ISSN 2348 – 7968

Investigation of Single Cylinder Diesel Engine Using Bio Diesel from Marine Algae

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Abstract

Biodiesel is biodegradable with less CO_2 and NOx emissions. Continuous use of petroleum sourced fuels is now widely recognized as unsustainable because of depleting supplies and the contribution of these fuels to the accumulation of carbon dioxide in the environment. Renewable, carbon neutral, transport fuels are necessary for environmental and economic sustainability. Algae has emerged as one of the most promising sources for the biodiesel production. In these study ENTROMORPHA algae is used to extract the biodiesel. The investigation was carried out in the single cylinder water cooled DI diesel engine with the Diesel fuel and various blends of biodiesel (B20, B40, B60, B80 and B100). The performance and emission parameters will be analyzed. B20 blends show the maximum brake thermal efficiency than the other blends. The smoke density for all the blends increases, however the B20 shows lower smoke density.

Keywords: *Author Guide, Article, Camera-Ready Format, Paper Specifications, Paper Submission.*

1. Introduction

Biodiesel is an alternative fuel based on vegetable oils or animal fats, even those recycled after restaurants have used them for cooking. Vehicle engines can be converted to burn biodiesel in its pure form, and biodiesel can also be blended with petroleum, diesel and used in unmodified engines. The name Biodiesel was introduced in the United States during 1992 by the National Soy diesel Development Board (presently national biodiesel board) which has pioneered the commercialization of Biodiesel in the United States. Biodiesel is safe, biodegradable, reduces air pollutants associated with vehicle emissions, such as particulate matter, carbon monoxide and hydrocarbons, NOx. Biodiesel can be used in any mixture with petroleum, diesel as it has very similar characteristics but it has lower exhaust emissions. Biodiesel can be manufactured as a high quality fuel for compression ignition engines and is widely accepted, particularly when blended into conventional diesel fuel, when produced to specifications already established in Europe. It has a lower energy content conventional diesel and a volumetric fuel consumption increase of about 6% with biodiesel is typical of reported data. The alternative diesel fuels must be technically acceptable, economically competitive, environmentally acceptable and easily available.

Biodiesel consists of the methyl esters of the fatty acid components of the triglycerides that make up most animal fats and vegetable oils. It is produced by the transesterification process in which the fats/oils are reacted with methanol to form the biodiesel methyl esters and glycerol, the latter being sold as a by-product. Commercial biodiesel production technology is available with plants of up to 100,000 tonnes per year having being constructed. The process technology is well understood although there are some variants on the technologies used. Although this technology continues to evolve, yields of biodiesel are already near theoretical limits. Technology for the pre-treatment of fats and oils and the purification of the methyl esters and glycerol is well established and commonly used outside the biodiesel industry. Biodiesel can be blended in any proportion with mineral diesel to create a biodiesel blend or can be used in its pure form. Just like petroleum diesel, biodiesel operates in compression ignition (diesel) engine, and essentially require very little or no engine modifications because biodiesel has properties similar to mineral diesel.

The algae should be thought of as a type of simple plant that develops when water and light are present. It occurs in all colours from green to brown to red.Algae have emerged as one of the most promising sources for biodiesel production The word algae represent a large group of different organisms from different phylogenetic groups, representing many taxonomic divisions.

ISSN 2348 – 7968

2. **Methodology**

2.1 Preparation of Biodiesel

The biodiesel was prepared from the algae by mechanical extraction method and chemical extraction method. The detailed explanation of both the methods was discussed here.

2.2 Types of Mechanical Extraction Method

- Expression / expeller press type extraction
- Ultrasonic-assisted extractions

2.3 Types of Chemical Extraction Method

- Hexane solvent method
- Soxhlet apparatus, method
- Super critical fluid extraction method

In above said methods the expression/expeller press type extraction from the mechanical extraction method and soxhlet method from the chemical extraction method were used for this work.

2.4 Soxhlet Apparatus Method

Soxhlet apparatus method extraction is used some chemical solvents. Oils from algae are extracted through repeated washing, or percolation, with an organic solvent such as petroleum ether, under reflux in special glassware. In these study ENTROMORPHA algae is used to extract the biodiesel. Initially the algae sample was collected from sea back water and dried with the room for about 72 hours. Then the dried algae sample of 0.25 kilo gram was subjected to the soxhlet apparatus with the solvent of petroleum ether and this cycle is repeated for 48 hours at 60°C. From this process 60 ml of crude oil was extracted. Then the extracted crude oil was heated in the rota evaporator around 70ºC, so that the petroleum ether present in the crude oil was evaporated. Then the purified crude oil is converted into biodiesel by the double transestrification process. In the transestrification process catalyst KOH was added with the extracted crude oil in the ratio of 1.5 g per 100 ml and 20 ml of methanol was added. After this process the algae oil was collected.

