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Performance Evaluation of 4 Stroke Single Cylinder VCR Diesel Engine Using Cotton Seed oil Methyl Ester Blends

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Abstract:
Biodiesel is known as the mono-alkyl-esters of long chain fatty acids derived from renewable feedstock, such as, vegetable oils or animal fats, for use in compression ignition engines. Different parameters for the optimization of biodiesel production were investigated in the first phase of this study, while in the next phase of the study performance test of a diesel engine with neat diesel fuel and biodiesel mixtures were carried out. Biodiesel was made by the well-known transesterification process. In this present work Cottonseed oil (CSO) was selected for biodiesel production. Cottonseed is non-edible oil, thus food versus fuel conflict will not arise if this is used for biodiesel production mustard oil was used as biodiesel,and physicochemical properties were investigated the blends of biodiesel and diesel used were B10, B20, and B30. Comparable engine performance characteristics were found for B10, B20, and B30 respectively for cotton seed oil blends.
Cotton seed methyl ester blend 30 (B-30) gives surpass results when compare to the diesel.

Keywords*: transesterification process, methyl esters, Blends, cotton seed, efficiencies.*

1. Introduction

Due to ever increasing demand for fossil fuels, several researchers studied the effect of different renewable alternative sources of energy on Engines. Besides use of fossil fuel triggers a huge amount of greenhouse gas and noise hence polluting the environment. This twin crisis of fossil fuel depletion and environmental degradation has motivated to studied the effect of different renewable alternative sources of energy on Engines. Biodiesel is one among them. Biodiesel are of two types: one derived from edible oil and other from non-edible oil source. Due to demand of edible oil for domestic purpose, non-edible oil is Preferred for Biodiesel production. The viscosity is reduced by removing the glycerol in the oil by the process of trans esterification. The Trans-esterification is the process of chemically reacting triglycerides with methanol in presence of Potassium hydroxide as a catalyst.

1.1. Cottonseed Oil Quality, Utilization and Processing

Cotton is one of the most important commercial crops of India and is the single largest Natural source of fibre

Figure 1: Cotton plant

Figure 2: Cotton seeds

1.2. Environmental Benefits

In 2000, biodiesel became the only alternate fuel in the country to have successfully completed the IPA- required Tier I and Tier II health effects testing under the clean air act. These independent tests conclusively demonstrated biodiesel does not pose threat to human health.

1.3. Biodegradability and Toxicity

Biodiesel is nontoxic and biodegradable. Tests sponsored by the United States Department of Agriculture confirm that biodiesel is ten times less toxic than table salt and biodegrades as fast as dextrose (a test sugar).

1.4. Greenhouse Effect

The ability of atmosphere to capture and recycle energy emitted by the earth surface is the defining characteristics of the greenhouse effect. The greenhouse effect is the rise in temperature that earth experiences because certain gases in the atmosphere (carbon dioxide, nitrous oxides, water vapour and methane) trap energy from the sun. Without these gases, head would escape back into the space and earth's average temperature would be about 15 C colder. Because of how they worm our world, these gases are referred to as greenhouse gases.

