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EXPERIMENTAL INVESTIGATION OF ISOBUTANOL IN COTTON SEED OIL METHYL ESTER FOR CI ENGINE

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ABSTRACT

Global warming and other environmental problems forced the humans to think about new fuels having least impact on the environment. The alternative fuels are the solutions for the future scarcity of the fossil fuels as well as a solution to the pollution due to automobiles. The biodiesels produced from various vegetable oils are used now a day's as alternative fuel for IC Engine. In this paper the biodiesel produced from transeseterification process of cottonseed oil is explained. The experiment was carried out for various blends B10, B20 and B30 with and without the additive. Isobutanol is used as the additives. The performance of IC Engine reveals that the efficiency is improved for blends with additive and Emission is also reduced for blends with additive.

Keywords: Cottonseed oil, Isobutanol, Transesterification, Blends.

INTRODUCTION

Wheels are one of the inventions that changed the life style of the humans which changed a lot in the transportation style of humans [1]. Actually the reason for very fast human life is mainly due to the transportation systems. The fuels are the blood of every prime mover. Fossil fuels are the main fuels that are used till date because of its easiness in using and performance. The emissions of CO, CO_2, and NOx from these fossil fuels are very high, which forced the human think about an alternative fuel [2]. Biodiesels are said to be the next generation fuels since the fossil fuels are finite source of fuels. The biodiesel is categorized into first and second generation biodiesel. The first generation biodiesels are those derived from the edible vegetable oils and animal fats[3]. Second generation biodiesels are derived from the waste materials. This paper deals with the biodiesel generation from the First generation method using cotton seed oil as the main raw material. The biodiesel is produced from cotton seed oil

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Properties	Units
Kinematic Viscosity @40°C	37.7 cst/s
Kinematic Viscosity @ 100^0 c	4.9 cst/s
Density	913kg/m^3
Specific heat and specific gravity	0.919kg/m^3
Calorific value	3581.06kJ/kg
Saponification number	190
Flash point	197^0 C
Cloud point	1.4^0 C
Fire point	220^0 C
Cetene number	37
Acid value	9.50mg/g
Iodine value	93.07mg/g
Molecular weight	19.97g/mol

using the transeseterification reaction. From all Biodiesel production methods transeseterification is the best and most used method. The alcohol used for Transeseterification is Methanol as it is the cheapest alcohol available. KOH is used as the catalyst. The production of biodiesel is done in laboratory scale.

OBJECTIVES

- **i.** Producing biodiesel using transeseterification reaction.
- **ii.** Preparing Blends B10, B20 and B30.
- **iii.** Mixing additives with blends and testing the biodiesel with additive and without additive separately for Performance and Emission analysis

Table-1

Cottonseed oil properties

PRODUCTION METHOD

Transeseterification is the method used to produce biodiesel in this paper. The reaction procedure is given as follows.

Initially 500 ml of the cottonseed oil is heated in a beaker to 100°C for removing water particles from the oil. Then the oil is allowed to cool down to 50°C.Then mix 150 ml of methanol with 5 g of KOH. The mixed solution of KOH and methanol is then added to the preheated cottonseed oil and maintained at a temperature of 50°C. Then the magnetic rotor is allowed to run in order to stir the solution at an rpm greater than 1300 rpm. After 2 hours a separation can be noted on the solution. The top layer of the solution is the Ester and the bottom layer is the Glycerol. The glycerol is separated from the solution with the help of a separator funnel. The remaining solution is then preheated to remove the water particles. The produced ester is then blended with the diesel for producing B10, B20 and B30.Then the different engine and emission test were done.

