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Emission and Performance Analysis of Micro Algae As a Biofuel Blends With Diesel in Direct Injection Diesel Engine

S.Selvadurai[1], S.Sivakumar[1], M.Vino[1], R.Ramar[1]

Department of Mechanical Engineering, Dhanalakshmi Srinivasan College of Engineering, Perambalur, Tamil Nadu, India[2, 3, 4]

ABSTRACT: The production of biodiesel from algae is one of the promising alternative fuel for diesel engines. The biodiesel was produced from algae oil by transesterification. Biodiesel blends of 10 and 20% were prepared. Oblique's were highly affected by fatty acids composition. Chemical and physical properties of biodiesel blends B10, B20, B40 and B50 were close to diesel oil. The performance parameters and exhaust emissions of a diesel engine burning biodiesel blends and diesel fuels were studied. Biodiesel blend B50 showed decrease in specific fuel consumption, exhaust gas temperature and increase in thermal efficiency compared to B20 and diesel fuels. There were reductions in the emissions gas for B50 compared to B20 and diesel fuels. It could be concluded that a high quality of biodiesel could be produced from microalgae S. Oblique and used efficiently and environmentally safe in conventional diesel engine.

KEYWORDS: Micro Algae bio-fuel, DI (Direct injection).

I. INTRODUCTION

The production of biodiesel from algae is one of the promising alternative fuels for diesel engines. The biodiesel was produced from algae oil by transesterification. Biodiesel blends of 10 and 20% were prepared. Obliques were highly affected by fatty acids composition. Chemical and physical properties of biodiesel blends B10, B20, B40 and B50 were close to diesel oil. The performance parameters and exhaust emissions of a diesel engine burning biodiesel blends and diesel fuels were studied. The performance test conducted in single cylinder water cooled four stroke direct injection diesel engine using algae biodiesel without any modification. And the results were compared with diesel fuel. Fossil fuels are current world scenario in which even the world economy depends on. Depletion of fossil fuels with increase in price rise also with alarming increase in pollution levels are major crisis for the society and our environment. Most of the alternative bio-fuels identified today are proved to be a partial substitute for existing one due to its undesirable fuel characteristics (Devan and mahalakshmi 2010). Adding to this a large number of vehicles is being introduced in the roads every day. Hence there is need for introducing new types of fuels in order to overcome the depletion of fossil fuels and increase in pollution.

II. LITERATURE REVIEW

It is renewable ,environmentally friendly and it can contribute in reducing the CO_2 level at the atmosphere because microalgae consume CO_2 and converts it to oil (Hossain et al., 2008).
Microalgae is non-edible and can grow in different conditions such as fresh water, marine water and/or grow in the lands which are not suitable for agriculture, therefore that will not affect the human food (Widjaja et al., 2009), (Mata et al., 2010).
Microalgae biodiesel production per unit of area is many times higher than crops biodiesel. The productivity of diatom algae are about 46000 Kg of oil/hectare/year (Demirbas, 2007).
Some microalgae oil content about 80% of dry weight (Amin, 2009).
Microalgae biofuel is non-toxic, contains no sulphur and highly bio-degradable. After extracting oil the left material can be used as soil fertilizer or to produce ethanol (Demirbas & Fatih Demirbas, 2010)
The extraction of microalgae oil from the biomass can be in physical or chemical methods. Oil press is used as physical extraction, while chemical extraction is used to make the extraction more effective (Anderson & Sorek, 2009).

Future of Biodiesel

Biodiesel is a safe alternative fuel to replace traditional petroleum diesel. It has high-lubricity, is a clean- burning fuel and can be a fuel component for use in existing, unmodified diesel engines. It is the only alternative fuel that offers such convenience. Biodiesel acts like petroleum diesel, but produces less air pollution, comes from renewable sources,

