PERFORMANCE AND EMISSION CHARACTERISTICS OF A DIESEL ENGINE WITH COTTONSEED OIL PLUS DIESEL OIL BLENDS.

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Abstract In the present study a 4-stroke 5hp diesel engine was tested with Diesel oil plus cottonseed oil blends. The blends in different proportions (10 to 50 percent by volume) were tested at constant speed of 1500 rpm. The said engine is operated at different loads and characteristics like Brake power, Brake thermal efficiency, specific fuel consumption etc. Engine performance for blends resulted in lower brake thermal efficiency. Smoke is also found to increase with the blends. The results of the present experimental investigations reveal that the performance of the blends is comparable with that of diesel. Hence blends can profitably be employed in an existing CI engine without major engine modifications, further it can be an immediate solution for the development of rural areas, and for the emergency use in the event of severe diesel fuel shortage.

Key Words Diesel Engine – Performance – Emission – Blends

چکیده در این مقاله یک موتور ۵ اسب ۴ زمانه، که در آن از مخلوطی از گازوئیل و روغن تخم پنبه، به عنوان سوخت استفاده شده، مورد ارزیابی قرار گرفته است. مخلوط مورد نظر (۱۰ تا ۵۰ درصد حجمی نسبت به مخلوط) در سرعت ثابت rpm ۱۵۰۰ مورد آزمایش قرار گرفت. موتور در شرایط کاری مختلف مثل قدرت ، راندمان حرارتی، میزان سوخت ویژه و غیره بررسی شد. نتایج نشان می دهد که افزودن روغن پنبه به گازوئیل باعث افت حرارت شده، اما میزان دود اگزوز را افزایش می دهد. این بررسی همچنین موید آن است که کارآیی مخلوط مذکور، قابل مقایسه با زمانی است که از گازوئیل، فقط به عنوان سوخت استفاده می شود و لذا می توان از مخلوط مذکور به خوبی و بدون تغییر در ساختمان موتور دیزل استفاده نمود. به این نتیجه می رسیم که از روغن پنبه به خوبی می توان در مناطق روستایی استفاده کرد که خود باعث گسترش این مناطق می گردد و در مواقعی که کمبود ناگهانی در گازوئیل به وجود می آید از روغن تخم پنبه در موتورهای دیزلی استفاده برد.

1. INTRODUCTION

High prices coupled with the paucity of petroleum reserves and environmental concerns have sparked a search for renewable engine fuels. As most of the developing nations are agricultural nations, producing plenty of oilseed crops and production of vegetable oils will not be a difficult task. In the present investigation blends of cottonseed oil and diesel oil have been chosen, as a fuel for CI engine. Experimental investigation has been carried out to assess the feasibility of these oils as CI engine fuels due to the following reasons (a) Present petroleum resources are dwindling at a faster rate (b) Some alternate fuel has to take the place of these fuels, in order to sustain the economic growth, and (c) The fuel must be vailable in ample quantity conforming to economic & environmental conditions.

Vegetable oils as alternate CI engine fuels have received modest interest for several decades, however economic factors have favored the use of petroleum based fuels. The first use of peanut oil was made in 1895 by Dr. Rudolf Diesel himself, who predicted "The use of vegetable oils for engine fuels may seem insignificant today, but such oils may become in course of time as important as petroleum and coal tar products of the present time". At present, the uncertainties concerning adequate, stable supplies of petroleum fuels have renewed interest in vegetable oils a CI engine fuel. Initial use of vegetable oils as CI engine fuels may be regional and confined to rural areas, where they are readily available (1). One of the probable first applications could be on farm pumps and agricultural tractors and rural transportation. Engines using vegetable oils can produce the same power output, however with reduced Thermal efficiency and increased emissions (particularly smoke). Further, vegetable oils lead to problems of gum formation and sluggish combustion (2). The specific objectives of the experimental study is as following

1.The effect of cottonseed oil plus Diesel oil blends on diesel engine performanc characteristics.

2.Cold starting characteristics of the engine

3.Overheating problems and engine vibrations because of the use of cottonseed oil.

4.The effect of cottonseed oil plus diesel oil blends on exhaust emission of the engine.

5.The feasibility of cottonseed oil plus diesel oil blends as diesel fuel extenders, and for emergency use in the event of severe diesel fuel shortage.

6.Determination of the optimum percentage of cottonseed oil and diesel oil blends for a fairly good engine performance.

7.Feasibility of other non-edible oils like Karanja oil, Ratanjyot (Jatropha) oil, Mahua oil, Linseed oil, Neem oil etc, in CI engine at higher compression ratios.