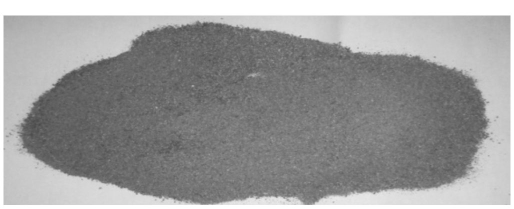
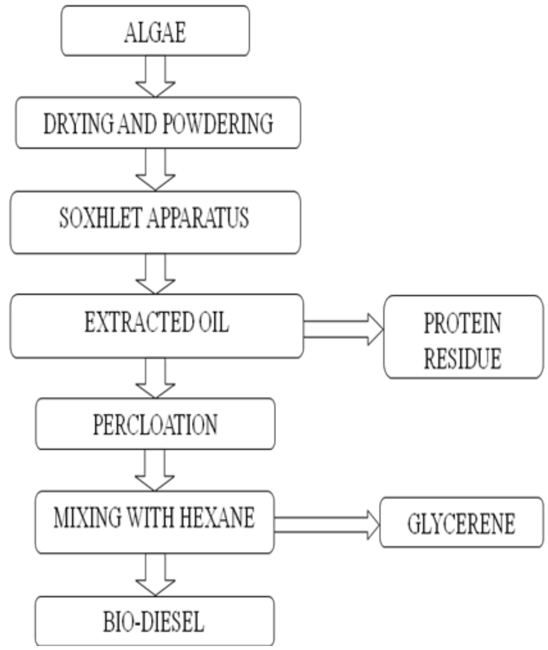


Figure 4.1 Grained algae



Production of biodiesel from algae

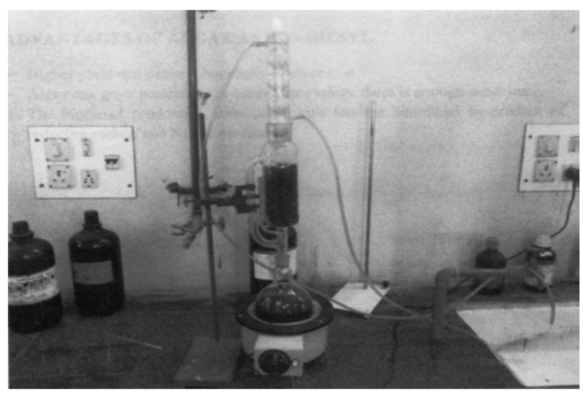


Fig 4.2 Extraction process of algal oil by soxhlet apparatus method

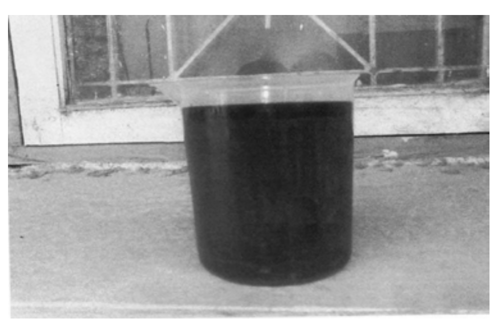


Fig 2.3 Extracted Algal oil

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3. Tables, Figures and Equations

3.1 Experimental setup

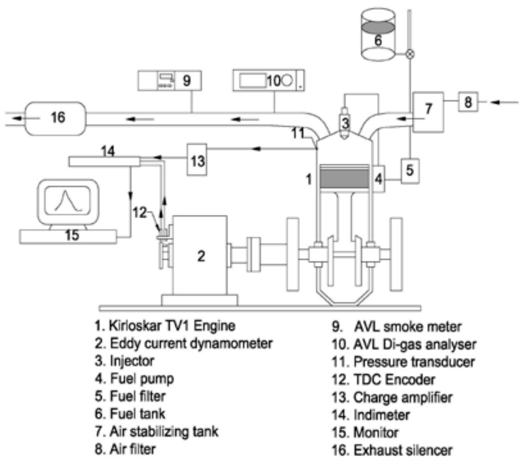

Fig 3.1 Experimental setup (Kirloskar TV-1 Engine)

3.2 Properties of Diesel and Algae oil

Properties	Diesel	Algae oil
Density (kg/m^3)	829	862
Specific gravity	0.829	0.862
Kinematic Viscosity (CST)	25.7	36.7
Flash Point (°C)	37	194
Fire Point (°C)	40	210
Cetane Number	52	50
Calorific value (kJ/kg)	43000	39940