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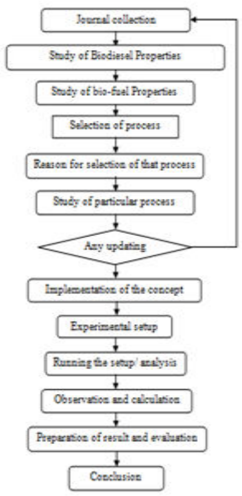
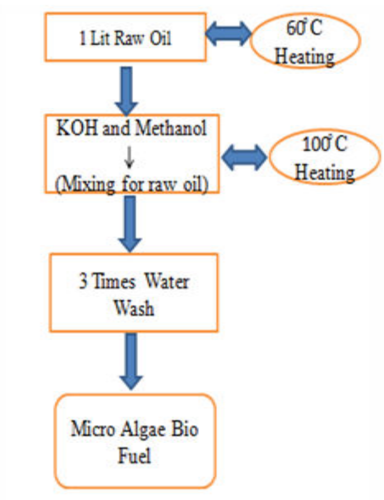
is biodegradable and is safer for the environment. Producing biodiesel fuels can help create local economic revitalization and local environmental benefits. Many groups interested in promoting the use of biodiesel already exist at the local, state and national level. Biodiesel is designed for complete compatibility with petroleum diesel and can be blended in any ratio, from additive levels to 100 percent biodiesel.
Biodiesel

III. ANALYZING THE PROBLEMS

The diesel engines are considered to be fuel efficient and sturdier than gasoline engines. However, they produce hazardous emissions such as oxides of nitrogen (NO_x), particulates of matter, smoke, and CO (carbon monoxide) in high magnitudes. To increase the performance and to reduce the emissions from the diesel engines, various techniques such as fuel modification, engine design alteration, exhaust gas treatment, etc. have been tried. Several researchers have contributed their efforts on fuel modification techniques in which some chemical reagents are incorporated along with the conventional diesel fuel. The processed form micro algae (biodiesel) has emerged as a potential substitute for diesel fuel on account of its renewable source and lesser emissions, without any modifications in its existing construction.

METHODOLOGY





IV. DIRECT INJECTION DIESEL ENGINE

Diesel Engine

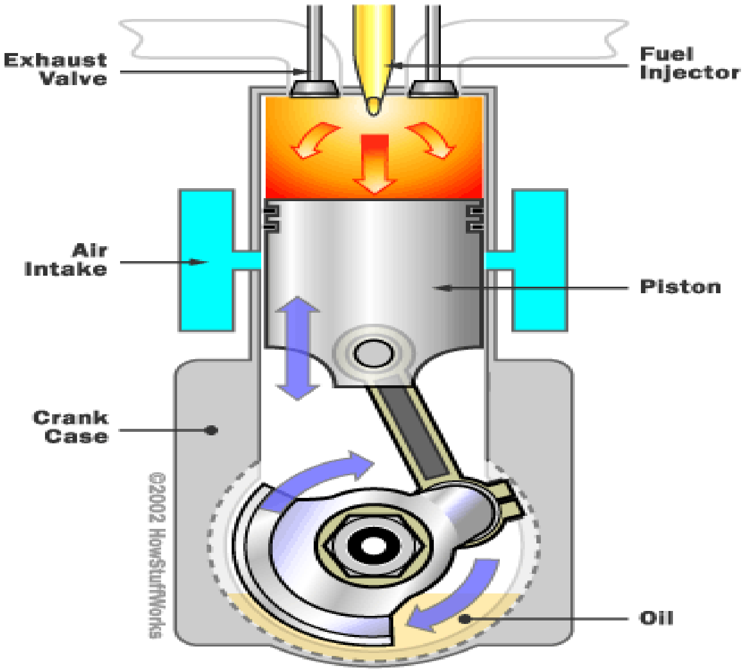
The diesel engine (also known as a compression-ignition engine) is an internal combustion engine that uses the heat of compression to initiate ignition and burn the fuel that has been injected into the combustion chamber. This contrasts with spark-ignition engines such as a petrol engine (gasoline engine) or gas engine (using a gaseous fuel as opposed to gasoline), which use a spark plug to ignite an air-fuel mixture.

The diesel engine has the highest thermal efficiency of any standard internal or external combustion engine due to its very high compression ratio. Low-speed diesel engines (as used in ships and other applications where overall engine weight is relatively unimportant) can have a thermal efficiency that exceeds 50%. .

