

Investigation and Performance Evaluation of Pine oil blended with Diesel using the Twin Cylinder Diesel Engine

Dr. Hiregoudar Yerrenagoudaru¹, Manjunatha K², Shyam Sundar.R³

¹Professor (Thermal Power Engineering), Mechanical Engineering Department, RYMEC Bellary, Karnataka, India

²Asst. Professor (Thermal Power Engineering), Mechanical Engineering Department, RYMEC Bellary, Karnataka, India

³MTech (Thermal Power Engineering), Mechanical Engineering Department, RYMEC Bellary, Karnataka, India

Abstract—In view of increasing pressure on crude oil reserves and environmental degradation as an outcome, fuels like Biofuel may present a sustainable solution as it can be produced from a wide range of carbon based feedstock. The present investigation evaluates Biofuel as a C I engine fuel.

The objectives of this report is to analyze the fuel consumption and the emission characteristic of a twin cylinder diesel engine that are using Biofuel & compared to usage of diesel that are available in the market.

This report describes the setups and the procedures for the experiment which is to analyze the emission characteristics and fuel consumption of diesel engine due to usage of the both fuels. Detail studies about the experimental setup and components have been done before the experiment started. Data that are required for the analysis is observed from the experiments. Calculations and analysis have been done after all the required data needed for the thesis is obtained. The experiment used C I engine with no load which means no load exerted on it.

A four stroke Twin cylinder C I engine was adopted to study the brake thermal efficiency, brake specific energy consumption, and emissions at different loads with the fuel of Biofuel. In this study, the diesel engine was tested using Biofuel. By the end of the report, the successful of the project have been started which is Twin cylinder C I engine is able to run with Bio fuel but the engine needs to run by using diesel fuel first, then followed by Bio fuel and finished with diesel fuel as the last fuel usage before the engine turned off. The performance of the engine using Biofuel compared to the performance of engine with diesel fuel. Experimental results of Bio fuel and Diesel fuel are also compared.

Keywords: Diesel, Performance, Emissions, Biofuel, Pineoil.

I. INTRODUCTION

Rising petroleum prices, increasing threat to the environment from vehicle exhaust emissions and fastly depleting stock of fossil fuels have generated an intense international interest in developing alternative renewable fuels for IC engines. Bio fuel is an oxygenated fuel which increases the combustion and makes reduce exhaust emission. It can be produced from crops with high sugar or starch content. Some of these crops include sugarcane, sorghum, corn, barley, cassava, linseed plants,

sugar beets etc. Besides being a biomass based renewable fuel, Biofuel has cleaner burning and higher octane rating than the various vegetable oils [1-5]. Jason and Marc (2002) presented the exergetic environmental assessment of lifecycle emissions from M-85, E-85 (used for the gasoline engine) and other alternative fuels [6]. Diesel exhaust is a major contributor to various types of air pollution, including particulate matter (PM), oxides of nitrogen (NO_x), and carbon monoxide (CO) [7]. It has been demonstrated that the formation of these air pollutants can be significantly reduced by incorporating or blending oxygenates into the fossil fuels matrix [8]. Diesel engines are an important part of the public and private transportation sector and their use will continue and grow into the future. But their smoke has become biggest threat to health and environment [9]. Keeping in mind the higher octane number of the ethanol, variable compression ratio engine is a good option in this direction using the ethanol diesel blend as fuel; Shaik et al. (2007) demonstrated VCR engine has great potential for improving part-load thermal efficiency and reducing greenhouse gas emissions [10].

There were many attempts made to use Biofuel in compression ignition (CI) engine. Huang et al. (2008) carried out tests to study the performance and emissions of the engine fuelled with the ethanol diesel blends [11]. They found it feasible and applicable for the blends with n-butanol to replace pure diesel as the fuel for diesel engine. Bhattacharya and Mishra (2002) evaluated the feasibility of preparing diesel-ethanol blends using 200° (anhydrous ethanol) and ethanol lower proof [12]. They found that ethanol blends indicated power producing capability of the engine similar to that of diesel. Hansen et al. (2001) found that the properties of ethanol-diesel blends have a significant effect on safety, engine performance, durability and emissions [13]. Wang et al. (2003) analyzed that the most noteworthy benefits of E-diesel use lie with petroleum fuel reductions and reductions in urban PM₁₀ and CO emissions by heavy vehicle operations [11]. Ajav and Akingbehin (2002) experimentally determined some fuel properties of local ethanol blended with diesel to establish their suitability for use in compression ignition engines [14]. Eckland et al. (1984) presented, State-of-the-Art Report on the Use of Alcohols in Diesel Engines [15].