Experimental evidence from several investigators has proved that vegetable oils are suitable for diesel engine and can be used directly without major engine modifications (1,3). Gerhard vellguth (2) studied the performance of a diesel engine when ingected with vegetable oils. He conducted variable load tests on the engine with rapeseed oil, peanut oil and soyabean oil. He reported that vegetable oils produce the same power output with a slightly reduced thermal efficiency and increased emissions. However their performance is slightly inferior to diesel. He concluded that vegetable oils could be used as fuels in diesel engines. One major obstacle in using vegetable oils is its high viscosity which leads to problems of fuel flow in the injector fuel lines and filter (1,8). High viscosity leads to poor atomization of the oil and leads to high levels of smoke. In order to improve the performance of vegetable oils different methods like heating, dual fuelling, and transesterification have been tried (6).

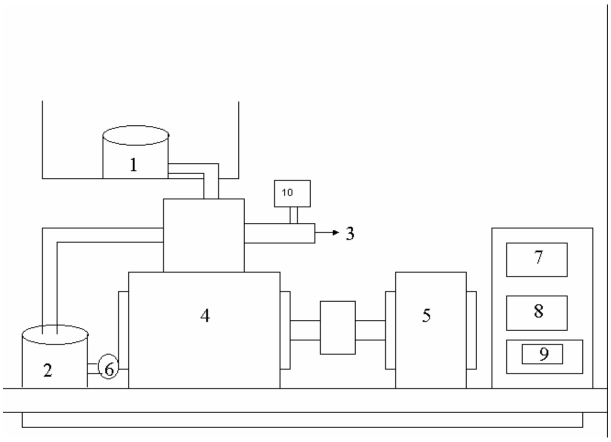
2. ABBREVATIONS

BP =Brake power of the engine in KW
B.Th.eff =Brake thermal efficiency in percentage
=BP/(mass of the fuel consumed per sec X calorific value)
Compression ratio =(swept volume +clearance volume)/clearance volume
SFC =specific fuel consumption in Kg/kWh
HSU =Hatridge smoke units
CSO=Cottonseed oil
DO=Diesel oil

3. ENGINE SPECIFICATIONS

Type: 4-stroke single cylinder, Direct injection, water cooled,
Stationary engine test rig with open combustion

chamber,
Make = Kirlosker.
Bore =80mm
Stroke = 110mm
Rated Power = 3.7 KW



Experimental setup

1. Fuel tank
2. Air drum
3. Exhaust
4. Diesel Engine
5. Dynamometer
6. Air flow meter
7. Temperature indicator
8. Stop watch
9. Dynamometer controller
10. Smoke meter

The present experimentation is carried out on a single cylinder, direct injection, water-cooled diesel engine having (5 HP) 3.7 KW as rated power at 1500 rpm. The engine is provided with an open combustion chamber. The engine was coupled to a dynamometer to measure its output. The fuel flow rates were measured with calibrated a burette. A smoke meter in HSU measured the soot. Blends of CSO + DO were prepared as 10%, 20%, 30%, 40%, 50%, for better homogenization compressed air is passed through the blends. All the tests were conducted at identical conditions of engine stability.

The injection timing and compression ratio were unaltered during the entire testing. By keeping the speed constant at 1500 rpm and without changing any of engine settings the following parameters were studied, brake power output, brake thermal efficiency, exhaust gas temperature, exhaust particulate matter etc. Before testing, all the components are inspected and cleaned properly. Crankcase lubricating oil is changed because partially burned fuel reacts with cylinder walls to dilute or contaminate lubricant. Initially the engine is operated on 100% diesel for 10 minutes to pre-heat the engine and then blends of (CSO+DO) in the ratio of 10%+90% is supplied to the engine and its performance, exhaust emissions are determined. The procedure is repeated with 20%+80%, 30%+70%, 40%+60%, and 50% +50%.

With 50%CSO and 50% DO, it is observed that though the exhaust emissions are not much affected the performance is seriously affected. Hence further reduction in the proposition of diesel is not advisable as it results in maximum wear and tear due to improper combustion.

5. RESULTS AND DISCUSSIONS

The test samples in the range of 10% to 50% blends were tested in the laboratory; which show the following differences, when compared with standard diesel.

