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Performance and Emission Characteristics of Twin Cylinder CI Engine Using Cottonseed Oil Blended With Methanol

Dr. Hiregoudar Yerrennagoudaru [1], Manjunatha K [2]Chandragowda[3]
[1]*Professor and PG Co-ordinator (Thermal Power Engineering), Mechanical Engineering Department, RYMEC Bellary, Karnataka, India*
[2]*ASST Professor and PROJECT Coordinator (Thermal Power Engineering), Mechanical Engineering Department, RYMEC Bellary, Karnataka, India*
[3]*ASST Professor (Thermal Power Engineering), Mechanical Engineering Department, RYMEC Bellary, Karnataka, India*
[4] *M.Tech (Thermal Power Engineering), Mechanical Engineering Department, RYMEC Bellary, Karnataka,* India

Abstract: *Creating a suitable energy and environmental, alternative energy is needed to develop instead of using fossil fuels. The demand of resources and fuels for the technologies development is increasing day by day. In order to keep the development high we need to think about some alternative fuel with better efficiency which would help the demand keeping in mind the resources for the future generation An alternative fuel needs to be developed and researched upon which could help us get greener and better tomorrow. In this paper I would like to highlight upon the usage of Methanol (30%) blended with Cottonseed oil (70%) for a compression ignition engine and the performance characteristics of this blended fuel. The HC, CO emissions are measured in exhaust gases using gas analyzer and it is observed that HC, CO emissions in Methanol Blend with vegetable oil are less compare to diesel.*

Keywords: *CI Twin Cylinder Engine, Engine Performance, Emissions, Cottonseed oil, Methanol.*

I. Introduction

A lot of researches have been done on the prospect of methanol as an alternative fuel. Methanol, CH_3OH, is the simplest of alcohol and originally produced by the destructive distillation of wood. Today it is produced in very large quantities from natural gas by the reformation of the gas into carbon monoxide and hydrogen followed by passing these gases over a suitable catalyst under appropriate conditions of pressure and temperature [1]. Historically, alcohols have been added to the engine intake air (fumigation) since they do not mix well with diesel [2, 3]. Few tests have been conducted using fumigation method. The results are very impressive. The thermal efficiency for fumigated diesel has improved 30% in a direct injection engine at certain combination of alcohol and diesel fuel ratios and overall equivalent ratio [4]. It has been observed that engines running on methanol alone were prone to pre-ignition, in spite of high octane rating of the fuel. Due to the cost factor and other technical problems, the use of methanol as fuel was confined mainly to the racing arena. For internal combustion engines, alcohols, methanol and ethanol, are tested and demonstrated in the world [5]. E10 (10% ethanol in volume and 90% gasoline in volume) fuel and M15 (15% methanol in volume and 85% gasoline in volume) is used [6]. Table 1 compares a parts of the fuel properties, from which the advantages can be summarized as following [7, 8 and 9]: (1) Emissions from methanol cars are low in reactive hydrocarbons (which form smog) and in toxic compounds. Methanol-fuelled trucks and buses emit almost no particulate matter (which cause smoke, and can also be carcinogenic), and much less nitrogen oxides than their diesel-fuelled counterparts. (2) Methanol can be manufactured from a variety of carbon-based feedstock such as natural gas, coal, and biomass (e.g. wood). Use of methanol would diversify the country's fuel supply and reduce its dependence on imported petroleum. (3) Methanol is much less flammable than gasoline and results in less severe fires when it does ignite. (4) Methanol has a higher laminar flame propagation speed, which may make combustion process finish earlier and thus improve engine thermal efficiency [9]. (5) Methanol is a high-octane fuel that offers excellent acceleration and vehicle power. Though the latent heat of methanol is higher, measures are not necessary for the mixture preparing due to lower fraction, while it may increase engine volumetric efficiency and thus increase engine power [6]. With economies of scale, methanol could be produced, distributed, and sold to consumers at prices competitive with gasoline. This paper will carry out further study on the effects of methanol, and its fraction on CI engine.

Methanol is another kind of oxygenates, with high Oxygen content, high heat of evaporation, and low Viscosity, making it a potential additive for biodiesel fuel [10]. Cheung et al. [11–13] and Yu et al. studied the influence of methanol addition on the performance and emissions of engine fueled with biodiesel in a pump-line-injector diesel engine and a common-rail (CR) diesel engine respectively.