Techniques that have been evaluated for concurrent use of diesel and alcohols in a compression-ignition engine include (1) alcohol fumigation, (2) dual injection (3) alcohol/diesel fuel emulsions, and (4) alcohol/diesel fuel solutions. Heisey and Lestz (1981) reported significant reductions in particulate generation; however, NOx generation increases [16]. Likos et al. (1982) reported increased NOx and hydrocarbon emissions for diesel-ethanol emulsions [17]. Khan and Gollahalli (1981) reported decreased NOx and hydrocarbon emissions with increased particulate emissions for diesel-ethanol emulsions [18]. Lawson et al. (1981) reported increased NOx and decreased particulate emissions with diesel methanol emulsions [19]. This type of inconsistent performance is what has hindered the use of ethanol in diesel. Baker (1981) reported diesel-ethanol emulsions produce similar NOx, hydrocarbon, and particulate emissions as compared to baseline runs with straight diesel [20]. Ahmed (2001) found Diesel engines are major contributors of various types of air polluting exhaust gasses such as particulate matter (PM), carbon monoxide (CO), oxides of nitrogen (NOx), sulfur, and other harmful compounds [21]. Ethanol blended diesel (e-diesel) is a cleaner burning alternative to regular diesel for both heavy-duty (HD) and light-duty (LD) compression ignition (CI) engines used in buses, trucks, off-road equipment, and passenger cars. Karabektas and Murat Hosoz (2009) reported the increase of fuel consumption with increase in percentage of ethanol in the blends [22]. Rao et al. (2008) carried out experiment in order to find out optimum compression ratio, experiments were carried out on a single cylinder four stroke variable compression ratio diesel engine [23].

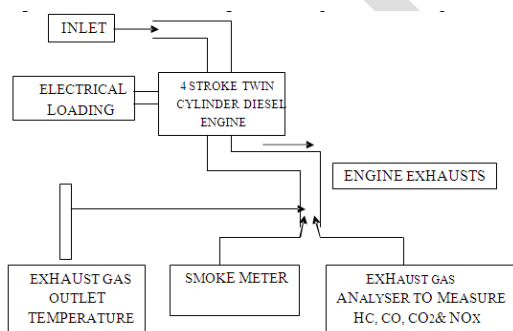


Fig 1: Schematic arrangement of Experimental Set-up

II. OBJECTIVES OF THE PROJECT

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

a) Properties of diesel and Bio Fuel.

Table-1

Sl. No	Properties	Diesel	Pine oil (C ₁₁ H ₁₀ BrN ₅)
1	Density(kg/m ³)	850	950
2	Calorific value (kJ/kg)	46,500	43404.03
3	Kinematic viscosity @ 40 ⁰ C (cst)	3.05	1.04
4	Cetane number	55	4
5	Flash point °C	52	65
6	Fire point °C	56	97.6
7	Specific gravity	0.86	0.91

III. EXPERIMENTAL SET UP (TEST RIG)

Kirloskar Make Four Stroke Twin Cylinder Diesel Engines Of Av Series.



Fig 2: Test engine

Table-2 Test Engine specification

Engine type	Four stroke Twin cylinder diesel engine
No. of cylinders	02
Stroke	100 mm
Bore Diameter	87 mm
Engine power	15 KW
Compression ratio	17.5:1
RPM	1500
Type of starting	Crank starting
Load type	Water loading

Table-3
Load bank specification

Max. Output	15 KV
Generator type	1 Phase
Amps	63
RPM	1500
PF	0.8
Volts	240

A. Precaution Observed Starting 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°C and 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

B. Experimental procedure

Experiments were initially carried out on the engine using diesel as fuel in order to provide base line data. The Bio fuel 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 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; the supply of diesel was slowly substituted by Bio fuel for which a two way valve was used. After engine conditions stabilized and reached to steady state, the base line data were taken. Load was varied using the alternator load bank and the same was recorded. Gaseous emissions, fuel consumption were also recorded from the respective sensor.

