Experimental Performance Analysis of A Diesel Engine Fueled with Bio-Fuel Blends As Alternatives

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***Abstract*— Biodiesel is a fuel derived from renewable resources, such as vegetable oils and animal fats. Biodiesel is believed to be a promising substitution to petroleum diesel for the reason that it has similar properties. Moreover, when compared to conventional petroleum diesel, it is biodegradable, renewable and non-toxic. This paper mainly focuses on the characterization of biodiesel from two different sources such as neem seed and coconut. There is a minimal observed change in the performance of the engine. Neem seed oil blend have better performance when compared to coconut oil blend. This is due to the delayed combustion of neem seed oil blend.**

Keywords—Bio-fuel, Blend, performance, Bio-diesel.

I. INTRODUCTION

Nowadays for any country petroleum formed fuels have become important for its development. Products derived from crude oil continue to be the major and critical sources of energy for transportation sector all over the world. However, petroleum reserves are non-renewable and are depleting day by day. Fuel consumption was projected to increase from 83 million barrels per day in 2004 to 118 million barrels per day by 2030. If present trend continues the world in the year 2000 A.D. will be more crowded than that of today [1].

Over the next 20 years, demand for petroleum and other liquid fuels is expected to increase more rapidly in the transportation sector than in any of the other endues sectors. India's transportation energy use is projected to grow at an average rate of 3.3 percent per year compared with the world average of 1.7 percent per year. In India Diesel is mainly consumed in the transport, industrial and agricultural sectors. Increase in energy demand due to growth in population has affected the underground fossil fuel resources [2].

It is important to identify suitable alternate fuel as substitution in place of diesel fuel. Any alternate fuel which finds suitable as substitute to diesel is comparatively inferior to diesel in both performance and combustion characteristics. Hence there is a need to improve and optimize the fuel properties and operating parameters respectively.

Rudolf Diesel investigated using vegetable oil to fuel engines of his design, and in a 1912 presentation to the British Institute of Mechanical Engineers [3].

A. Motivation and goal

In the recent times, non-renewable energy sources contribute about 90% of the fuel requirement for energy generation and transportation. Rapid urbanization, increasing population and high living standards create demand for alternative energy sources. Scarcity in petroleum resources and global warming increases the quest for a renewable, sustainable and more eco-friendly fuel source. Apart from the field of energy, petroleum also plays a vital role as a raw material for many chemical products that includes pharmaceuticals, solvents, fertilizers, pesticides and plastics. As an upshot of this scarcity in petroleum resources, it is important to find out alternate energy sources, which drive the attention in areas such as biomass, fuel cells and solar cells.

B. International Energy Scenario

The international institute of applied system analysis (IIASA) was developed the first global scenario, later many were developed, during late 1979's. According to international energy agency (IEA), a survey was conducted by twenty six countries; in these twenty-one countries are being producing biodiesel, in these mainly European Union, east Europe and USA alone the overall capacity was 1300000 tons. Biodiesel was identified as fuel additive for environmental protection. This was concluded by US agency meeting which will meet the standards of California air resources board.

C. India's Energy Scenario

The As per 2009/10, estimates, the crude oil production in India stood at 33.67 MT which is approximately the same as compared to the previous year's production of 33.51 MT (2008-09). Since the Indian economy is growing at the rate of 6% or more and the energy demand is therefore, expected to rise to 166MT by 2019 and 622MT by2047. [1] The demand of crude oil in the country is met through indigenous supplies as well as through imports. The dependency on imported crude oil has been about 79% of the total demand in 2009/10

valued at Rupees 3753 billion which is 9% higher than the 2008-09,Fig I shows that the demand of crude has reached to 159.3MT during 2009-10 which is about three times more than 57.8MT during1979-2000.

