REVIEW PAPER ON ALGAE OIL AND RICE BRAN OIL BIODIESEL AS AN ALTERNATIVE FUEL FOR DIESEL ENGINE

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ABSTRACT

It is always needed that to find an alternate of Diesel due to its price fluctuations and depletion rate. Biodiesel is the proven technology for a quite long time. As a most populated country, in India biodiesel from a non edible source is the preferred one. Rice bran and algae are found to be low cost biodiesel source from many reports. Rice bran is a by product and algae are considered to be non edible source. Rice bran oil methyl esters (RME) and micro algae oil methyl esters (MAME) were prepared using transesterification process. A test was carried out in a constant speed, single cylinder diesel engine with their blends viz., RME 10, RME 20, MAME 10, MAME 20 to test their performance and emission characteristics. The test was conducted at five sets of loads and three injection timings. The biodiesel blends recorded slightly high brake specific fuel consumption values and less brake thermal efficiency values than Diesel. The results shown reduced carbon emissions (UHC, CO and smoke) for the blends compared to pure diesel. According to the test results, micro algae oil biodiesel performed very close to pure diesel.

Keywords: *CI engine, injection timing, micro algae oil, rice bran oil, Performance, Exhaust emissions.*

INTRODUCTION

Price and finiteness of fossil fuels are the reasons behind the arrival of alternate fuels. Many researchers studied the use of plant oils as substitute for the conventional Diesel. Biodiesel is a proven substitute of Diesel in many countries, it was stated by F. Ma et al., and A. Demirbas et al., 2003; worldwide there are so many biodiesel sources available like soybean, Jatropha, palm, pongamia according to the climate and soil conditions, stated by C.E.Georing et al., 1983 and Fernando Neto Silva et al., 2003.But these biodiesel types reported their drawbacks of high making cost, large land area and also it greatly affects the food chain. So an economically good biodiesel source considering the above facts is the required one. Kandukalpatti Chinnaraj Velappan et al., 2007; reported that India produces more than 1 metric million tons of Rice bran oil every year. The feed stock for Rice bran crude oil is low cost compared to the conventional oils for biodiesel production. Micro algae are photosynthetic micro organisms can grow very rapidly consumes less nutrients and can live even in wastelands. Chisti., 2007; reported that compared to other plants it has high growth rate and requires less land areas.

Micro algae has no sulphur and produces less carbon emissions and particulate matter, stated by M.A.Delucchi., 2003; so many researchers reported that the fuel properties of algae oil biodiesel as a substitute for petroleum diesel are matches with the standards. By keeping the above facts a study was conducted to test these two fuels to examine their performance and emission characteristics in a CI engine.

MATERIALS AND METHODS

The Fresh water algae biomass was collected from an open pond at sathyabama Univeristy. The collected biomass were cleaned, and dried in open sun for 2-3 days. Then dried biomass was powdered and the powder was crushed with hexane and iso proponal solvent mixture for extracting lipid in it. The lipid is separated from the biomass and heated for removing the solvent. The required amount of Rice bran oil was obtained from a grocery store. These oils were subjected to Transesterification process.

Transesterification process requires an alcohol normally Methanol or Ethanol and a catalyst either sodium hydroxide or potassium hydroxide. The Chemicals used in this work were procured from Southern India suppliers, Chennai. This work used sodium hydroxide and methanol, the reaction is held between these two with the oil, at 65°C for 3 hours duration and the solution is agitated periodically during the reaction. The reaction results biodiesel and glycerol in two separate layers. The top layer is the required biodiesel and it was separated after filtering the glycerol by using separator. The obtained biodiesel is tested for its properties. The tested properties are listed in Table 1.

Experimental procedure

The test was conducted at a constant speed, four stroke, vertical, and air cooled Diesel engine. Two blends of the Rice bran and algae oil blends 10% of rice bran oil biodiesel and 90% of conventional diesel (RME10), 20% of rice bran biodiesel and 80% of conventional diesel (RME20), 10% of Algae biodiesel and 90% of conventional diesel (MAME10) and 20% of Algae biodiesel and 80% of conventional diesel (MAME20) were tested and the performance and emission parameters were taken. The loading is by means of an eddy current dynamometer. The test is conducted at three injection timings 20° BTDC (retard), 23° BTDC (normal) and 26° BTDC (advanced).