Working Principle

The diesel internal combustion engine differs from the gasoline powered Otto cycle by using highly compressed hot air to ignite the fuel rather than using a spark plug (compression ignition rather than spark ignition).

In the true diesel engine, only air is initially introduced into the combustion chamber. The air is then compressed with a compression ratio typically between 15:1 and 22:1 resulting in 40-bar (4.0 MPa; 580 psi) pressure compared to 8 to 14 bars (0.80 to 1.40 MPa; 120 to 200 psi) in the petrol engine. This high compression heats the air to 550 °C (1,022 °F). At about the top of the compression stroke, fuel is injected directly into the compressed air in the combustion chamber. This may be into a (typically toroidal) void in the top of the piston or a pre-chamber depending upon the design of the engine. The fuel injector ensures that the fuel is broken down into small droplets, and that the fuel is distributed evenly. The heat of the compressed air vaporizes fuel from the surface of the droplets. The vapour is then ignited by the heat from the compressed air in the combustion chamber, the droplets continue to vaporise from their surfaces and burn, getting smaller, until all the fuel in the droplets has been burnt.



V. FUEL PROPERTIES AND EXPERIMENTAL SETUP

Fuel Properties

Properties	Diesel	microalgaebiodiesel+ diesel (50%+50%)	Microalgae100% biodiesel
Specific gravity	0.821	0.8506	0.8634
Viscosity at 40°c (centi stokes)	35.2	36.3	36.0
Flash point(°c)	48	86	59
Fire point(°c)	63	92	75
Pour point (°c)	3	-10	<4
Density at 15°c gm/c.c	0.82	0.8498	0.8802
Calorific value kcal/kg	43989	43622	10954

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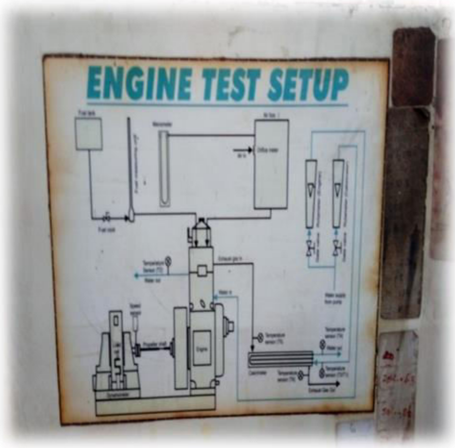
EXPERIMENTAL SETUP

Engine specification

Maker	**Kirloskar Av1**
Type	Vertical cylinder, DI diesel engine
Speed	1500 rpm
Compression ratio	17.5:1
Cooling system	Water
Bore and stoke	87.5mm × 110mm
Fuel	Diesel & Bio-diesel

Engine Test Setup



Thus after Transesterification process the property of micro algae oil has been converted into efficient bio diesel.

As well as the high level of compression allowing combustion to take place without a separate ignition system, a high compression ratio greatly increases the engine's efficiency. Increasing the compression ratio in a spark-ignition engine where fuel and air are mixed before entry to the cylinder is limited by the need to prevent damaging pre-ignition

Engine experimental set up

PROCEDURE

1. Experiments were conducted with transesterified micro algae seed oil and diesel blends having 25%, 50%, 75%, and 100% (B25-B100) transesterified micro algae seed oil on volume basis at different load levels.
2. Tests of engine performance on pure diesel were also conducted as a basis for comparison.
3. The percentage of blend and load, were varied and engine performance measurements such as brake specific fuel consumption, air flow rate, and exhaust gas temperature and emissions were Measured to evaluate and compute the behavior of the diesel engine.

4. Each time the engine was run at least for few minutes to attain steady state before the measurements were made. The experiments were repeated thrice and the average values were taken for performance and emission measurements.