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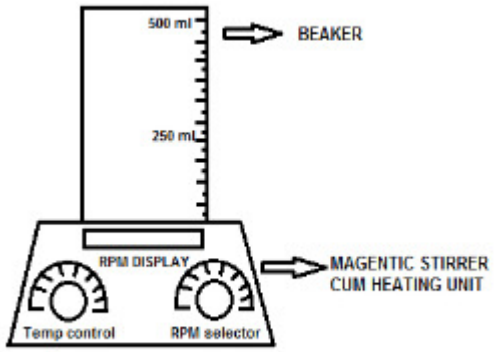

Figure-1 Gyratory apparatus

Table-2:

Cottonseed oil Methyl Ester Properties

Parameters	Values
Kinematic Viscosity @40^{0}c	35.96 cst/ s
Kinematic Viscosity @ 100^0 c	4.9 cst/s
Density	0.85kg/m^3
Specific heat and specific gravity	0.813g/cc
Calorific Value	9187.39 kcal/kg
Flash point	164^O C
Cloud point	-9 ^{0}C
Fire point	172 ^{0}C
Cetene Number	43
Acid value	32 mg KOH/g
Iodine value	80.32 mg/g
Molecular weight	28.70 g/mol

Preparation of bio diesel

The different blends of the biodiesel are made by mixing ester with diesel. The blends B10, B20 and B30 consisting 10%, 20% and 30% of ester respectively and the remaining percentage will be diesel. The Isobutanol is added with each blend at 10% in volume of each blend. The blends without adding Isobutanol and adding Isobutanol are kept separately for doing engine performance testing. The table-3 showing the properties of Isobutanol.

Table-3 Properties of Isobutanol

Property	Range
Flash point,^{o}C	37.7 ^{o}C
Specific Gravity 20/20 ^{o}C	0.8030 kg/m2
Viscosity at 20 ^{o}C	3.95
Auto ignition temperature ^{o}C	440 ^{o}C
Surface tension at 20 ^{o}C	22.94
Heat of combustion kj/kg	36162

EXPERIMENTAL SETUP

The engine tests were conducted below 1500 rpm. Initially the engine is allowed to achieve the steady speed. Then the blends with additive and without additive are tested separately on the engine to get the performance and emission values. The engine loads were adjusted using eddy current dynamometer. All performance and combustion characteristics reading were recorded online and the exhaust gas emissions were analyzed on Kane Flue Gas analyzer.

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Figure-2 Engine setup for performance and emission tests.

The engine parameters of the engine from which the performance test carried out is given in table 4.

Table-4: Engine parameters

Make	Kirloskar
Type	1 Cylinder 4 Stroke
Power	5.2 KW
RPM	1500
Bore	80 mm
Stroke length	110 mm
Method of Starting	Hand Starting
Cooling System	Water cooled
Compression ratio	17.5
Rotation	Clockwise/anticlockwise
Fuel Filter	Present

RESULTS AND DISCUSSION

The Brake thermal efficiency, Specific fuel consumption and Mechanical efficiency of each blend are tested on the engine. The values are tabulated and compared for the blends with additive and without additive. The emission tests were also conducted to identify the emission characteristics of blends with additive and without additive.

Preparation of blends:

The blends are prepared by adding Iso-butanol with each additive in 10% of volume to each blend. The blends are tested separately and compared the performance and emission of each blends.

1. Brake Thermal Efficiency

The Brake thermal efficiency of the blends B10, B20 and B30 are tested separately. Each blend is separated as with additive and without additive groups.

Table-5: Brake Thermal Efficiency of B10

Load	Brake Thermal Efficiency	
	B10	**B10 (A)**
0	13.6	14.6
4	17.76	18.6
8	27.11	28.1
12	33.29	34.3
15	37.14	38.2

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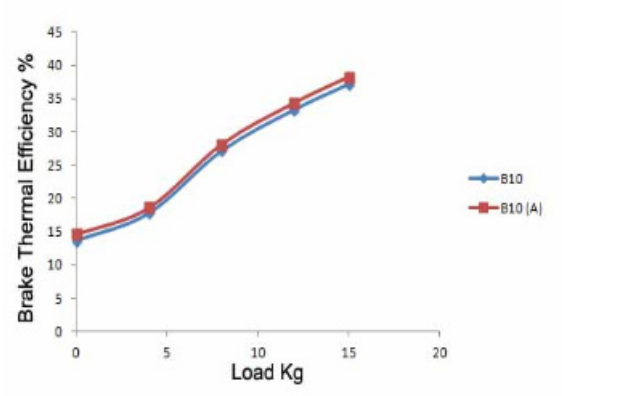