RESULT AND DISCUSSION

PERFORMANCE CHARACTERISTICS

Brake Thermal Efficiency (BTE)

Figure 1, 2 and 3 shows the variation of brake thermal efficiency of Rice bran and Micro algae biodiesel blends and diesel at various injection timings. Diesel recorded high brake thermal efficiency than other two blends on all loads because of its high heating value. Compared to RME blends, MAME blends show better and improved brake thermal efficiency. The kinematic viscosity of MAME is quite less than RME so, it improves the atomization, fuel vaporization and also combustion. Biodiesel have low volatility, slightly superior viscosity, and lower heating value it had shown lower brake thermal efficiency than conventional diesel. Brake thermal efficiency of the engine was increased if the injection timing is advanced for the biodiesel blends.

Brake Specific fuel consumption (BSFC)

Figure 4, 5 and 6 shows the variation of brake specific fuel consumption of Rice bran and Micro algae biodiesel blends and diesel at various injection timings. The BSFC values for all the fuel types increased with increase in load. When the load increases the engine efficiency and combustion quality increases. The biodiesel blends made the engine to consume more fuel than diesel because of their low heating value. MAME shows comparatively less BSFC values than RME. At advanced injection timing large amount of evaporated fuel accumulates in the combustion chamber during the ignition delay, burns quickly leads to rapid heat release rate thus exerts sudden increase in pressure and temperature.

EMISSION CHARACTERISTICS:

Unburnt hydrocarbon emission (UHC):

Figure 7, 8 and 9 shows the variation of UHC emissions of Rice bran and Micro algae biodiesel blends and diesel at various injection timings. Since the oxygen content is more for the blends they recorded less UHC values at all injection timings and Loads. MAME emitted less UHC than RME when the injection timing was advanced, emission values still reduced due to higher complete combustion.

Carbon monoxide emission (CO): Figure 10, 11 and 12 shows the variation of CO emissions of Rice bran and Micro algae biodiesel blends and diesel at various injection timings. Due to more oxygen content in the biodiesel blends combustion is improved hence the carbon monoxide emission was reduced. Complete combustion is ensured at advanced injection timing leads to reduced CO emissions for all the fuels.

Oxides of nitrogen (NOx): Figure 13, 14 and 15 shows the variation of NOx emissions. NOx emissions recorded were high for the blends due to their high oxygen content. Higher combustion temperature at advanced injection timing also increases these emissions.

Smoke emission (Smoke): The Figure 16, 17 and 18 shows the variation of smoke emissions. Because the biodiesel blends exhibited complete combustion the smoke emission is less. MAME recorded less smoke emissions than other fuel types, these emissions further reduced when the injection timing is advanced.

Table.1.Fuel Properties

Property	Diesel	MAME	RME
Viscosity(cst) at 40 ˚C	3.9	3.51	5.045
Cetane Number	49	57	46
Calorific Value (kJ/kg)	43200	40362	37082
Flash Point (˚C)	58	92	124
Fire Point(˚C)	64	124	147
Specific Gravity	0.804	0.792	0.8899
Sulfur content	-	-	Less than 20 ppm

