

Experimental Study of Performance and Emission Characteristics by Adding Ethanol Additive in Ricebran Methyl Ester Oil in CI Engine

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ABSTRACT: A number of studies currently focus on the renewable fuels to reduce the petroleum fuels. Biofuels such as biodiesel and bioethanol have been studied and tested in many countries including India. One of the methods to reduce the use of fossil fuel is blending ethanol with fossil diesel. However, an emulsifier or a co-solvent is needed to homogenize the diesel-ethanol blends. This paper is aimed to investigate experimentally the performance and exhaust emission characteristics by adding additive as ethanol in methyl ester of rice bran oil in CI engine. The experimental results showed that the highest brake thermal efficiency was observed with 5% ethanol in diesel-biodiesel-ethanol blend was lower than that of diesel fuel. The hydrocarbons and smoke were lower than that of diesel fuel, the rice bran oil biodiesel can be used as an additive to mix higher percentage of ethanol in diesel-ethanol blends to improve the performance and reduce the emissions of a diesel engine

KEYWORDS: biodiesel, methanol, additive ricebran methyl ester

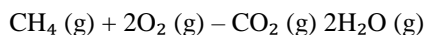
I. INTRODUCTION

Energy is very important for life quality and social development of people as well as economic growth. Industries are forced to looking for new products to meet new specifications. This can be achieved by new formulation of existing fuels. Fossil fuels have been an important conventional energy source for years. The climate changes occurring due to increased carbon Dioxide (CO₂) emissions and global warming, increasing air pollution and depletion of fossil fuels are the major problems in the present century. The present researchers have focused on the biofuels to reduce dependence on fossil fuels and to reduce air pollution. The biofuels can play an important role towards the transition to a lower carbon economy and also combine the benefits of low greenhouse emissions with the reduction of oil import.

II. BASIC CONCEPT

FUELS

Fuels are any materials that store potential energy in forms that can be practically released and used as heat energy. In a complete combustion reaction, a compound reacts with an oxidizing element, such as oxygen or fluorine, and the products are compounds of each element in the fuel with the oxidizing element. The combustion of methane as follows:



Liquid fuel, Solid fuel and gaseous fuel are the major types of fuel. Biodiesel comes under the liquid non-conventional fuel.

BLEND

Blends of biodiesel and conventional hydrocarbon based diesel are products most commonly distributed for use in the retail diesel fuel market place. Much of the world uses a system known as the 'B' factor to the state the amount of biodiesel in any fuel mix.

- 100% Biodiesel referred to as B100.
- 20% Biodiesel, 80% Petro diesel - B20 ROME
- 15% Biodiesel, 80% Petro diesel and Ethanol 5% – B20E5ROME
- 17% Biodiesel, 80% Petro diesel and Ethanol 3% – B20E3ROME

- 19% Biodiesel, 80% Petro diesel and Ethanol 1% – B20E1ROME

ADDITIVES DEFINITION

Something that is added as one substance to another to alter or improve the general quality or to counteract undesirable properties.

DIESEL FUEL ADDITIVE

It helps to maintain diesel engine performance by keeping fuel injectors clean and improving lubricity of diesel fuel. Additive can withstand the high temperature of the combustion chamber not only cleans the engines. But act as catalysts there by reducing consumption of diesel by 6 to 12% and harmful carbon and particles emissions substantially reduces around 50% in India.

The property of the biodiesel is an important parameter for determining the fuel property. The properties considered for biodiesel as follows.

REQUIREMENTS FOR BIODIESEL PREPARATION

1. VEGETABLE OIL RESOURCE

From the literature review we found the following vegetable oil used as a feed stock for biodiesel preparation. The rice bran oil taken as feed stock for the present work.

2. CHEMICAL COMPONENTS

Chemical components needed to perform transesterification process. The transesterification process discussed upcoming topics briefly. The chemical components used for our project as follows

a) METHANOL

Methanol (CH_3OH) is used in our project to replace glycerol ($\text{C}_3\text{H}_5(\text{OH})_3$) with the supporting of NaOH catalyst. Glycerol has three sites upon which fatty acids can be attached, while methanol has only one. About 150 ml of CH_3OH for making biodiesel from 750 ml of vegetable oil.

b) NaOH

Sodium hydroxide is a chemical component normally of used as catalyst for encouraging the reactions as possible lowest time. About 2.62 gms of NaOH for making biodiesel from 750 ml of vegetable oil.