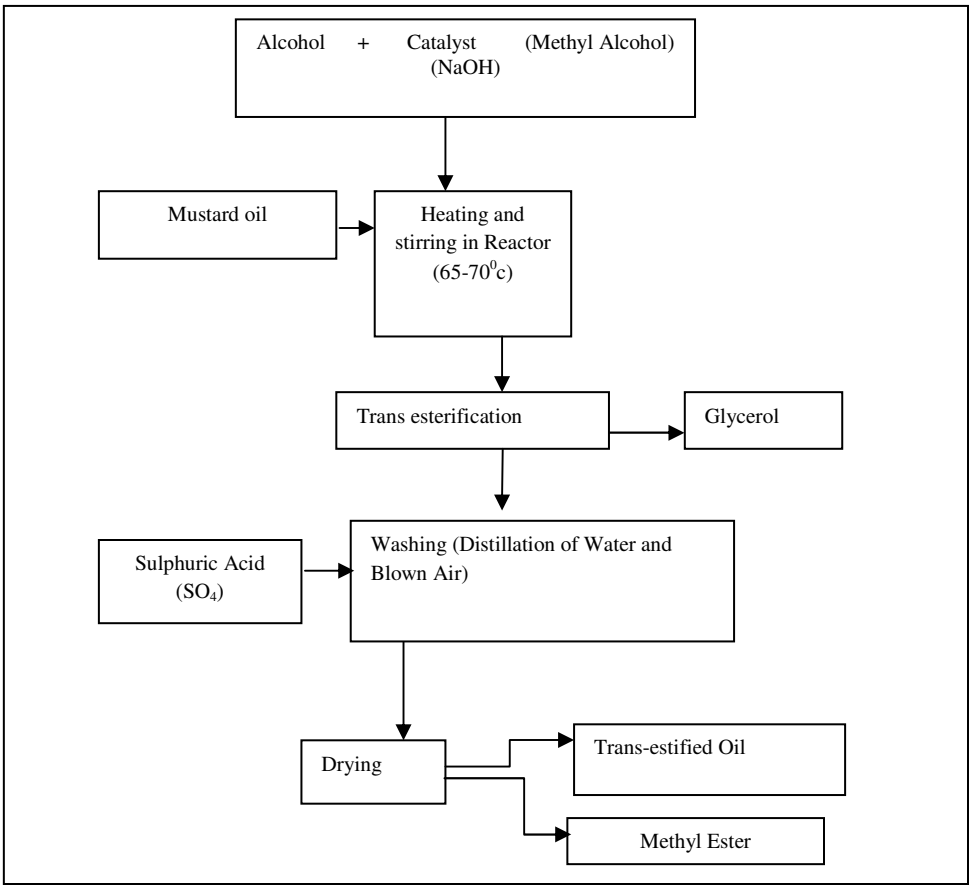

Figure 3: Trans-esterification process

1.5. Trans-esterification

Trans-esterification is the chemical reaction that involves triglycerides and alcohol in the presence of a catalyst to form esters and glycerol. This trans-esterification involving three consecutive reversible reactions, they are the conversion of triglycerides to diglycerides, followed by the conversion of diglycerides to monoglycerides. Glycerides are then converted into glycerol, giving one ester in each step.

The overall trans-esterification reaction is given by three consecutive and reversible equations as shown below:

- Triglyceride (TG) + ROH ↔ Diglyceride (DG) + RCOOR1
- Diglyceride (DG) + ROH ↔ Monoglyceride (MG) + RCOOR2
- Monoglyceride (MG) + ROH ↔ Glycerol + RCOOR

The products of the reaction are the biodiesel itself and glycerol. The Flow chart of trans-esterification process of Mustard oil is shown in Fig. 3

2. Experimental Setup and Procedure

Using Mustard and cotton seed oils tests are to be conducting on different equipment's, to be found some of the fuel properties. Later performance tests were conducted on 4- stroke single cylinder VCR water cooled diesel engine.

Figure 4: Four Stroke single cylinder VCR diesel engine

2.1. Engine Specifications

Orifice meter diameter(m)	0.02
Dynamometer arm length(m)	0.185
Coefficient of discharge for orifice, C_d	0.6
Ambient temperature (Deg C)	27
Fuel density (kg/m3)	815
Fuel Calorific value (KJ/kg)	44100
Cylinder diameter (m), D	0.0875
Stroke (m), L	0.11
No of cylinders	1
No of rev/cycle	2
Specific heat of exhaust (KJ/kg0K)	1.542

Table 1: Engine Specification

2.2. Determination of Flash and Fire Point

Apparatus required:

- Pens key-Marten's closed cup flash and fire point set up

Flash and fire point are obtained by using pen sky test. The apparatus consists of a brass cup and cover fitted with shutter mechanism without shutter mechanism (open cup), test flame arrangement, hand stirrer (closed cup), thermometer socket, etc., heated with energy regulator, a thermometer socket made of copper.

Figure 5: Penskey martin flashpoint apparatus

2.3. Density

The volumetric mass density, of a substance is its mass per unit volume. The symbol most often used for density is 'ρ'. Mathematically,

$$\rho = m/v$$

Figure 6: Density measurement

2.4. Viscosity

The resistance to flow, exhibited by fuel blends, is expressed in various units of viscosity.

Viscosity is measured by using Redwood viscometer. By using stop watch Take time for collecting every 20 ml quantity of fuel at different temperature intervals. The process is same for water. Then we get viscosity in centistokes.