Figure-3 B10 –Brake Thermal Efficiency

The brake thermal efficiency is found increased in the same blend with added Iso-butanol as additive as show in fig 3

Table-6 Brake Thermal Efficiency of B20

Load	Brake Thermal Efficiency	
	B20	B20 (A)
0	13.4	12.6
4	17.2	19.5
8	27.01	28.3
12	33.1	33.3
15	37.37	36.9

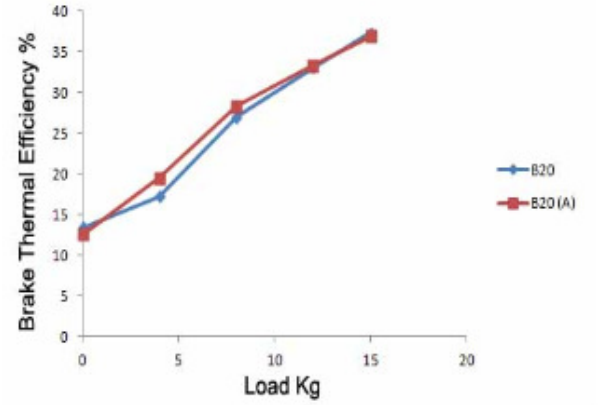

Figure-4 Brake Thermal Efficiency of B20

The Brake Thermal Efficiency of the blend B20 with added additive is found to be higher than that of the blend without additive. Anyway due to some unknown reasons on some points this scenario is changing.

Table-7 Brake Thermal Efficiency of B30

Load	Brake Thermal Efficiency	
	B30	B30 (A)
0	12.9	14.4
4	16.48	18.5
8	24.87	28.9
12	32.52	34.1
15	33.53	38.37

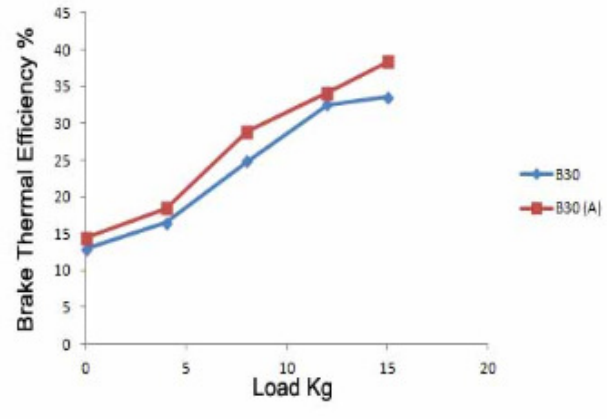

Figure-5 Brake Thermal Efficiency of B30

The Brake thermal efficiency of the blend B30 with added additives showing higher percentage of increase in efficiency than that of the blends without added additive. The conclusions from the results of the Brake Thermal Efficiency are that by adding the Iso-butanol along with the prepared biodiesel, the Brake Thermal Efficiency of the Engine can be increased.

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2. Specific Fuel Consumption

The specific fuel consumption of the fuel was also tested using the engine test rig. The blends B10, B20 and B30 were tested separately to find out the specific fuel consumption.

Table-8 Specific Fuel Consumption of B10

Load	Brake Thermal Efficiency	
	B10	B10 (A)
0	8.5	9.5
4	11.5	12.5
8	15	16
12	18	19
15	20	22

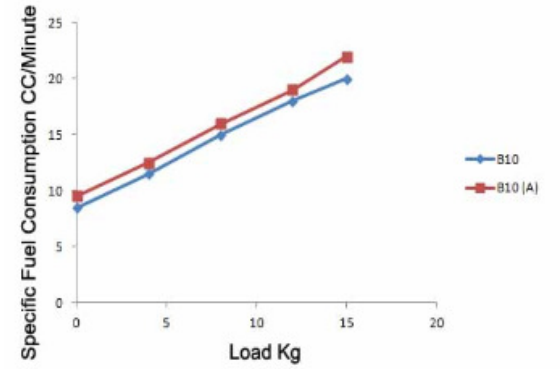

Figure-5: Specific Fuel Consumption of B10

The Specific Fuel Consumption of the B10 is increased while added the Iso-butanol as an additive about 5 % to 8 %.