EQUIPMENTS AND APPARATUS

The equipment's used to make biodiesel from vegetable oil by transesterification process. The equipment's for our work used as follows:

a) MAGNETIC STIRRER

Magnetic stirrer is an electrical device, used to rotate the chemicals while reaction carried out for better bonding by magnetic action. TheMagnetic stirrer used for our work capable of rotating at 1600 rpm and it heated the fuel up to 80°C . The rotary action made by magnetic pallet. The magnetic stirrer as shown in the following figure;



(a)



(b)

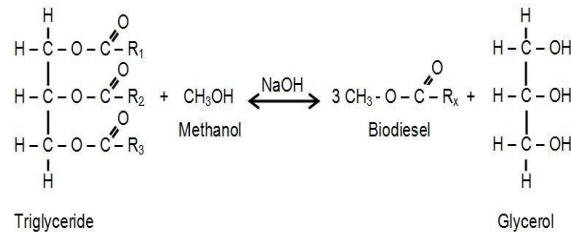
Fig1(a) Magnetic stirrer (b)Separation funnel

b) SEPARATION FUNNEL

Separating funnel is an equipment to separate biodiesel from the glycerine content after the transesterification process. After separation the biodiesel consumes top area and the glycerol consumes bottom area of the separation funnel. The figure 4.2 shows the separation funnel as follows

III. TRANSESTERIFICATION PROCESS

Transesterification is the chemical process which replaces one type of alcohol for another in an ester. An ester is made by combining an alcohol with an acid. The transesterification Process as follows in the chemical process:



Equation Transesterification process

From the chemical process found that vegetable oil is an ester of glycerol with long chain fatty acids. The formula for vegetable oil is $\text{C}_3\text{H}_5(\text{RCOOH})_3$, with the fatty acids represented by RCOOH attached to a glycerol ($\text{C}_3\text{H}_5(\text{OH})_3$) molecule. Methanol (CH_3OH) is used to replace glycerol ($\text{C}_3\text{H}_5(\text{OH})_3$).

The following parameters considered in the project as follows:

- Reaction temperature
- Ratio of alcohol to vegetable oil
- Amount of catalyst
- Mixing intensity (RPM)
- Raw oils used
- Catalyst

STEPS INVOLVE IN TRANSESTERIFICATION PROCESS**a) Preparation of requirements steps for making Bio diesel**

1. 750ml of new vegetable oil.
2. 2.62 grams of NaOH (also known as lye). NaOH is used for some drain cleaners, such as red devil drain cleaner.
3. 150ml of methanol.
4. Blender with a low speed option in the stirrer. The pitcher for the blender is to be used only for making biodiesel.
5. Digital scale measure (2.62 grams of NaOH).
6. Glass or plate containing that is marked for 750 ml.
7. Safety glasses, gloves and probably an apron, because getting NaOH or Methanol are toxic.

b) Preparing of Biodiesel general steps

1. To prepare the biodiesel in a room temperature (or) warmer room. Since, the chemical reaction will not proceed to completion. If the temperature is too low.
2. 150 ml Methanol poured into a glass blender pitcher.
3. The blender on its lowest setting and slowly add 2.62 grams of NaOH. This reaction produces NaOH, which must be used right away or else it loses its effectiveness. (Like NaOH it can be stored away from air or moisture but, that might not be practical for a home setup).
4. The methanol and NaOH mixed until the NaOH has completely resolved (about 2 minutes). Then, 750 ml vegetable oil added to its mixture.
5. Continued blending this mixture (on low speed) for 80 to 90 minutes for getting better biodiesel.
6. The mixture poured into the wide mouth jar, the liquid start to separate into the layer. The bottom layer will be glycerine. The top layer is the Biodiesel.
7. Allowed at least a couple of hour for the mixture to fully separate, the top layer as biodiesel fuel and glycerine at bottom layer obtained.

