Combustion Characteristics of Macro and Micro Algae Biodiesel

A.Ganesh[1] , K. Gokula Kannan[1]
Student,
Department Mechanical Engineering, Sathiyabhama University,
Chennai, India

Abstract: The interest on biodiesel research in India is mainly due to fluctuating crude prices, limited oil reserves and the strict emission standards. Here the experimental work has been carried out on a single cylinder, direct injection Diesel engine using Macro and Micro biodiesel blends under constant speed by varying the injection timings. The results show increased specific fuel consumption. The Brake thermal efficiency values of biodiesel are closer to Diesel. Compared to Diesel both the biodiesel blends give lesser un burnt hydrocarbons, Carbon monoxide and smoke emissions. Slight higher NOx emissions were found in Bio Diesel blends. While advancing the injection timing the performance and emission characteristics were good, compared to retarding it.

INTRODUCTION

At present, India is producing only 30% of the total petroleum fuels required. The remaining 70% is being imported. Biodiesel, an alternate of diesel, is defined as fatty acid methyl or ethyl esters from vegetable oils or animal fats. It is a renewable, biodegradable and oxygenated fuel .There are four methods normally used to convert oil and fats into bio diesel, they are direct use and blending, thermal cracking, transesterification, micro emulsion, out of which transesterification is the most popular method for making bio diesel from vegetable oil. Transesterification process is called as the chemical conversion of the oil to its fatty ester . In the Transesterification process, a catalyst (sodium hydroxide or potassium hydroxide) is used to split the oil molecules. An alcohol (methanol or ethanol) is used to combine with the separated esters. The byproduct from the reaction is glycerin. The viscosity of the end product is considerably reduced after the reaction. An alga has several advantages like being a potentially greener fuel feedstock and also it can be grown on nonarable areas. But still it struggles to find a place in the list of known biofuel crops. An alga is the preferred source because of its higher yield. The biomass can be doubled within 24hrs; the doubling time estimated was approximately 3.5hrs .The recent studies show that from the cultivation point of view, the algae are easy to cultivate, need very little or no attention, less nutrients and the water which is unsuitable for human consumption can be used. Even though many reports explained the techniques about the conversion of algae oil in to biodiesel there are no or less reports gives the algae esters properties in comparison with diesel and almost no significant amount of work to explain the performance of it in a diesel engine. Many reports indicate Gracileria, Gelidium, kappaphycus etc are being cultivated in large scale in India for food and pharmaceutical applications. But only few of them have concentrated on biofuel from algae. There is lack of information regarding performance on a diesel engine using alga biodiesel. Therefore the main aim of this work is to extract the oil from an alga and to present the physical and chemical properties. The Performance, combustion, and emission characteristics of Esters of Algal oil are to be carefully investigated in a CI engine.

OIL EXTRACTION PROCESS

The Macro and Micro algae around 20 Kgs were collected from Central Marine Fisheries Research Institute, Chennai. The algae were shade dried for two days. The dried algae (5.5kg) powder was crushed in mortar and pestle with hexane and isoproponal solvent mixture (3/2 volume ratio). The extract was filtered and was allowed to stand in a separating funnel for a day; the top layer was taken and evaporated to remove the solvent. The resulting oil (1300 ml) was subjected to transesterification process. Transesterification of Algal Oil into Biodiesel.

Fig-1: Macro Algae

Fig 2: Micro Algae

TRANSESTERIFICATION OF ALGAL OIL INTO BIODIESEL

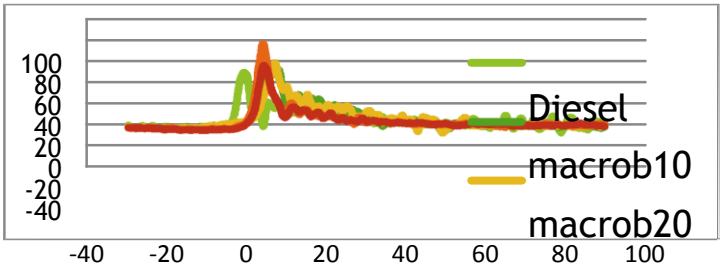
In this work sodium hydroxide is used as the catalyst, methanol is used as alcohol. The reaction is held between algal oil (the triglyceride), methanol and sodium hydroxide pellets at 65°C for 3hrs duration and the solution is stirred to ensure proper mixing. The reaction produces biodiesel and glycerol. The top layer is the required methyl esters and it is separated after filtering the glycerol, the methyl ester is then washed with water and the top layer is separated (850ml) and is then dried for property testing. The Properties of the biodiesel sample was tested by adapting ASTM testing protocols and are presented in Table 1.