Fig 1, BTE vs. BP at 20°BTDC

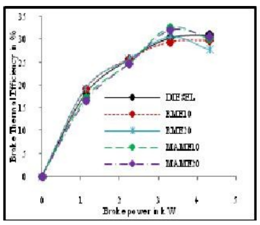


Fig 3, BTE vs. BP at 20°BTDC

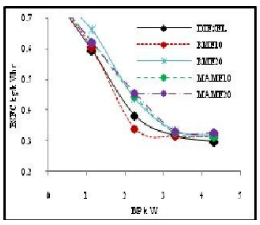


Fig 5, BSFC vs. BP at 23°BTDC

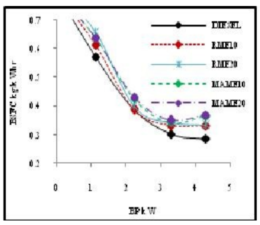


Fig 7, UHC vs. Load at 20°BTDC

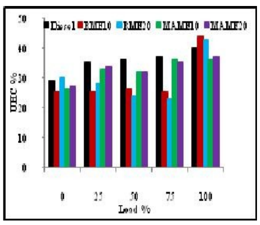


Fig 2, BTE vs. BP at 23°BTDC

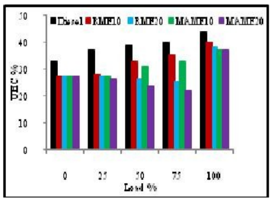


Fig 4, BSFC vs. BP at 20°BTDC

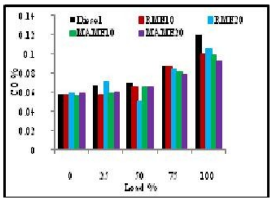


Fig 6, BSFC vs. BP at 26°BTDC

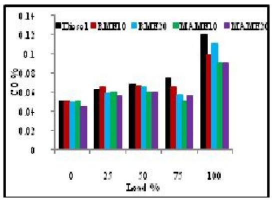


Fig 8, UHC vs. Load at 23°BTDC

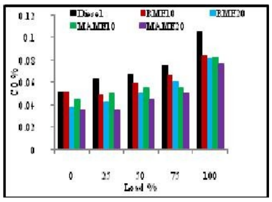


Fig 9, UHC vs. Load at 26°BTDC

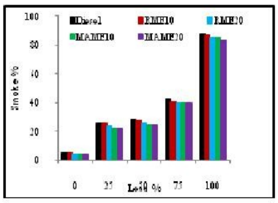


Fig 10, CO vs. Load at 20°BTDC

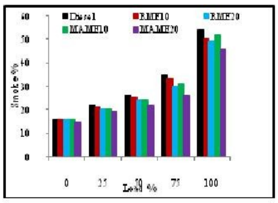


Fig 11, CO vs. Load at 23°BTDC

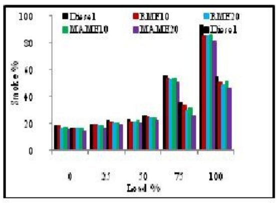


Fig 12, CO vs. Load at 26°BTDC

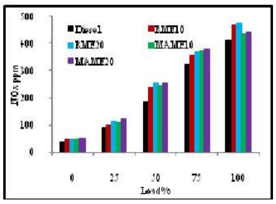


Fig 13, Smoke vs. Load at 20°BTDC

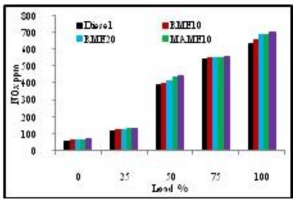
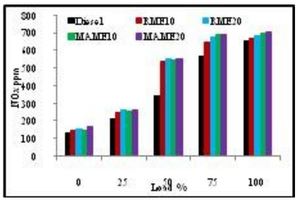


Fig 14, Smoke vs. Load at 23°BTDC



CONCLUSIONS

Based on the experimental results on the performance and emission characteristics of rice bran oil biodiesel and micro algae oil biodiesel blends in the test engine, the following conclusions were arrived: Both rice bran and micro algae oil biodiesel were prepared by transesterification process and the properties are match with the standards. Micro algae oil biodiesel blends recorded high brake thermal efficiency and less BSFC values than rice bran biodiesel blends. The carbon emissions and smoke emissions for both biodiesel blends were less compared to Diesel. The biodiesel blend's Oxides of nitrogen emission were high. Advancing the injection timing recorded better and improved performance and combustion of the test engine, hence both these type of fuels blends can be an environmental friendly as well economic alternate source of fuel.

REFERENCES

1. *Chisti Y, Biodiesel from microalgae, Biotechnology Advances, 5(3), 2007, 294–306.*
2. *Delucchi MA, A Lifecycle Emissions Model (LEM): lifecycle emissions from transportation fuels; motor vehicles, transportation modes, electricity use, heating and cooking fuels, Main report UCD-ITS-RR-03-17; 2003. Demirbas, A, Biodiesel fuels from vegetable oils via catalytic and non catalytic supercritical Alcohol Transesterification and methods:*

A survey, Energy convers Management, 44, 2003, 93-109.

3. *Fernando Neto da Silva, Antonio S P and Jorge R T, Technical feasibility assessment of oleic sunflower methyl ester utilization in diesel bus engine, Energy convers Management, 44, 2003, 2857-2878.*
4. *Georing C E, Schwab A, Doughherty M,Pryde M and Heakin A, Fuel properties of eleven vegetable oils, Trans ASAE, 85, 1982, 1472-1483.*
5. *Ilavarasi A, MubarakAli D, Parveez Ahamed A and Thajuddin N, Production of FAME from freshwater microalgae and profiling of fatty acids for biodiesel feedstock, Phykos, 42 (1), 2012, 10 – 14.*
6. *Kandu Kalpatti Chinnaraj Velappan, Less NOx biodiesel: CI engine studies fuelled with rice bran oil biodiesel and its five blends, Journal of scientific and Industrial Research, 66, 2001, 60-71.*
7. *Li Fen Wu, Pei Chung Chen, Ai Ping Huang, Chi Mei Lee, The feasibility of biodiesel production by microalgae using industrial wastewater, Bioresource Technology 113 (2012) 14–18.*
8. *Ma, F., Hanna, M.A, Biodiesel production: A review, Bio resource Tech., 990, pp.1-15*