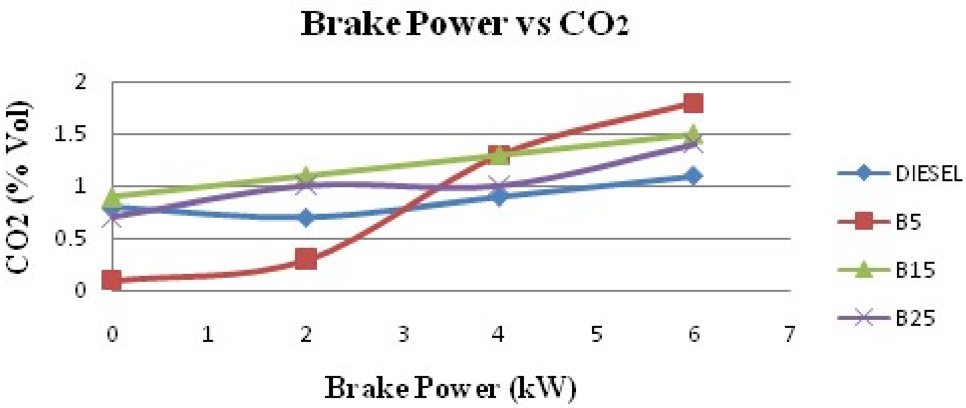


Figure 6.4 Comparison Of Co_2

This is mainly due to improper combustion of fuel efficiency. CO_2 Emission is increase in the blends in the blends of B5 and B15. The CO_2 emission of B25 nearer to diesel.

UNBURNED HYDROCARBONS

The unburned hydrocarbon emission of blends of Algae oil is more compared to that for neat diesel for all loads. This is because of poor mixture formation tendency of blends of Algae oil as shown in figure 6.5.

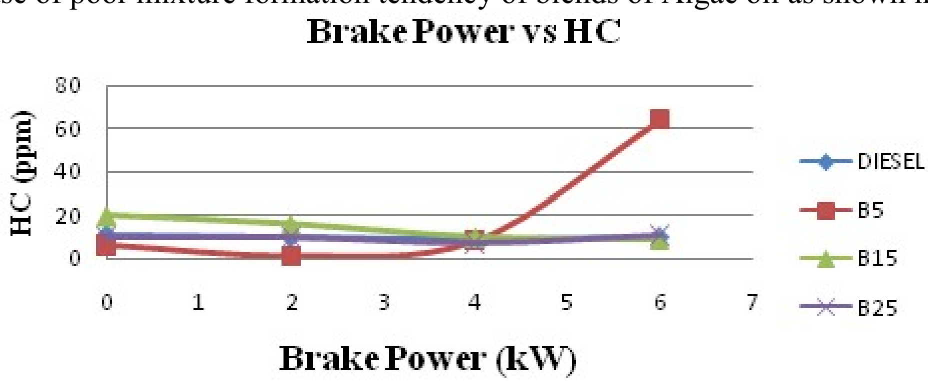


Figure 6.5 comparison of HC

In addition to the other factors, the lower thermal efficiency wth these blends also is responsible for this trend. It may be noted that a lower thermal efficiency with these blends will lead to injection of higher quantities for the same load condition.

OXIDES OF NITROGEN

Figure 6.6 indicates that blends of Algae oil shows lower NO_x emission compared to neat diesel fuel. This is due to atomization of algae oil leads to poor combustion and lead lower NO_x emission. Compare all the blend B25 is emitted lower NO_x emission.

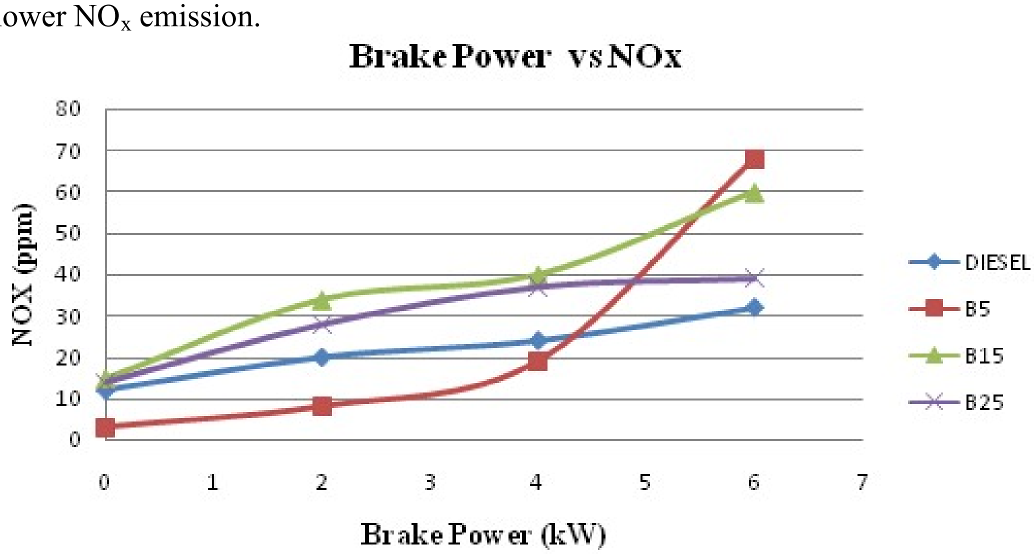


Figure 6.6 Comparison Of No_x

CONCLUSION

When compared to all the blends of the bio-diesel has high efficiency and in the mean while the specific fuel consumption was to be lower than the various blends with the diesel. The carbon monoxide emission is higher than that of diesel blends. This is due to higher viscosity and poor atomization tendency of algae oil leads to poor combustion and higher carbon monoxide emission. The unburned hydrocarbon emission of blends of algae oil is more compared to that for neat diesel for all loads. This is because of poor mixture formation tendency of blends of algae oi. When compared to the neat diesel blend B25 is emitted 41% lower NOx emission. The specific fuel consumption is increased in the case of Algae Oil-Diesel blends compared to neat diesel. The unburned hydrocarbon and carbon monooxide emissions are increased with blends of Algae oil-Diesel as compared to neat diesel. The smoke density also increase for the blends of Algae oil-diesel compared to neat diesel. The oxides of nitrogen (NOx) diesel. The exhaust gas temperature decrease with the bleds Algae oil compared to neat diesel. In general the performance and emission level of algae diesel blends does not improve, but it can be used as a low cost alternative fuel for diesel engine.

FUTURE WORK

The future scope is about to be a certain amount of ethanol will be added to the existing one to increase the properties of bio diesel nearer to the neat be CO and CO_2. Hence th eengine performance is also been increased. Emission test shows reduction in NOx and smoke in exhaust gases for Algae oil with respect to conventional fuels at medium and higher power output.

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