The same process carried out for both vegetable oils,
The figures show the transesterification processes as shown below;

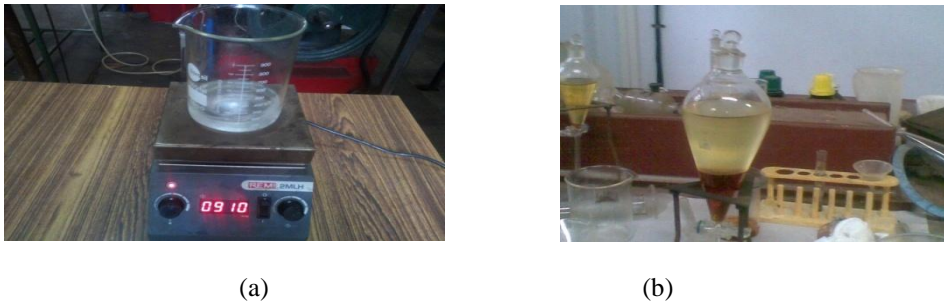


Fig2 (a)Reaction of NaOH with Methanol, (b)Separation layer formation

BIODIESEL SEPARATION

The separation of biodiesel separation and filtration ant technologies plays an important role in the production of biodiesel. In order to produce a final product that meets specifications, excess water contaminants must be efficiently removed throughout the entire production process, and absolute-rated liquid particulate filters, liquid/liquid coalesces, depth filter modules, filter presses, and centrifugal discharge filter systems can help producers by:

- Providing efficient separation of H₂O from Biodiesel after H₂O washing.
- Reducing neutralization chemicals and wash water volumes.
- Decreasing settling times and spaces – debottlenecking.
- Enhancing distillation steps by reducing inputs -
- Debottlenecking.
- Increasing Biodiesel and glycerine product yields and purity.
- Enabling high-purity, particle – free glycerine.
- Delivering high –quality, particle – free glycerine.

TABLE 1: Overall properties of the biodiesel

TYPE OF OILS	FLASH POINT (°C)	FIRE POINT (°C)	DENSITY Kg/m ³	CALORIFIC VALUE KJ/Kg-K	VISCOSIY N/sec	SPECIFIC GRAVITY
(B0)DIESE L	72	77	0.832	44000	0.89	0.824
B20	188	192	0.132	41900	0.97	0.841
B20E1	74	79	0.830	41550	3.4348	0.837
B20E3	73	80	0.829	41120	3.3893	0.834
B20E5	71	81	0.812	40840	3.2768	0.831

IV. EXPERIMENTS

The performance study has been carried out for different blends of biodiesels of rice brain oil with diesel oil. The emission level is also measured. The maximum load for CI engine is 19.28kg.

In the first experiment the emission characteristics are presented in Table 5.1 for 100% diesel. The net load, water temperature, exhaust gas temperature and time taken for 10cc fuel have been recorded.

Table 5.1 EXPERIMENTAL MEASUREMENT FOR B0

S.NO	NET LOAD (kg)	TIME for 10cc of fuel (sec)	Exhaust temperature (°C)	gas	Inlet temperature (°C)	water	Outlet water temperature (°C)
1	0	73	161		30		54
2	4	51	213		30		63



3	7	43	246	30	66
4	10	37	278	30	71
5	15	27	378	31	78

Table 5.2 presents the emission characteristics for 20% rice bran oil and 80% diesel (B20). The net load, cooling water temperature, exhaust gas temperatures and time taken for 10cc fuel have been recorded.

Table 5.3 EXPERIMENTAL MEASUREMENTS FOR B20E5 ROME

S.NO	NET LOAD (kg)	TIME for 10cc of fuel (sec)	Exhaust gas temperature (°C)	Inlet water temperature (°C)	Outlet water temperature (°C)
1	0	66	145	30	44
2	4	50	195	30	56
3	7	42	243	30	68
4	10	35	271	30	81
5	15	26	353	31	92

V. EMISSION OBSERVATIONS

The emission test carried out by crypton gas analyser. The following experimental table shows the emission observations.

In the first experiment the emission characteristics are presented in Table 5.4 for 100% Diesel (B0). The carbon di oxide, carbon monoxide, oxygen, hydrocarbons and nitrous oxide have been recorded.

TABLE 5.4 EXPERIMENTAL MEASUREMENTS FOR B0

S.NO	LOAD (kg)	CO (%vol)	HC (ppm by vol)	CO ₂ (%vol)	NO _x (ppm by vol)
1	0	0.03	41	1.22	53
2	4	0.02	47	1.38	84
3	7	0.03	60	1.96	101
4	10	0.04	67	2.53	282
5	15	0.04	73	2.80	310

Table 5.5 presents the emission characteristics for 20% Rice bran oil and 80% Diesel (B20). The carbon di oxide, carbon monoxide, oxygen, hydrocarbons and nitrous oxide have been recorded.