VI. MODEL CALCULATION

PLAIN DIESEL

DATA USED

FUEL: diesel, SPECIFIC GRAVITY: 0.824, 2πR=1, CV: 43989 kJ/kg

TOTAL FUEL CONSUMPTION

TFC=x/time×specific gravity of fuel×3600/1000
=10/39.75×0.824×3600/1000

TFC=0.746 kg/hr

BRAKE POWER

BP=2πRN×(T_1-T_2) ×9.81/60×1000
=1×1500×3.4×9.81/60000

BP=0.83 kw

SPECIFIC FUEL CONSUMPTION

SFC=TFC/BP
=0.746/0.83

SFC=0.90kg/kw.hr

FRICTIONAL POWER

Frictional power is obtained from graph between **BP&TFC** by using interpolation method

FP=1.25 kw

INDICATED POWER

IP=FP+BP
=1.25+0.83

IP=2.08 kw

MECHANICAL EFFICIENCY

η_m =BRAKE POWER/INDICATED POWER
=0.83/2.08

η_m =39.90%

BRAKE THERMAL EFFIENCY

$\eta_{B.T}$ =BRAKE POWER×3600/TFC×CAALORIFIC VALUE
=0.83×3600/0.746×43989
=0.091

$\eta_{B.T}$ =9.1%

MICRO ALGAE BIO DIESEL [B50]

DATA USED

FUEL: PBD B25, SPECIFIC GRAVITY: 0.840, CV: 43701.84 kj/kg

1. TOTAL FUEL CONSUMPTION

TFC=x/time×specific gravity of fuel×3600/1000
=10/34.90×0.835×3600/1000

TFC=0.86 kg/hr

2. BRAKE POWER

BP=2πRN×(T_1-T_2) ×9.81/60×1000
=1×1500×3.4×9.81/60000

BP=0.83 kw

3. SPECIFIC FUEL CONSUMPTION

SFC=TFC/BP
=0.86/0.83

SFC=1.034kg/kw.hr

4. FRICTIONAL POWER

Frictional power is obtained from graph between **BP&TFC** by using interpolation method