IV. RESULTS AND DISCUSSION

A. Performance parameter

Tabular Column IV

Diesel							
Sl.no	Load in Newton	BP kw	BSFC kg/kw-hr	η_{Bth} %	CO %	HC ppm	Smoke
1	29.43	0.9245	0.8482	10.03	0.10	70	68
2	49.05	1.5409	0.5513	15.43	0.09	80	77
3	78.48	2.4655	0.3650	23.31	0.08	70	80

Tabular Column V

Pine oil blended with diesel (B 20)							
Sl.no	Load in Newton	BP kw	BSFC in kg/kw-hr	η_{Bth} %	CO %	HC ppm	Smoke
1	29.43	0.9245	0.846	9.996	0.04	30	58
2	49.05	1.5409	0.572	14.79	0.03	50	85
3	78.48	2.4655	0.416	20.34	0.03	90	99

B. Specific Fuel Consumption

a) Brake Specific Fuel Consumption

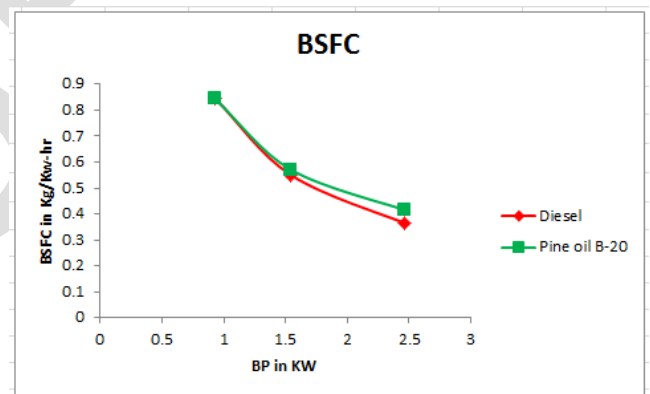


Fig – 3. Variations of BSFC at Different Load

b) Brake thermal efficiency

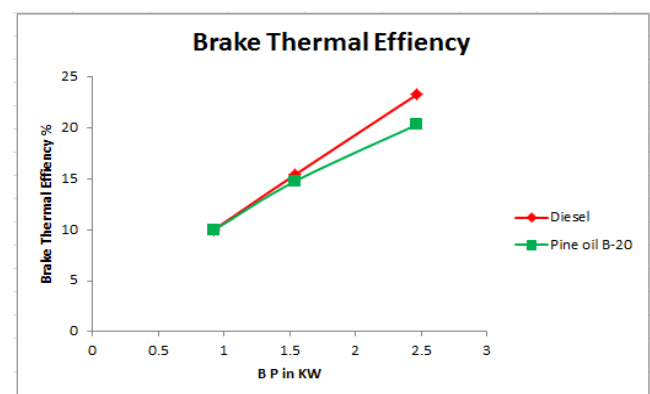


Fig – 4. Variations of Brake Thermal Efficiency at Different Load

C. Emission parameters:

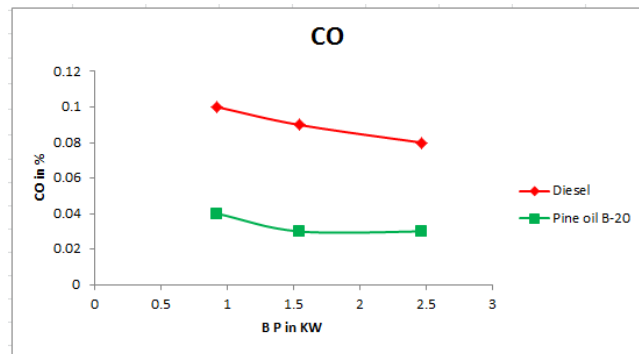


Fig - 5. Variations of CO at Different Load

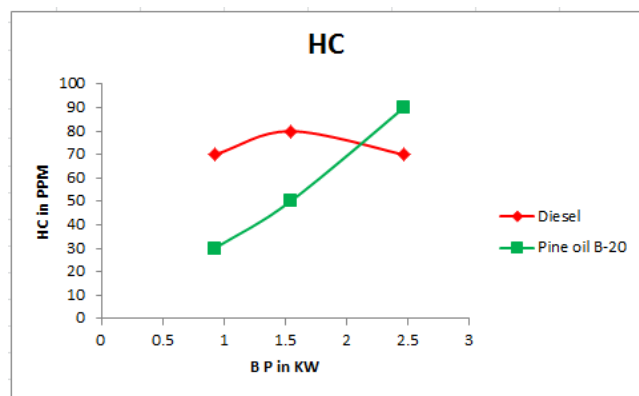


Fig - 6. Variations of HC at Different Load

D. Smoke

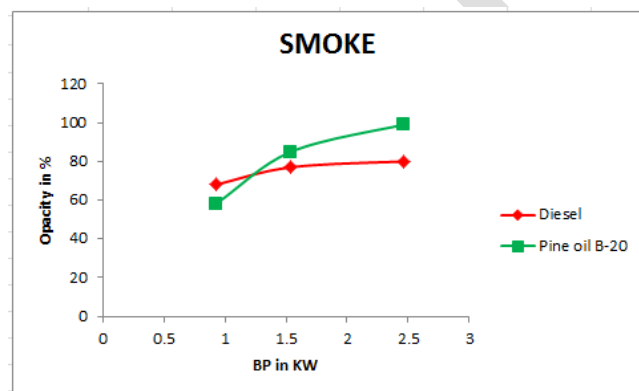


Fig - 7. Variations of Opacity at Different Load

V. CONCLUSION AND FUTURE SCOPE

Based on the performance and emissions of Bio fuel, it is concluded that the bio fuel oil represents a good alternative fuel with closer performance and better emission characteristics to that of a diesel. From the above analysis the bio fuel shows closer performance compared to the Diesel in the sense of better performance characteristics like Brake thermal efficiency, Specific fuel consumption and decrease in the emission parameters like, Smoke, HC, CO is lower than the diesel. Hence the bio fuel can be used as a substitute for diesel.