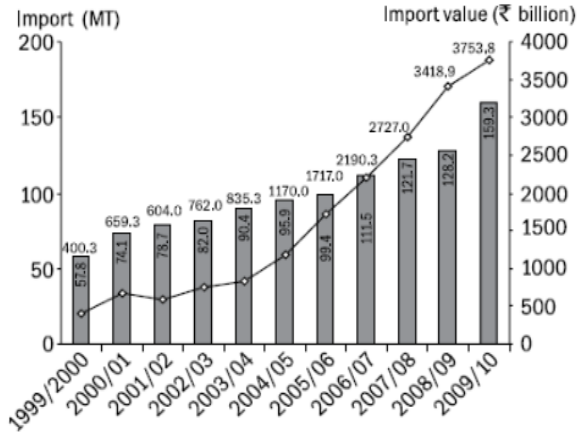

Fig. 1. Annual imports and cost of crude oil imports [4]

D. Alternative Energy Source

The Limited sources of fossil fuel, strives the scientific society to develop alternative energy sources. Biodiesel is derived from renewable resources such as vegetable oils and animal fats. Biodiesel is believed to be a promising substitution to petroleum diesel for the reason that it has similar properties. There is a very large market potential for alternative fuels. According to International Energy Outlook 2015 report, the global demand for oil has grown from 70 million barrels per day in 2003 to 80 million barrels per day in 2015 with a projected demand of 118 million barrels per day in 2030. The global demand for oil continues to rise steadily, while the current oil price is already 35% higher than predicted prices. Members of the organization of petroleum exporting countries are expected to supply 14.6 million barrels per day. The higher oil price has induced substantial increase in production by non-member countries around 23.7 million barrels per day.

Table 1.1: Long-term goal set by different countries

Country	Renewable Energy Goals
Germany	Biodiesel target of 10% by 2015; Reduction of greenhouse gas emissions by 40% by 2020 against 1990 levels.
China	Share of 10% biodiesel by 2010, 15% by 2020.
UK	Renewable transport fuels accounting for 5% in 2010 and 10% in 2015; Reduction in carbon dioxide emissions by 26-32% (2020) to 80% (by 2050) against 1990 baseline.
USA	Soya biodiesel share of 4% in 2016; Replacement of 15% of current gasoline consumption by 2017 (State of the Union 2007)
India	Share of 10% biodiesel by 2020

E. Environmental Impact of Biodiesel

Another major contributing factor to the importance of biodiesel production is reduction of greenhouse gas emission. Since biodiesel is produced from plants, which obtain carbon dioxide from air during photosynthesis, it reduces the overall carbon dioxide emission. Life cycle analysis of biodiesel demonstrates that overall carbon dioxide emissions 6 are reduced by 78%, when biodiesel is utilized instead of petroleum-based diesel fuel (Van Gerpen 2005). The Environmental Protection Agency has mandated a standard known as ultra-low sulphur diesel, requiring diesel fuels used in both on and off-road vehicles to be lowered to 15 ppm of sulphur (API 2015) [4].

F. Biodiesel Standards

The existence of a national biodiesel standard limits the quantity of poor quality biodiesel available on the market, providing buyers with more consistent fuel performance and encouraging producers to provide an appropriate product. major contributing factor to the importance of biodiesel production is reduction of greenhouse gas emission. As biodiesel is gaining its recognition as an alternate fuel, standards and regulatory compliance are mandatory for its commercialization and market introduction. There are three major biodiesel standards that are most referred namely, the American Standard Specifications for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels, ASTM D6751, the European Standard for Biodiesel, EN 14214 and the German standard, for fat methyl ester, vegetable and animal products, DIN V 51606. The major differences between these standards are their intended applications and the preferred test methods [5].

II. OBJECTIVES OF THE EXPERIMENT

The objectives of the present experiment are:

- To identify and compare potential sources for the production of biodiesel which includes neem and coconut oil and to define the requirements for biodiesel production by the esterification process, testing its quality by determining its parameters.
- To determine the physical and chemical properties of biodiesel using standard methods and to compare them with ASTM D6751 standard.
- The experimental works have been performed with respect to engine's output performance running on normal diesel will be compared to its performance when running on biodiesel.
- To evaluate the engine's performance on the important parameters which includes brake thermal efficiency, brake specific fuel consumption and exhaust gas temperature.
- The study will be conducted to combine fuel property characterization and simultaneous engine performance with fuel blends considering the strategic issues to its feasibility.