Table-9 Specific Fuel Consumption of B20

Load	Brake Thermal Efficiency	
	B20	B20 (A)
0	9	11
4	12	12
8	15	15.5
12	18	19.5
15	20	23

The Specific fuel consumption of B20 also increased with added Iso-butanol as an additive.

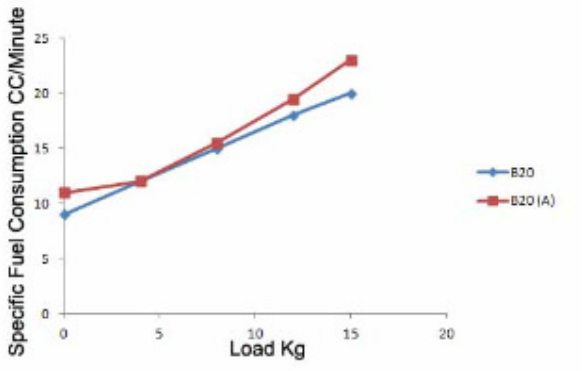

Figure-6: Specific Fuel Consumption of B20

Table-10 Specific Fuel Consumption of B30

Load	Brake Thermal Efficiency	
	B30	B30 (A)
0	8.5	10
4	12	13
8	15	16
12	18.5	19
15	21	22

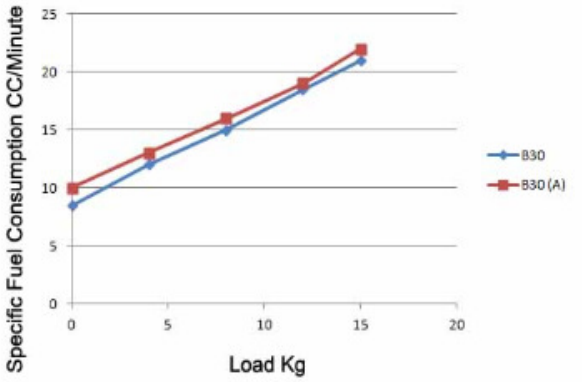

Figure-7: Specific Fuel Consumption of B30

The Specific Fuel Consumption of the B30 also increased by added Iso-butanol.

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3. Mechanical Efficiency

The each blend is tested to find out the mechanical efficiency by adding the additive and without adding the additive

Table-10: Mechanical Efficiency of B10

Load	Brake Thermal Efficiency	
	B10	B10 (A)
0	24.8	25.8
4	34.05	35.05
8	53.78	54.78
12	69.62	70.62
15	78.62	79.62

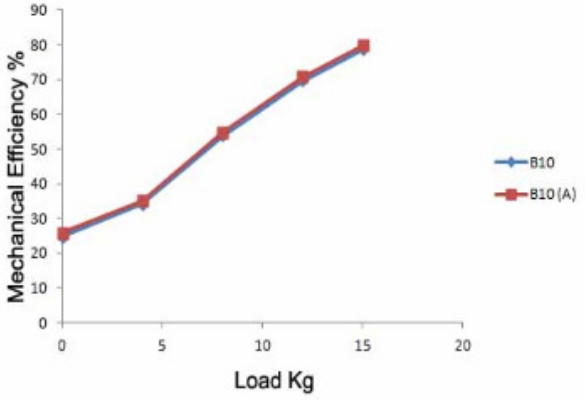

Figure-8: Mechanical Efficiency of B10.

The mechanical efficiency of B10 is increased with added Is-butanol into 2% to 3%.