Figure 7: Redwood Viscometer

2.5. Fuel Properties of Cotton Seed Oil Methyl Esterand Diesel Fuel

Properties	Cotton seed	Diesel
Viscosity(cSt) 30 0C Redwood viscometer 40 0C (80 ml) 50 0C	9.1 4.2 1.6	4.2
Flash point (^{0}C)	120	55
Fire point (^{0}C)	140	60
Density (Kg/m3)	933.2	815.1

Table 2: Fuel properties

2.6. Calorific Value

The calorific value of a fuel is the thermal energy released per unit quantity of fuel when the fuel is burned completely and the products of combustion are cooled back to the initial temperature of the combustible mixture. It measures the energy content in a fuel.

OIL	B10	B20	B30
Blends of Cotton seed oil with Diesel	43700	43300	42900

Table 3: Calorific values of blends

3. Results & Discussion

3.1. Experimental Observations for Diesel

Experiments were conducted on the specified diesel engine at constant speed using diesel and note down the observation at zero load, voltmeter reading, and ammeter reading speed, time taken for 10cc of fuel consumption and the manometer readings and tabulated in the form of tables. By varying loads steps 0, 4, 8, 12, 16 are note down all the readings in diesel engine. Take all the readings at constant speed of the engine 1500 rpm. While doing experiments fill the fuel into the tank mounted on panel frame, on engine check the lubricating oil in the engine sump with help of dip stick and set optimum flow rate of water in Rota meter**.**

3.2. Experimental Observations for Diesel (D100)

S. No	Load kg	m_f kg/s	BP	FP kW	ηmech %	ηbt %	ηit %
1	0	0.00013	0	2.17	0	0	37.56
2	4	0.00020	1.1745	2.17	35.11	13.31	37.91
3	8	0.00027	2.3262	2.17	51.73	19.53	37.76
4	12	0.00035	3.4551	2.17	61.42	22.38	36.44
5	16	0.00045	4.546	2.17	67.68	22.90	33.84

Table 4: Diesel (D100)

3.3. Experimental Observations Forcotton Seed Oil Methylester Blends

S. No	Load kg	m_f kg/s	BP kW	FP kW	ηmech %	ηbt %	ηit %
1	0	0.00013	0	1.95	0	0	32.57
2	4	0.00020	1.1737	1.95	37.57	13.03	34.69
3	8	0.00027	2.3246	1.95	54.38	19.34	35.56
4	12	0.00034	3.4505	1.95	63.89	23.02	36.02
5	16	0.00043	4.5490	1.95	69.99	23.93	34.18

Table 5: Cotton seed oil Methyl Ester Blend B10

S. No	Load kg	m_f kg/s	BP kW	FP kW	ηmech %	ηbt %	ηit %
1	0	0.00013	0	2.03	0	0	35.78
2	4	0.00019	1.1752	2.03	36.66	13.63	37.19
3	8	0.00026	2.3292	2.03	53.43	20.29	37.99
4	12	0.00033	3.4482	2.03	62.94	24.05	38.22
5	16	0.00042	4.5551	2.03	69.17	24.63	35.61

Table 6: Cotton seed oil Methyl Ester Blend B20

S. No	Load kg	m_f kg/s	BP kW	FP kW	ηmech %	ηbt %	ηit %
1	0	0.00012	0	2.01	0	0	38.72
2	4	0.00018	1.1767	2.01	36.92	14.51	39.30
3	8	0.00025	2.3338	2.01	53.72	21.76	40.50
4	12	0.00032	3.4665	2.01	63.29	24.71	39.03
5	16	0.00042	4.5490	2.01	69.35	24.94	35.97

Table 7: Cotton seed oil Methyl Ester Blend B30

From the above results we recommended the Cotton seed oil methyl ester blend 30. Because it gives the surpass performance compare to the other blends.