II. Objectives of the present study

- It is proposed to use Methanol Fuel in the diesel engine (CI engine).
- The emissions like CO, HC, and Smoke in the exhaust gases are also proposed to reduce during the combustion itself.
- To study the performance evaluation of the using Methanol blended with Hippi oil as fuel in the diesel engine to Analyze the exhaust emissions and measurements, reduction in the exhaust gas

III. Sources of Bio-Fuel

Methanol is a renewable energy source because the energy is generated by using a resource, sunlight, which cannot be depleted. Creation of Methanol starts with photosynthesis causing a feed stock, such as sugar cane or a grain such as maize (corn), to grow. These feed stocks are processed into methanol.
Following are the methods to produce the

a) Following are methods to producing Bio Fuel:-

- Fermentation
- Distillation
- Dehydration
- Blending (Methanol and Cotton Seed Oil)

b) Methods of Extraction of Cottonseed oil

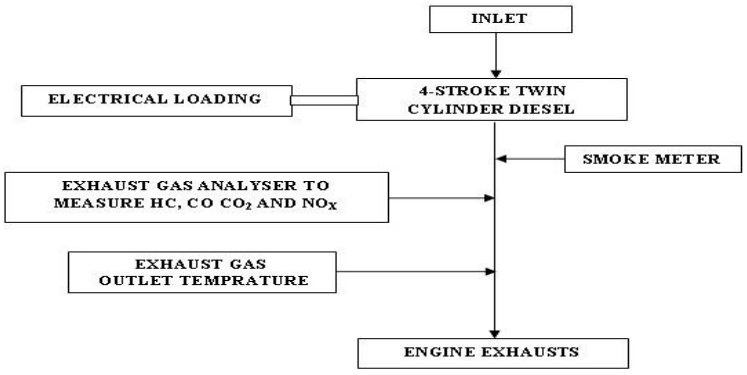
- Two methods of extraction are available.
- Water Steam distillation
- Soxhlet extraction

c) Properties of Bio Fuels.

Sl. No	Properties	Methanol	Cottonseed oil
1	Density(kg/m^3)	796.6	874
2	Calorific value (kJ/kg)	23,800	39500
3	Kinematic viscosity @ 40C (cst)	1.04	50.7
4	Cetane number	4	50.7
5	Flash point ºC	12	205
6	Fire point ºC	97.6	228
7	Specific gravity	0.79	0.948

IV. Experimental setup

The experimental test set up Figure-1 consisted of twin cylinder diesel engine, four stroke, Forced cooling system, crank start. The setup is provided with a resistance load bank, Multi gas analyzer made by test and Stack monitoring kit for particulate matter & formaldehyde as HCHO.,etc for performance and emissions analysis



The engine is cooled using the water jackets on the engine block and cylinder head using a Forced Feed System. While the recommended injection timing given by the manufacturer is 27º BTDC (static), theopening pressure of the nozzle was set at 1800 bar and the engine speed at 1500rpm.There are a number of transducers

used in the engine such as piezoelectric pressure transducer flush with the cylinder head surface to measure cylinder pressure. Specifications of engine are shown in Table 2.

d) Engine Specification

Table 2-Engine specification	
Engine type	Four stroke Twin cylinder diesel engine
No. of cylinders	02
Stroke	100 mm
Bore Diameter	87 mm
Engine power	15KV
Compression ratio	17.5:1
RPM	1500
Type of starting	Crank starting
Load type	Electric load bank

Fig 2: Test engine

e) Load Bank Specification

Table 3- Load Bank Specification	
Max. Output	15 KVA / 12.06 KW
Generator type	1 Phase
Amps	63
RPM	1500
PF	0.8
Volts	240

V. Precaution Observed Before Starting Of The Engine

At the time of starting the engine for each of the tests it was measured that the engine level was in the safe zone and its condition is also good in case the condition was bad, then fresh SAE 40 was introduced into the pump after draining the old . The foundation and mounting bolts were checked periodically as they may go loose due to high speed operations and vibrations.

In the course of experiments the following precautions were observed:

- The ambient temperature variations during the experiment should not be more than 6°Cand this was observed as far as possible.
- After each load is applied the engine in allowed to settle before further loads are applied.