1. Figure .1 shows fuel flow rate with respect to brake power in that the lower energy content/ unit mass of blend compared to diesel fuel resulted in increased mass flow rate. A possible explanation is that the more viscous fuel blends reduce normal injection pump leakage enough to make a significant change in the volume discharged per stroke. Although the heating value relationship tends to reduce the specific energy input rate as blend fraction increases, the net effect is an increase in fuel heat supplied. Engine performance and emissions were influenced by basic difference between diesel fuel and (CSO+ DO) blends such as heating values, viscosity, density etc.,

2. In Figure.2, at constant speed of 1500 rpm is observed so the brake thermal efficiency decreases with the increase in CSO content in diesel. This

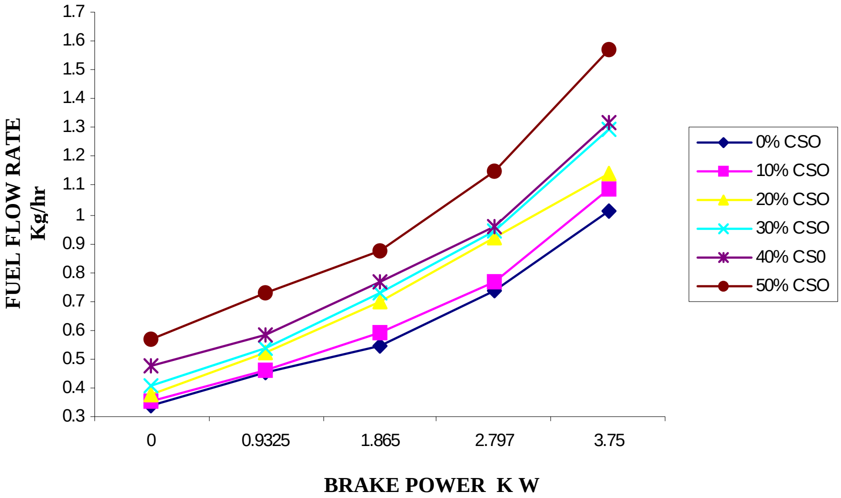


Figure 1. VARIATION IN FUEL FLOW RATE WITH BP FOR DIFFERENT CSO/DO BLENDS

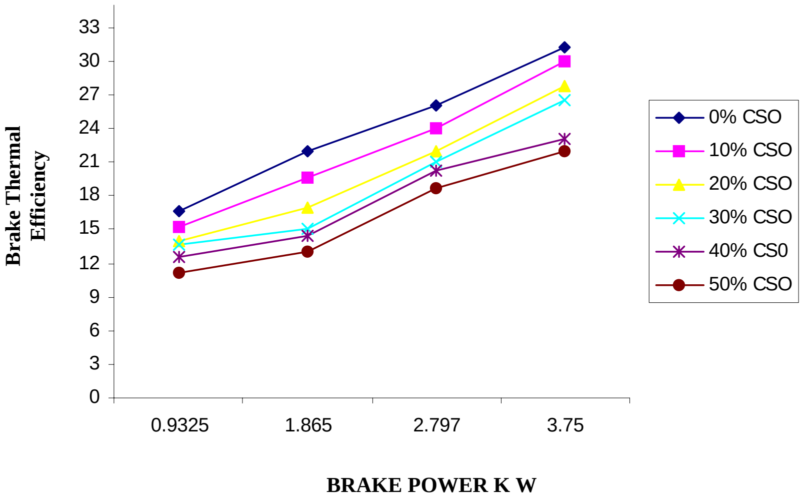


Figure 2. VARIATION OF B.T.E. WITH BP FOR DIFFERENT CSO/DO BLENDS

decrease in efficiency is less, compared to the ability of the combustion system to accept the CSO blends as fuel. This may be due to the high viscosity of CSO content in the blends, and this may degrade fuel spray characteristics and lead to improper combustion, which result in a minor decrease in efficiency. Brake Thermal efficiency decreases slightly with respect to BP at the maximum load; this may be due to a lower heat content of CSO, which leads to non-uniform combustion of the fuel.

3. Figure 3, shows the increase in soot with an increase in CSO content in the diesel at different load conditions, which may be due to the