TABLE 5.5 EXPERIMENTAL MEASUREMENTS FOR B20 ROME

S.NO	LOAD (kg)	CO (%vol)	HC (ppm by vol)	CO ₂ (%vol)	NO _x (ppm by vol)
1	0	0.02	22	0.91	36
2	4	0.02	34	1.45	86
3	7	0.03	47	1.99	190
4	10	0.02	50	2.41	248
5	15	0.04	62	4.62	617

Table 5.6 presents the emission characteristics for 20% Rice bran oil with 5% ethanol as additive and 80% Diesel (B20). The carbon di oxide, carbon monoxide, oxygen, hydrocarbons and nitrous oxide have been recorded.



TABLE 5.6: EXPERIMENTAL MEASUREMENTS FOR B20E5 ROME

S.NO	LOAD (kg)	CO (%vol)	HC (ppm by vol)	CO ₂ (%vol)	NO _x (ppm by vol)
1	0	0.03	37	1.00	32
2	4	0.02	44	2.05	115
3	7	0.03	58	2.20	160
4	10	0.02	66	2.37	276
5	15	0.04	75	3.11	396

VI. RESULTAND DISCUSSION

The specific fuel consumption, thermal efficiency, emission levels have been calculated for all the studies carried out .

6.1 RESULTS OF PERFORMANCE STUDY

Table 6.1 represents the results of calculation for specific fuel consumption, thermal efficiency etc. for 100% diesel (B0)

Table 6.1 Results of performance study on 100% diesel

S.NO	TFC (kg/hr)	BP (kw)	SFC (Kg/kw-hr)	FUEL POWER (kw)	IP (kw)	η _m (%)	η _{BTh} (%)	η _{I.Th} (%)
1	0.406	0		4.96	2.5	0	0	50.38
2	0.5816	1.088	0.539	7.10	3.578	30.12	15.16	50.33
3	0.689	1.887	0.365	8.42	4.387	43.01	22.40	52.09
4	0.801	2.696	0.297	9.79	5.196	51.88	27.53	53.07
5	1.098	4.044	0.271	13.42	6.544	61.79	30.13	48.76

Table 6.2 represents the results of calculation for specific fuel consumption, thermal efficiency etc. for 20% rice bran oil and 80% diesel (B20)

Table 6.2 Results of performance study on 20% rice bran oil and 80% diesel (B20)

S.NO	TFC (kg/hr)	BP (kw)	SFC (Kg/kw-hr)	FUEL POWER (kw)	IP (kw)	η _m (%)	η _{BTh} (%)	η _{I.Th} (%)
1	0.426	0		4.958	2	0	0	40.33
2	0.617	1.088	0.572	7.181	3.078	35.02	15.01	42.86
3	0.738	1.887	0.391	8.589	3.887	48.54	21.96	45.25
4	0.865	2.696	0.320	10.067	4.696	57.41	26.77	46.64
5	1.164	4.044	0.287	13.54	6.044	66.40	29.85	44.61

Table 6.3 Results of performance study on 20% rice bran oil with 5% ethanol as additive and 80% diesel (B20E5)

S.NO	TFC (kg/hr)	BP (kw)	SFC (Kg/kw-hr)	FUEL POWER (kw)	IP (kw)	η _m (%)	η _{BTh} (%)	η _{I.Th} (%)
1	0.453	0		5.39	2.4	0	0	46.68
2	0.598	1.088	0.555	7.12	3.478	30.99	15.88	51.24
3	0.712	1.887	0.377	8.48	4.287	41.01	23.35	53.06
4	0.854	2.696	0.317	10.18	5.096	52.90	27.80	52.55
5	1.150	4.044	0.284	13.69	6.44	62.75	30.99	49.39

**BRAKE THERMAL EFFICIENCY (η_{B.Th.} (%))
B0 VS B20 (RICE BRAN), B20E5**

VII. CONCLUSION

The energy sources such as these could partially replace the use of those fuels which are responsible for environmental pollution and may be scarce in the future.

The following conclusions have been drawn from this study;

- B20E3 proportion slightly increases in Brake thermal efficiency compared to the diesel.
- B20E3 and B20E5 increases in Indicated thermal efficiency compared to the diesel.
- The HC emission decreases in B20 compared to the diesel.
- The overall emission reduces for biodiesel of all range of blends.

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