REFERENCES

- [1]. Alan C. Hansen, Qin Zhang and Peter W. L. Lyne, "Ethanol-diesel fuel blends a review", *Bioresource Technology*, Volume 96, Issue 3, February 2005, Pages 277-285.
- [2]. Hanbey Hazar, "Effects of biodiesel on a low heat loss diesel engine", *Renewable Energy* 34 (2009) 1533-1537.
- [3]. Neven Voca, Boris Varga, Tajana Kricka, Duska Curic, Vanja Jurisic and Ana Matin, "Progress in ethanol production from corn kernel by applying cooking pre-treatment" *Bioresource Technology* Volume 100, Issue 10, May 2009, Pages 2712-2718.
- [4]. Avinash Kumar Agarwal, "Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines" *Renewable Energy*, 27 November 2006.
- [5]. Hakan, Bayraktar. "Experimental and theoretical investigation of using gasoline-ethanol blends in spark-ignition engines", *Renewable Energy*, 2005; Volume 30, Issue 11: pp1733-1747.
- [6]. Jason J, Daniel Marc, Rosen A, "Exergetic Environmental Assessment of Life Cycle Emissions for various Automobiles and Fuels, *Exergy* 2 (2002) 283-294
- [7]. Hwanam Kima, Byungchul Choi, "Effect of ethanol-diesel blend fuels on emission and particle size distribution in a common-rail direct injection diesel engine with warm-up catalytic converter", *Renewable Energy* 33 (2008) 2222-2228.
- [8]. De-gang Li, Huang Zhen, Lu Xingcai, Zhang Wu-gao and Yang Jian-guang, "Physico-chemical properties of ethanol-diesel blend fuel and its effect on performance and emissions of diesel engines", *Renewable Energy* 30 (2005) 967-976.
- [9]. Sehmus Altuna, Husamettin Bulutb and Cengiz Oner, "The comparison of engine performance and exhaust emission characteristics of sesame oil-diesel fuel mixture with diesel fuel in a direct injection diesel engine", *Renewable Energy* 33 (2008) 1791-1795.
- [10]. Amjad Shaik, N Shenbaga Vinayaga Moorthi, and R Rudramoorthy, "Variable compression ratio engine: a future power plant for automobiles an overview," *Proc. IMechE Vol. 221 Part D* April 2007. DOI: 10.1243/09544070JAUTO573.
- [11]. Jincheng Huang, Yaodong Wang, Shuangding Li, Anthony P. Roskilly, Hongdong Yu, Huifen Li, "Experimental Investigation on the Performance and Emissions of a Diesel Engine Fuelled with Ethanol-diesel Blend," *ATE* 2697, 2008.
- [12]. T K Bhattacharya and T N Mishra, "Studies on Feasibility of using Lower Proof Ethanol-Blends as Fuel for Compression Ignition Engines", *IE (I) Journal-AG* 263 145, December 21, 2002
- [13]. Alan C. Hansen, Peter W. L. Lyne, Qin Zhang, "Ethanol-Diesel Blends: A Step towards A Bio-Based Fuel for Diesel Engines", *American Society of Agricultural and Biological Engineers (ASAE)* August 1, 2001.
- [14]. R.Kamo And W. Bryzik "Tacom/Cummins Adiabatic Engine Programm" Sae Paper No. 830314.