Before stopping the engine, it was allowed to run on pure diesel for some time. This is done so that the engine can be restarted easily

VI. Experimental Procedure

Experiments were initially carried out on the engine using diesel as fuel in order to provide base line data. The methanol were prepared and made to run on the engine.

1st Case:-The engine was started using neat diesel and allowed to run for at least 30 minutes before taking observations. After engine conditions stabilized and reached to steady state, the base line data were taken. Load was varied (Zero load & full load condition) using the alternator load bank and the same was recorded. Gaseous emissions, fuel consumption were also recorded from the respective sensor.

2nd Case:-The engine was started on diesel and when engine became sufficiently heated.After engine conditions stabilized and reached to steady state, the base line data were taken. Load was varied (Zero load & full load condition) using the alternator load bank and the same was recorded. Gaseous emissions, fuel consumption were also recorded from the respective sensor.

VII. Results And Discussion

The performance and exhaust emission parameters of the engine with methanol blend with hippi oil from zero to full load condition are presented and discussed below.

Tabular Coloumn:

Table 4: Oil type: Diesel **calorific value**: 43200 kJ/kg **Specific gravity**: 0.86

Sl.no	Load In %	Speed (rpm)	Mass of fuel Mg/stroke	Mass of fuel kg/hr.	BP (KW)	BSFC (kg/kw-hr)	BSEC (kJ/kw-hr)	BTE (%)
1.	0	1500	7.5	0.675	1.303	0.518	22377	16.08
2.	100	1500	39	3.51	12.014	0.292	12614	28.52

Table 5: Oil type: methanol blend with Cottonseed oil **calorific value**= 34790 kJ/kg **Specific gravity**= 0.9

SI. no	Load In %	Speed (rpm)	Mass of fuel Mg/stroke	Mass of fuel kg/hr.	BP (KW)	BSFC (kg/kw-hr)	BSEC (kJ/kw-hr)	BTE (%)
1.	0	1500	7.5	0.675	1.303	0.518	18021.5	19.97
2.	100	1500	43.5	3.915	16.10	0.243	8459.80	42.56

Table 7: Emissions

LOAD In %	Fuels	CO In %	HC In PPM	Smoke g/mm^3
Zero Load	DIESEL	0.05	20	4.7
Full Load	DIESEL	0.02	40	13.4
Zero Load	70%COT+30% ME	0.04	10	0.6
Full Load	70%COT+30% ME	0.02	20	1.7

a) Specific fuel consumption

From figure-1 it is clear that as the load increases specific fuel consumption decreases for different loads andthe SFC of methanol blend with hippi oil is less than the diesel.

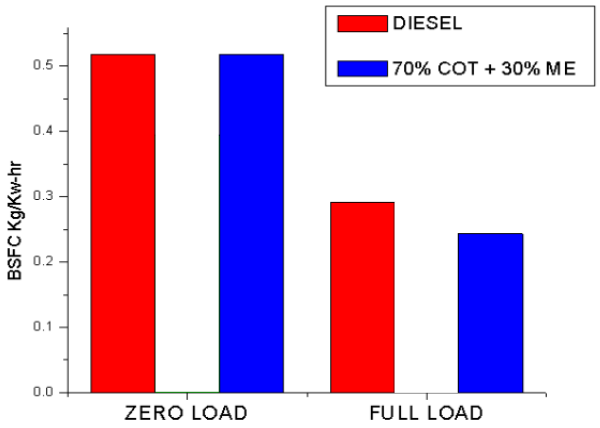


Figure- 1: Comparison of Brake specific fuel consumption vs Load

b) Brake thermal efficiency

Figure 2, shows the variation of brake thermal efficiency with respect to methanol blend with hippi oil & diesel at different loads. From the graph it is observed that as load increases brake thermal efficiency is also increases for diesel as well as methanol blend with hippi oil.