Characteristics Test	Micro	Macro	Protocol
Density	0.792	0.795	ASTM D 1298
Viscosity @40°C	3.51cST	4.84	ASTM D 445
Calorific Value	40362KJ/Kg	33290KJ/Kg	ASTM D 240
Flash Point	92°C	132°C	ASTM D 93
Fire Point	124°C	142°C	ASTM D 93
Cetane Number	57	48	ASTM D 613
Sulphur Content	Nil	18	ASTM D 524
Carbon Residue	Nil	Nil	ASTM D 524
Pour Point	-18.3°C	-2°C	ASTM D 2500

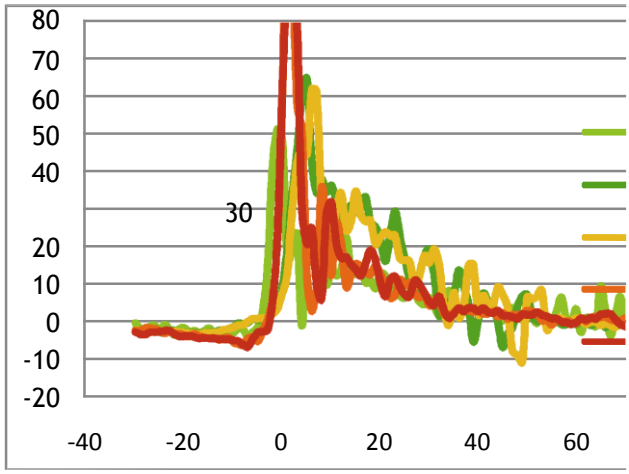
Table 1

Engine test

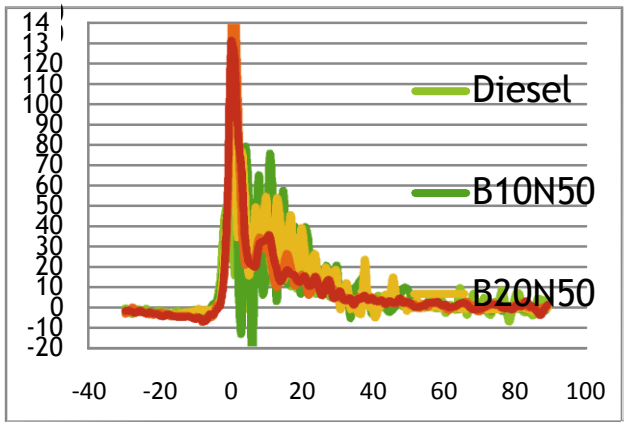
The test was conducted at constant speed, four stroke, vertical, and air cooled Diesel engine. Two blends of algae biodiesel B10 and B20 were tested and the performance, combustion and emission parameters were taken. The loading is by means of an eddy current dynamometer.



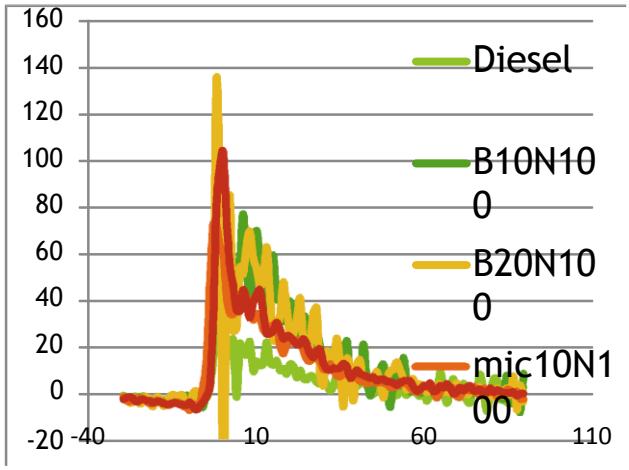
CA vs HR (0% Load)



CA vs HR (25% Load)



CA vs HR (50% Load)



CA vs HR (100% Load)

Conclusion

The performance and emission analysis of both the biodiesel fuel types shows that, they are better alternative to Diesel. Except NOX emission the other emission values are less compared to Diesel. Biodiesel blends consume more fuel and the volumetric efficiency values for them are slightly lesser than Diesel. The advancement in the injection timing brought better results than other two injection timings. From the results we can conclude that the Rice bran oil and algae oil biodiesel blends (B20) can be a used modifying the Engine.

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