FP=2.25 kw

5. INDICATED POWER

IP=FP+BP

=2.25+0.83

IP=3.08 kw

6. MECHANICAL EFFICIENCY

η_m =BRAKE POWER/INDICATED POWER

=0.83/3.08

η_m =27.02%

7. BRAKE THERMAL EFFIENCY

$\eta_{B.T}$ =BRAKE POWER×3600/TFC×CAALORIFIC VALUE

=0.83×3600/0.686×10954

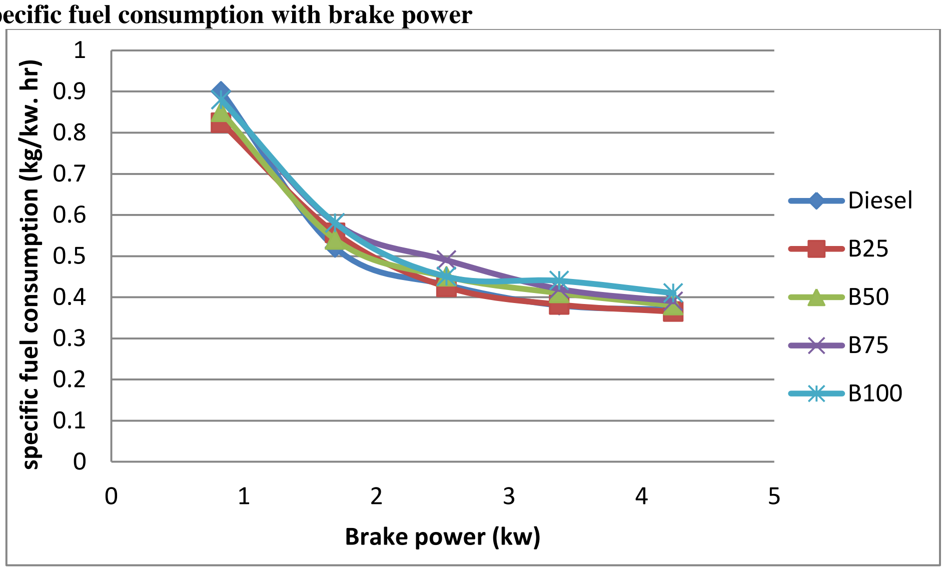
=0.100

$\eta_{B.T}$ =14.70%

VII. RESULTS AND DISCUSION

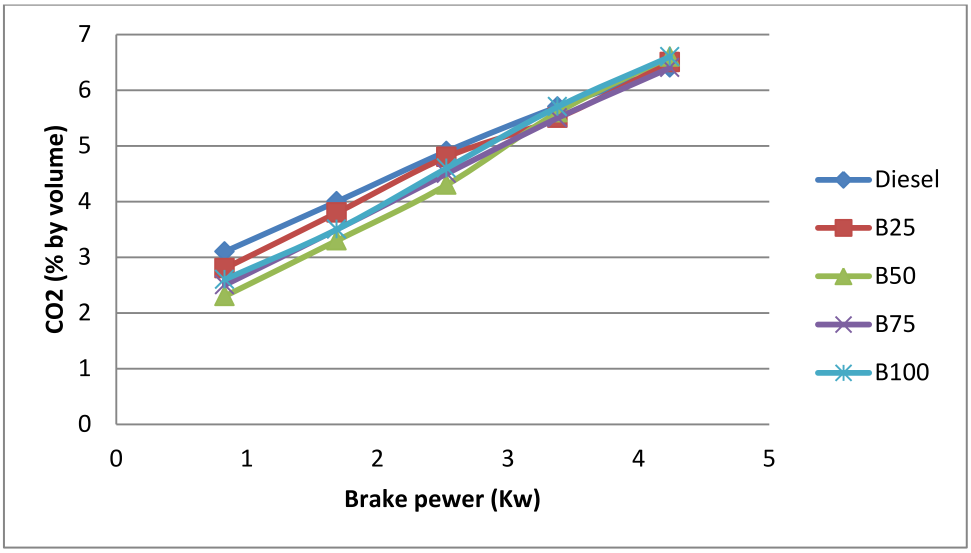
A series of engine tests were carried out using diesel and biodiesel to find out the effect of various blends on the performance and emission characteristics of the engine. Investigations are carried out on the engine mainly to study the effect of specific fuel consumption, brake thermal efficiency, mechanical efficiency and emissions such as NOx, CO, CO2, and HC.

Variation of specific fuel consumption with brake power



Brake specific fuel consumption variation brake power for the micro algae oil and pure diesel. It is observed that the brake specific fuel consumption is found to decrease with increase in load. Among the blends B50 concentration shows the minimum specific fuel consumption than other blends and pure diesel. The minimum BSFC is observed as 0.36 for B50 blend where as for pure diesel it was 0.37 at initial load of the engine. This may due to better combustion and an increase in the energy content of the blend. This is also due to lower calorific value of the blended fuel as compared with diesel.

Variation of CO_2 with brake power



The variation of carbon dioxide with brake power of the engine is shown in figure-6. It is observed that carbon dioxide emission increase with increase of brake power. The Minimum carbon dioxide value for the diesel oil was 2.30 at B50 and at the initial brake power 0.83 at it was 3.10 for diesel. This is a result of low availability of oxygen during combustion

ADVANTAGES

1. It is a Renewable fuel, obtained micro algae.
2. It has low toxicity, in comparison with diesel fuel.
3. Degrades more rapidly than diesel fuel.
4. It also has lower emissions of contaminants: carbon monoxide, particulate matter, polycyclic aromatic hydrocarbons, and aldehydes
5. This fuel also has lower health risk, due to reduced emissions of carcinogenic substances.

VIII. CONCLUSION

The following conclusions were drawn from these investigations carried out on normal DI Diesel engine for different loads. The conclusions of this investigating at are as follows.

- The maximum brake thermal efficiency 22.53% was observed with the blend B50 as compared to pure diesel and the other blend at the brake power 4.24kw of the engine.
- The specific fuel consumption of the 0.36kg/kw-hr was observed with the blend B50 the SFC is lower for above blend than that of other blends and pure diesel.
- In the combustion analysis, the maximum cylinder pressure observed as 73.45bar for B50 blends than all the other blends at maximum brake power of the engine.
- The heat release rate is also higher for B75 blend than pure diesel and all the other blends.
- The CO2 percentage increased with increase of loads. The minimum value occurred at B75&B100.
- The hydro carbons are also lower for all the blends compared with diesel.

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