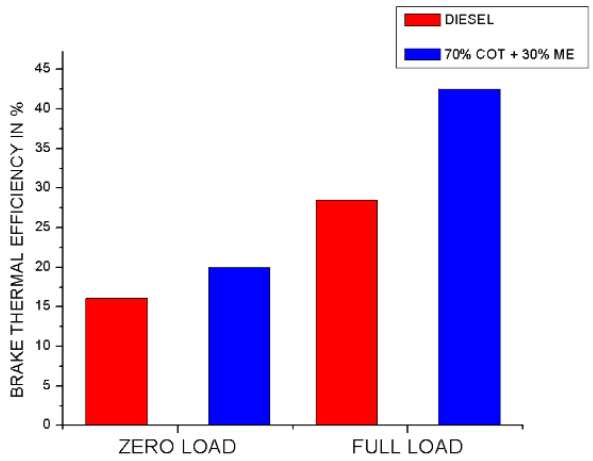


Figure- 2: Comparison of Brake thermal efficiency vs Load

c) Carbon Monoxide

Figures 3, shows the variation CO level with respect to diesel and methanol blend with hippi oil at different loads. From the graph it is clear that the CO level of methanol blend with hippi oil increases in zero load and equal in full load compare with diesel.

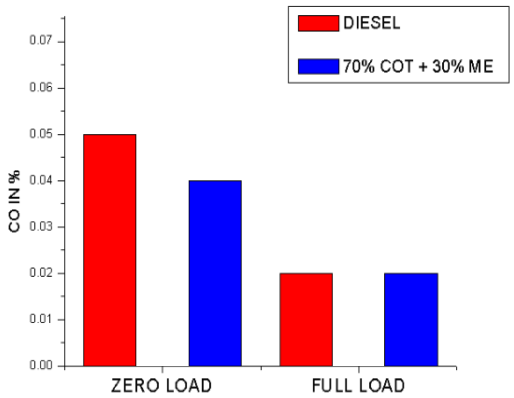


Figure- 3: Comparison of Carbon monoxide vs Load

d) Hydrocarbon

The variation of Hydrocarbon of the engine with diesel & methanol blend with hippi oil is shown in figure 4. From the graph it is clear that the HC level of methanol blend with hippi oil equal in zero load and decreases in full load compare with diesel

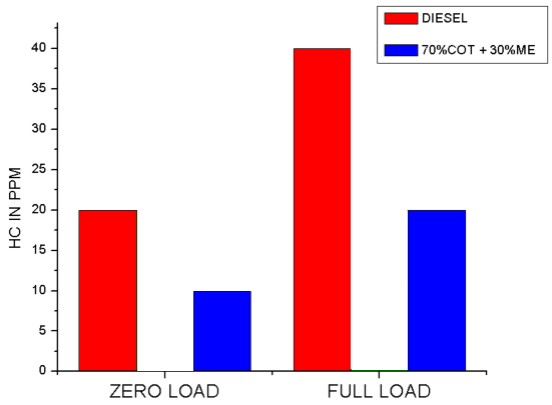


Figure- 4: Comparison of HC vs Load

e) SMOKE

The variation of smoke of the engine with diesel & methanol blend with hippi oil is shown in figure 5. From the graph it is clear that the smoke level of methanol blend with hippi oil decreases compare with diesel.

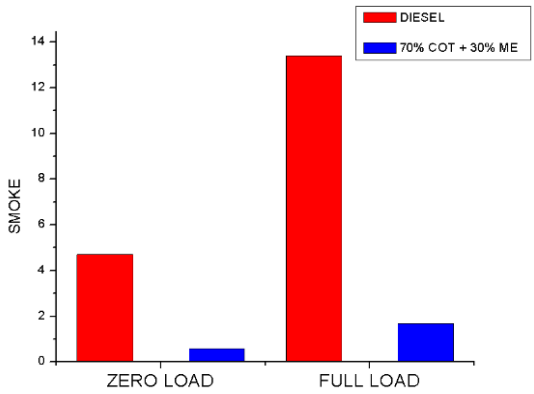


Figure- 5: Comparison of smoke vs Load

VIII. Conclusion

From the evaluation and comparison of the diesel and methanol blend with hippi oil have been experimented with in the twin cylinder diesel engine, it is inferred that the Methanol Blend with vegetable oil is suitable for running compression ignition engines. Methanol Blends with vegetable oils emits less pollutants compared to diesel.

From this project we tried to use Ethanol Blends with vegetable oil as substitute to diesel, run the engine and succeeded, this show that Methanol Blend with vegetable oil alternative to diesel fuel. The HC, CO emissions are measured in exhaust gases using gas analyzer and it is observed that HC, CO emissions in Methanol Blend with vegetable oil are less compare to diesel.

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