III. OILS USED AS BIOFUEL FOR BLENDING

A. Neem Seed Oil

Neem tree, which is also known as Azadrichtaindica, is one of the best-known trees in India, which is known for its medicinal properties. Extraction of oil has been of great interest worldwide. The fruit is a smooth (globous) olive-like drupe which varies in shape from elongate oval to nearly roundish, and when ripe is 1.4-2.8 centimetres by 1.0 1.5 centimetres. The fruit skin (exocarp) is thin and the bitter-sweet pulp (mesocarp) is yellowish-white and very fibrous. It is a typical tropical to subtropical tree and exists at annual

mean temperatures of 21-32 °C. It can tolerate high to very high temperatures and does not tolerate temperature below 4 °C. Calorific value of Neem seed oil is 39.82MJ/Kg.

B. Coconut Oil

The coconut tree (Cocosnucifera) is a member of the family Arecaceae (palm family). It is the only accepted species in the genus Cocos. Cocosnucifera is a large palm, growing up to 30 m tall, with pinnate leaves 4-6 m long and pinnae 60-90 cm long; old leaves Brake away cleanly, leaving the trunk smooth. Density of coconut oil is 0.925 g/cm3.

IV. PRODUCTION OF BIODIESEL

Biodiesel production is a deceptively complex process, rather than a simple process at first sight. There are a number of processes and operating parameters that affect the transesterification reaction used to produce biodiesel

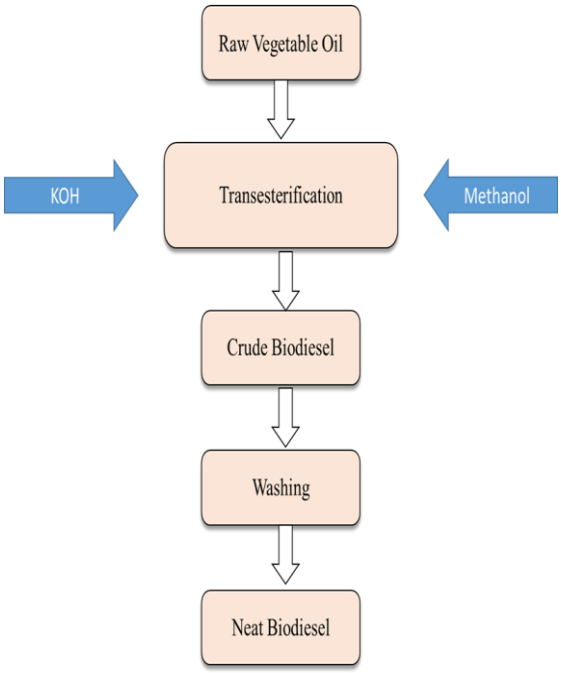

Fig. 2. Simple Flowchart for Bio-fuel Production

V. EXPERIMENTATION

Experimentation is carried out on a single cylinder four stroke diesel engine fitted with electrical dynamometer for testing with slight modifications to adjust for bio-fuel blend combustion.

Neem seed oil and coconut oil are used for blending. The fuel blends are named as B5 with 5% blend mixed in diesel and B10 with 10% blend mixed in diesel.

A. Blending of neem seed oil with diesel

a) Diesel

b) Neem Seed Oil

c) Addition of Neem Seed oil into diesel d) Biodiesel from Neem seed oil

Fig. 3. Blending of Neem seed oil with Diesel

B. Blending of Coconut oil with diesel

a) Coconut Oil

b) Addition of Coconut oil into diesel c) Biodiesel from Coconut oil

Fig. 4. Blending of Coconut Oil with Diesel

C. Experimental work on diesel engine setup

Fig. 5. Filling of fuel\tank with Biodiesel

Fig. 6. Diesel Engine Experimentation with Biodiesel

VI. RESULTS AND DISCUSSIONS

Results of performance tests are plotted on graphs for the above mentioned blends and diesel. Break thermal efficiency and Break specific fuel consumption is plotted along ordinate and Load is considered along abscissa.