3.3 Results and Discussion

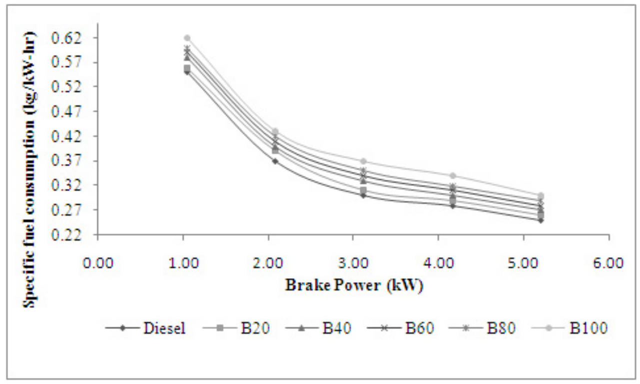

Figure 3.2 Brake power Vs Specific Fuel Consumption

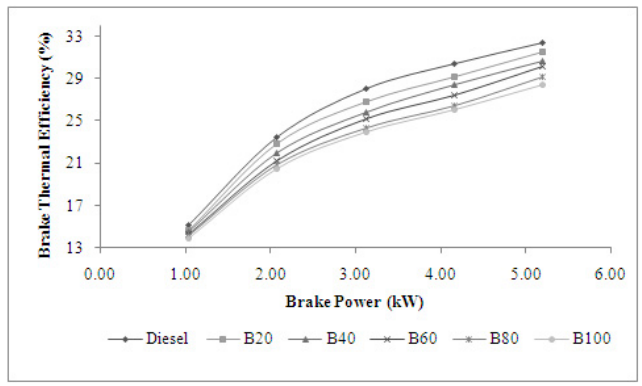

Figure 3.3 Brake power Vs Brake Thermal Efficiency

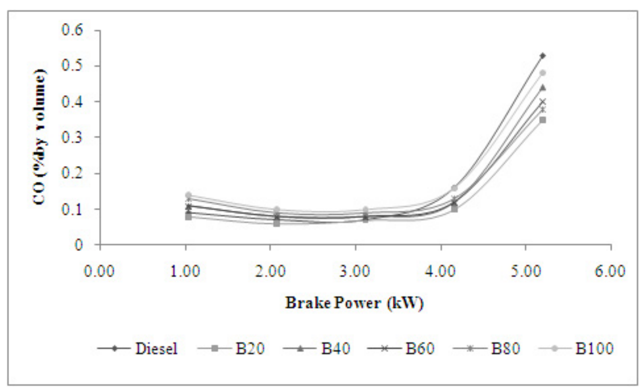

Figure 3.4 Brake power Vs carbon monoxide

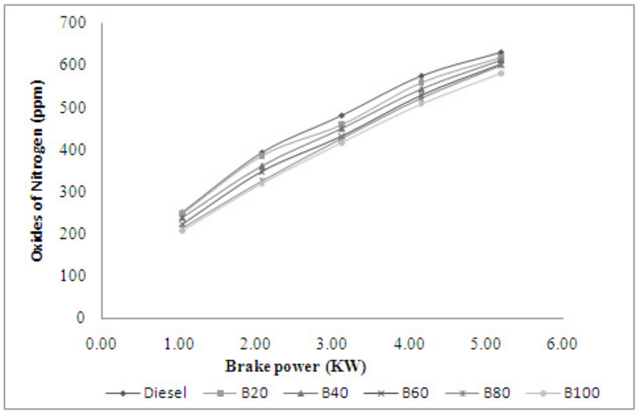

Figure 3.5 Brake power Vs Oxides of Nitrogen

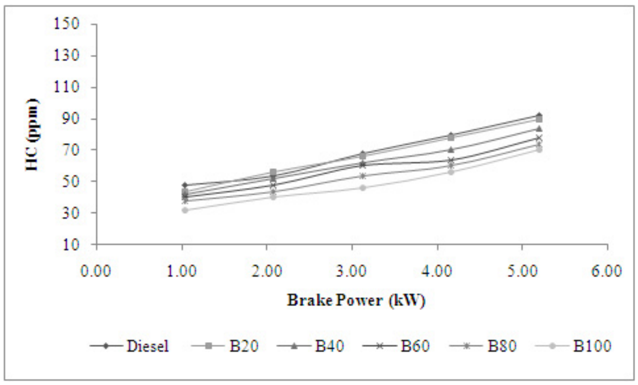

Figure 3.6 Brake power Vs Hydrocarbon

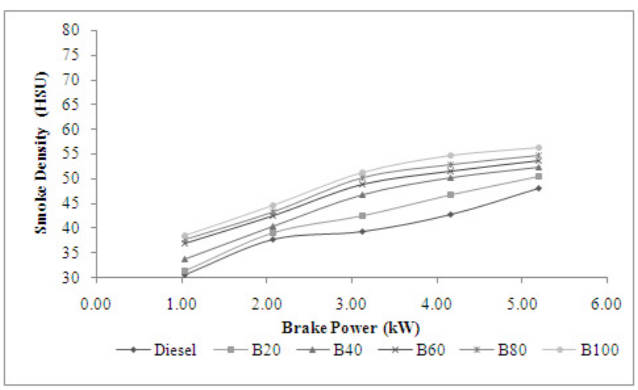

Figure 3.7 Brake power Vs Smoke density

Figure 3.2 shows the variations of specific fuel consumption with brake power for various blends of biodiesel and sole fuel. From the graph it is clear that the specific fuel consumption decreases while increasing the brake power of the engine for all blends. Among the blends B20 shows the lowermost specific fuel consumption than other blends.

Figure 3.3 shows the variations of brake thermal efficiency with brake power for various blends of biodiesel. From the graph it is clear that the brake thermal efficiency of sole fuel is 32% at the maximum brake power of engine. However it is higher than algae oil blends and B20 shows the maximum brake thermal efficiency compared to other blends. The reason is a high viscosity of algae oil and poor atomization of algae oil.

Figure 3.4 shows the variations of CO emission with brake power for various blends of biodiesel and sole fuel. From the graph it is clear that the CO emission decreases expect the maximum load. Among the blends B80 shows the lower CO emission. The reason is a high viscosity of oil.

Figure 3.5 shows the variations of NOx emission with brake power for various blends of biodiesel and sole fuel. From the graph it is clear that the NOx emission gradually increases up to a part load and then decreases. It is evident that heat release rate decreases and hence the NOx emission is also decreasing.

Figure 3.6 shows the variations of HC emission with brake power for various blends of biodiesel and sole fuel. From the graph it is clear that all the blends reduce the HC emission compared to the sole fuel. Among the blends B100 shows the maximum reduction in HC emission.

Figure 3.7 shows the variations of smoke density with brake power for various blends of biodiesel and sole fuel. From the graph it is clear that the different blends of algae oil show the maximum smoke density than that of sole fuel. Among the blends B20 shows the lower smoke density than other blends. The reason is a high viscosity of algae oil.