Table-11: Mechanical Efficiency of B20

Load	Brake Thermal Efficiency	
	B20	B20 (A)
0	26.1	23.6
4	35.02	36.74
8	52.12	56.33
12	65.7	67.25
15	73.9	72.53

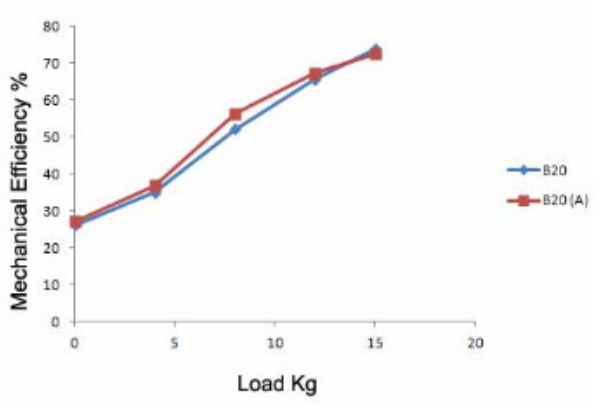

Figure-9: Mechanical Efficiency of B20.

The Mechanical Efficiency of B20 has increased above load 10KG with added Iso-butanol as additive.

Table-12: Mechanical Efficiency of B30

Load	Brake Thermal Efficiency	
	B30	B30 (A)
0	24.8	25.8
4	34.05	35.05
8	53.78	54.78
12	69.62	70.62
15	78.62	79.62

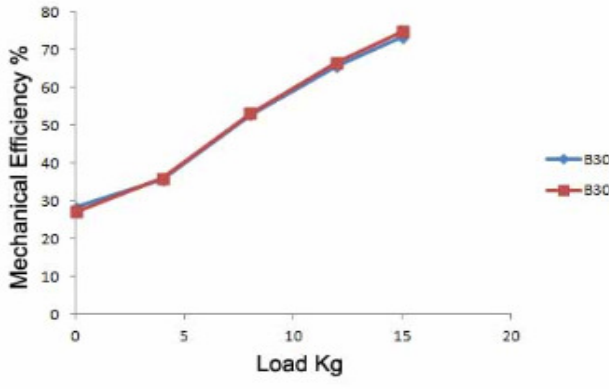

Figure-10: Mechanical Efficiency of B30

The Mechanical Efficiency of the blend B30 increased on increasing with added additive.

Emission Test Results:

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To find out the major pollutants with the engine exhaust, while using the prepared biodiesel as fuel, emission tests are conducted. The tests are carried out using Kane Flue Gas analyzer. The results showing decreased emission on the blends with added additives.

1. NO Emission:

The NO emission is higher with the increase of engine temperature. The NO emission decreases for the blends which used Iso-butanol. For the blend B10 only the emission is higher due to higher amount of diesel in it.

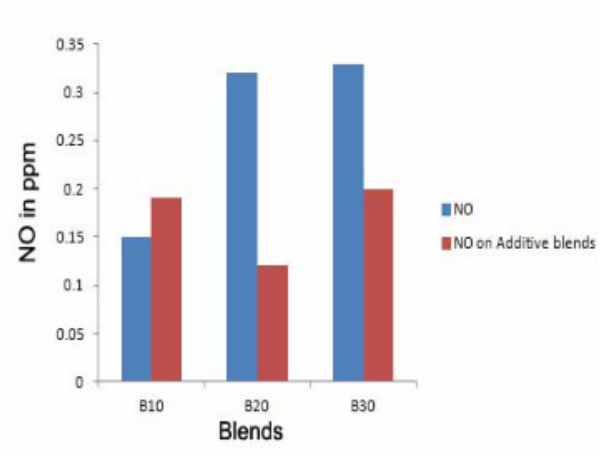

Figure-11: NO emission

2. NO_2 Emission

NO_2 emission is the next type of emission that is to be tested for finding out the emission characteristics of the prepared biodiesel. The blends with added additives and without additives are tested separately to find out the NO_2 emission.