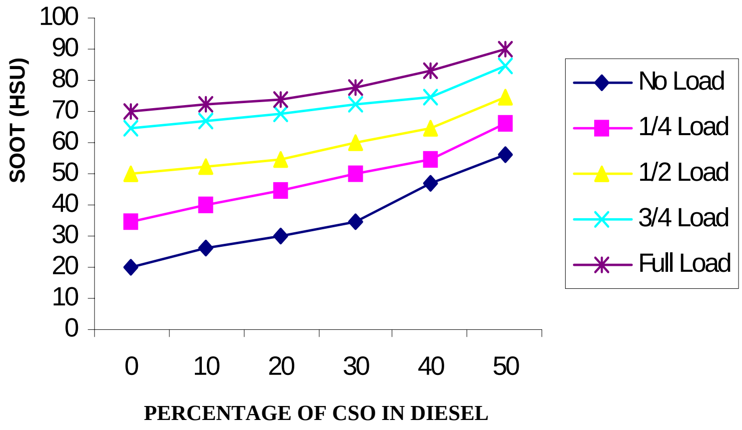


Figure 3. VARIATION OF SOOT WITH BP FOR DIFFERENT CSO/DO BLENDS

incomplete combustion of blends due to low heat values associated with high fuel viscosity, resulting in larger mean fuel droplet size and decrease in air fuel mixing rate. Poor atomization is a result of the viscous nature of the oil. The fuels physical properties such as density, viscosity can have a greater influence on smoke emission than the chemical properties. This can be attributed to higher carbon content in vegetable oils.

4. In Figure.4, densities of blends are slightly higher when compared with diesel fuel.

5.In Figure.5, viscosities of vegetable oil blends are significantly higher when compared with diesel.

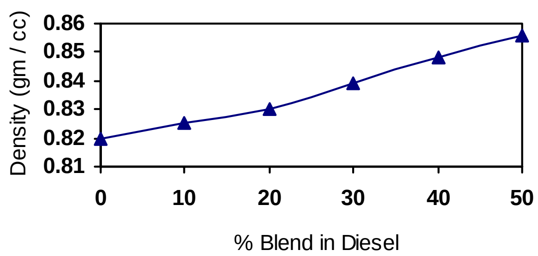


Figure 4. Blend Verses Density

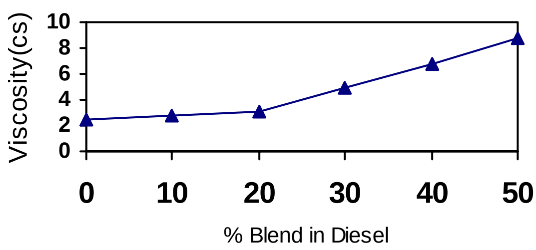


Figure 5. Blend Vs Viscosity

6.In Figure.6, heating values of blends reduced by 10% when compared with the Diesel.

In the general test observations there is very slight deposition on nozzle tip, deposits formed were soft and easily removable with cloth. For the

7. long-term operation, injection nozzle carbon deposits may lead to poor fuel atomization and dilution of the crankcase oil. Deposits that formed on the nozzle tip exterior are believed to originate from the thermal cracking of the fuel that boils from the nozzle sac late in the expansion stroke. This problem can be overcome by relocating the position of the injector nozzle in the engine cylinder head.

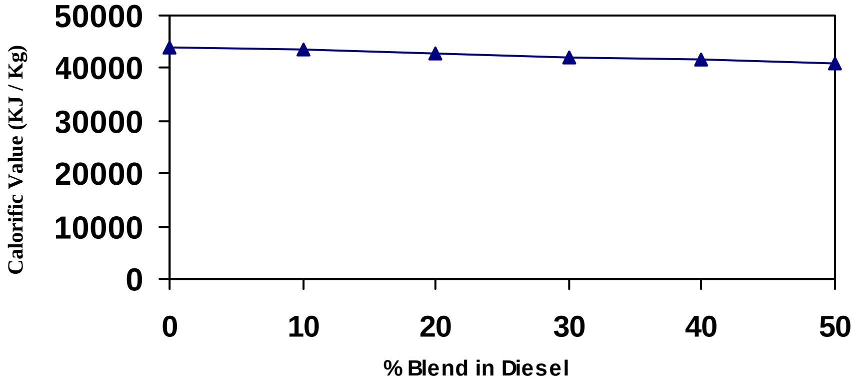


Figure 6. Blend Vs Calorific

6. CONCLUSION

Based on the investigations the following conclusions are drawn:

1.Comparison of engine performance for diesel and blends resulted in lower thermal efficiency.

2.Blends of up to 30% can be successfully employed in the rural areas to meet short – term, fuel scarcity, without engine modification.

3.Low temperature operations appear impractical due to the high cloud /pour points, unless some curative additive can be developed or means for heating the fuel system is added.

4.There is a very small nozzle tip deposition & no clogging of fuel filter was observed, which can be controlled by esterification

5.Soot was found to increase by increasing the percentage of CSO in the blend due to the poor atomization as a result of viscous nature of the oil. Hence providing an advanced injection timing and higher compression ratio can minimize this.

Thus, in developing nations CSO is available in ample quantity, if it is processed as per the fuel requirements in mass production then there is a chance for reducing its overall cost. Then it will become a renewable source of energy in the case of diesel fuel scarcity.

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