- [15]. P.Ram Mohan, K.Ram Mohan, C.M. Varaprasad "Matching Of Injection Timing In L.H.R Engines For Fuel Economy" Proc Of 3rd Asian Pacific International Symposis On Combustion Energy And Energy Utilisation December 95.
- [16]. Van Sudhakar "Performance Analysis of Adiabatic Engine" Sae 840431.
- [17]. C.M.Varaprasad, K.Ram Mohan "Performance of a Diesel Engine with a Semi-Adiabatic Piston on Diesel Methanol Mixtures" Dsir Seminar on Diesel Engines, Iit, Mumbai October 88.
- [18]. Rangaiaii Et Al "Performance of Ceramic Coated Diesel Engines with Methanol Diesel Mixtures" 9th National Conference in C.I Engines and Combustion 1985.
- [19]. K. Ram Mohan, C.M Varaprasad. P. Ram Hohan "Performance Evaluation of Diesel Engine with A Air-Gap Insulated Piston" Annual Paper Meeting The Institution of Engineers.
- [20]. Dr.C.Prabhakar Reddy & C.M.Varaprasad "Performance Evaluation On 4-Stroke Semi-Adiabatic Diesel Engine Using Diesel Methanol Mixtures" Project Report 1997 Mechanical Department V.E.C Bellary-4.
- [21]. Mather and Sharma "Internal Combustion Engines" 7th Edition 1996.
- [22]. Eckland, E. E.; R. L Bechtold; T. J. Timbario; and P. W. McCallum, "State-of-the-Art Report on the Use of Alcohols in Diesel Engines", *SAE Paper No. 840118*.
- [23]. Heisey, J. B. and S. S. Lestz, "Aqueous alcohol fumigation of a single-cylinder DI CI engine," *SAE Paper No. 811208*.

- [24]. Likos, B.; T. J. Callahan; and C. A. Moses, "Performance and Emissions of Ethanol and Ethanol-Diesel Blends in Direct-Injected and Pre-Chamber Diesel Engines", *SAE Paper No. 821039*.
- [25]. Khan, N and S. R. Gouhalli, " Performance and Emission Characteristics of a Diesel Engine Burning Unstabilized Emulsions of Diesel Fuel with Water, Methanol, and Ethanol", *SAE Paper No. 811210*.
- [26]. Lawson, A.; A. J. Last; A. S. Desphande; and E. W. Simmons, "Heavy-Duty Truck Diesel Engine Operation on Unstabilized Methanol -Diesel Fuel Emulsions", *SAE Paper No. 810346*.
- [27]. Baker, Q. A., "Use of Alcohol-in-Diesel Fuel Emulsions and Solutions in a Medium-Speed Diesel Engine", *SAE Paper No. 810254*.
- [28]. Irshad Ahmed Oxygenated Diesel, "Emissions and Performance Characteristics of Ethanol-Diesel Blends in CI Engines," *Society of Automotive Engineers, Inc. 2001-01-2475*.
- [29]. Murat Karabektas A, Murat Hosoz B, "performance and emission characteristics of a diesel engine using isobutanol-diesel fuel blends", *Renewable Energy 34 (2009) 1554-1559*.
- [30]. GVNSR Ratnakara Rao, V. Ramachandra Raju and M. Muralidhara Rao, "Optimizing The Compression Ratio Of Diesel Fuelled C.I Engine", *ARPJN Journal of Engineering and Applied Sciences, VOL. 3, NO. 2, APRIL 2008*.

IJSP