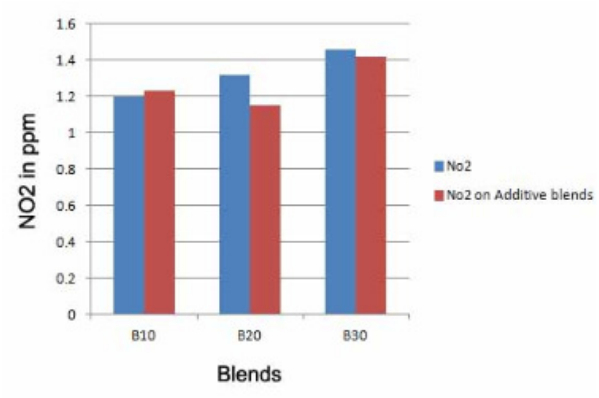

Figure-12: NO_2 Emission

The NO_2 emission is found to be least for the blends with added additives. Thus the added additives can decrease the NO_2 in the exhaust.

3. CO emission

The CO emission is more in diesel engines when the combustion of the fuel is less.

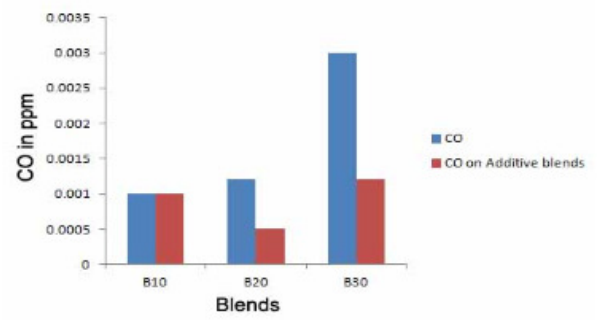

Figure-13: CO emission

The CO emission is decreased with the added additive in the blends. For the blend B10 the emission rate is nearly same. But for the Blends B20 and B30 the CO emission is decreased in a noticeable rate than that of the blends without added additive.

4. O_2 Emission

The O_2 emission is to be higher in the exhaust to ensure the emission in minimum. Thus this

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test is conducted on all blends to find out the amount of Oxygen in the exhaust gas.

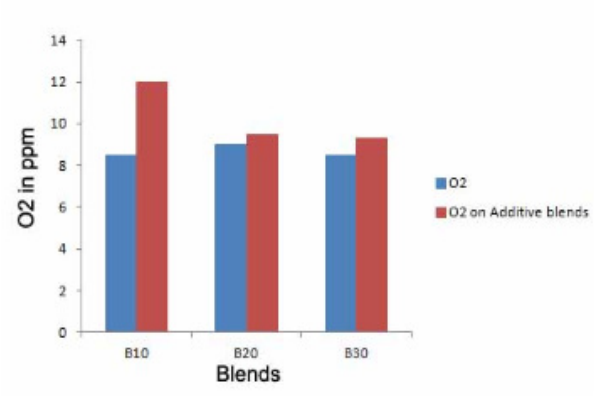

Figure-14: O_2 Emission

It can be observed that the amount of O_2 in the exhaust gas is increasing in the blends with added additives. This means that the addition of additive reduced the emission rate considerably.

CONCLUSION

From our experiments it is clear that production of Biodiesel through transeseterification reaction is easy using cotton seed oil. To overcome the need of alternate fuels in the field of automobiles in upcoming years due to over population and less availability of fuels like diesel, we tried out various blends of Cottonseed oil ester and diesel. The biodiesel prepared from cottonseed oil is used to prepare various blends.

The each blend is prepared in two types like with additive and without additive. The additive added is Iso-Butanol (10% of volume of each blend). The results of Engine performance and Emission tests showing improved performance on Blends with added additives.

- The Brake Thermal Efficiency of the blends with added additive is more than that of the other blends. The improvement is from 5 to 10%.
- The blends with added additive showing good improvement in Specific Fuel Consumption and Mechanical Efficiency.
- The NO and NO_2 Emissions are minimum for the blends with additive.
- The CO emission is considerably reduced on the blends with additive.
- The O_2 emission is more on blends with additive comparing the blends without additives, which mean that the emission is very less on blends with additives.
- From the observations the Blend B10 with added Iso-Butanol is the best blend that can be commercialized due to its optimum performance than other blends and its minimum cost comparing other blends.

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