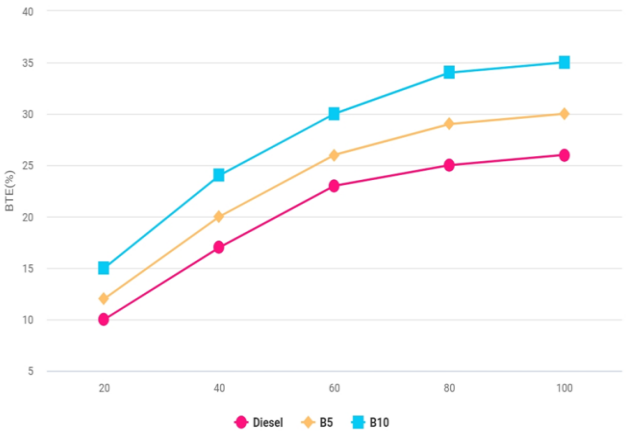

Fig. 7. Comparison of Break Thermal Efficiency between diesel and Neem seed oil blends

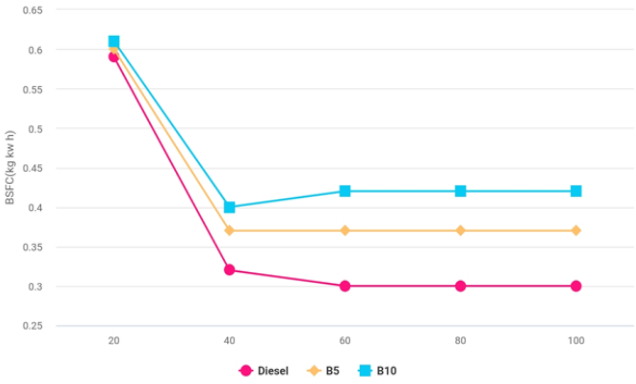

Fig. 8. Comparison of BSFC between diesel and Neem seed oil blends

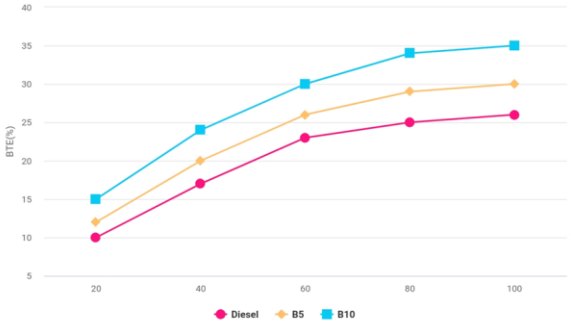

Fig. 9. Comparison of Break Thermal Efficiency between diesel and Coconut oil blends

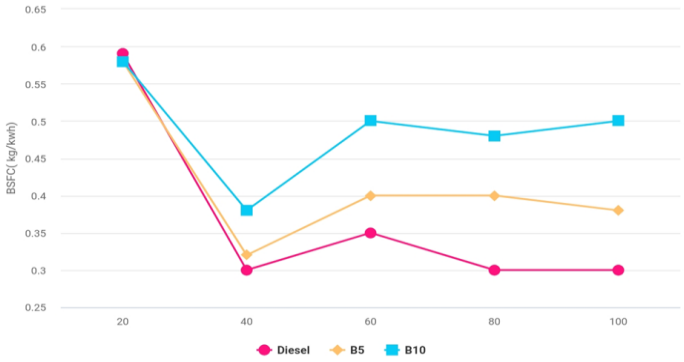

Fig. 10. Comparison of BSFC between diesel and Coconut oil blends

From the above graphs it is observed that, the performance of bio-fuel blends is better than diesel in terms of Break Thermal Efficiency and Brake Specific Fuel Consumption.

VII. CONCLUSIONS

Comparing Neem seed oil and coconut oil blend, the performance of neem oil blend is better. When comparison is done between B5 and B10 blends, B10 is better in both the aspects. Hence finally it is concluded that B10 neem seed oil blend is the most feasible solution for the desired properties of a bio-fuel.

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