4. Conclusions

The experiment was conducted in kirloskar AV-1 Engine. In this experiment along with the sole fuel, algae oil is used with various blends. The algae oil blended with sole fuel in the ratio of B20, B40, B60, B80, and B100.

The experiment was successfully conducted and the following results are obtained:

- For B20 blends show the maximum brake thermal efficiency than the other blends.
- The smoke density for all the blends increases, however the B20 shows lower smoke density.
- Up to a part load the NOx emission increases behind that NOx level gradually decreases all the blends.
- Expect the maximum load the CO emission decreases in all blends B80 shows the lower CO emission.
- The HC emission for all the blends decreases compared to the sole fuel.

It was conducted that the algae oil along the sole fuel reduces the emission in the diesel engine.

ISSN 2348 – 7968

References

- **A. Kerihuel,**"Ethanol animal fat emulsions as a diesel engine fuel – Part – I: Formulations and influential parameters", ***Journal of Fuels*** 85 (2006) 2640-2645.
- **M. Senthilkumar,** "Experimental investigations on the use of preheated animal fat as fuel in a compression ignition engine, ***Journal of renewable energy*** 30(2005) 1443-1456.
- **J. Patterson,**"Experimental study of DI diesel engine performance using three different biodiesel fuels". ***SAE.*** Paper No. 2006-01-0234.
- **C.D. Rakopoulos**, "Comparative performance and emissions study of a direct injection diesel engine using blends of diesel fuel with vegetable oils or bio-diesels of various origins" ***Journal of Energy Conversion and Management***47 (2006) 3272-3287.
- **Michele Aresta**, "Production of biodiesel from macroalgae by supercritical CO2extraction and thermochemical liquefaction", ***Springer-Verlag*** 29 November 2005
- **A.B.M. Sharif Hossain**, "Biodiesel Fuel Production from Algae as Renewable Energy", ***American Journal of Biochemistry and Biotechnology*** 4 (3):250-254, 2008
- **AriefWidjaja**, "Lipid production from microalgae as a promising candidate for biodiesel production", ***Makara, Teknologi***, Vol. 13, NO. 1, April 2009: 47-51
- **Angelo C. Pinto**, "Biodiesel: An Overview", ***J. Braz. Chem. Soc***., Vol. 16, No. 6B, 1313-1330, 2005

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