Draw the graphs between cotton seed oil methyl ester and pure diesel with different performance parameters like Brake power, Mechanical efficiencies, B_{the}, $I_{the\ etc....}$

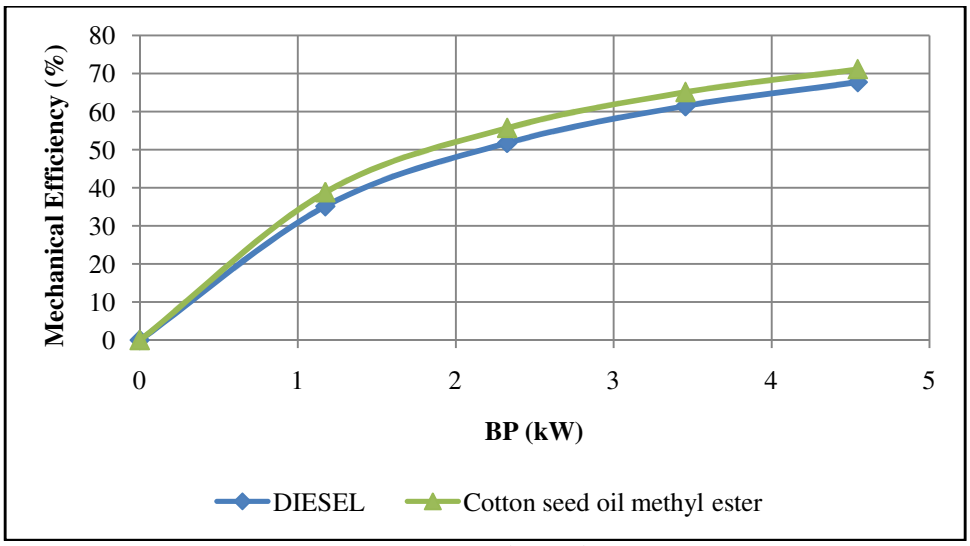

Figure 8: BP Vs Mechanical efficiency

The above Figure shows the B-30 gives the better results when compare to the pure diesel.

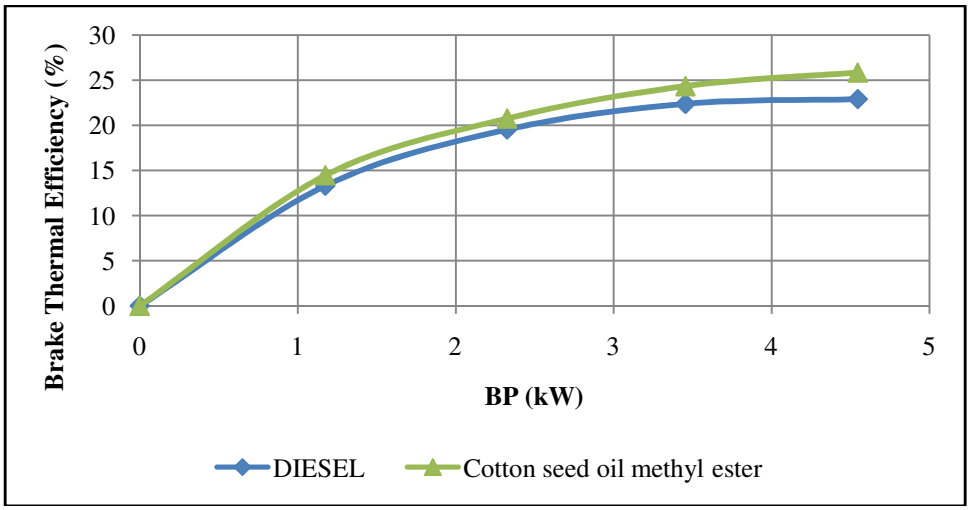

Figure 9: BP Vs Brake thermal efficiency

Brake thermal efficiency is more for the cotton seed oil methyl ester compare with the diesel.

4. Conclusion

Cotton seed oil methyl ester was produced by means of trans-esterification process using cottonseed oil.
Cotton seed oil methyl ester B-30 gives awesome Mechanical Efficiency (69.35) compare with the Diesel (67.68).
Cotton seed oil methyl ester B-30 gives admirable brake thermal efficiency (24.94%) results when compare to the diesel (22.90%).
Cotton seed oil methyl ester B-30 gives acceptable Indicated thermal efficiency (33.84%) results when compare to the diesel (35.97%).
Cotton seed oil methyl ester is a promising and relatively new feedstock for biodiesel production.
Cotton seed methyl ester blend 30 (B-30) gives surpass results when compare to the diesel so we can believe that the B-30 as acceptable alternate fuel for diesel.

5. Scope of Future Work

Further research can be carried out to analyze particulate matter, smoke and other emission of Mustard oil blends.

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