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COMPARATIVE INVESTIGATION ON COMBUSTION AND PERFORMANCE OF A DUAL FUEL ENGINE USING LPG AND BIODIESEL

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ABSTRACT

Diesel is the prime source of power for equipment and machinery used in industrial and agriculture sector. The cost of diesel and its transportation charges, account for a large percentage in the farm expenses. Also, the continuous increase in petroleum prices has caused significant erosion in the foreign exchange reserves of developing countries like India. Due to the increasing demand for energy and in view of the deteriorating effect of petroleum on environment, it has become essential not only to use the existing non-renewable fossil fuels conservatively and efficiently, but also to explore other sources of energy. Such sources of energy that would be renewable, cost effective, low technology based and are non-damaging to the environment. One such potential source of energy is the oil derived from the seeds of karanj tree (Pongamia Pinnata). With the use of karanj oil, as an alternative to diesel, a farmer can become self-sufficient in his energy requirements. Moreover, he would also be contributing towards a healthier environment and in reducing the dependence of the nation on other countries for oil imports. The research work carried out mainly is a comprehensive investigation into the possibility of using renewable fuel (karanj oil) along with LPG in dual fuel engine and comparing the results with those obtained in single fuel mode. Karanj oil is an inedible vegetable oil. High viscosity of vegetable oils poses problems in long term engine operations. Hence, viscosity of karanj oil was reduced by blending and transesterification process.

Keywords: *Industrial and Agriculture Sector, Environment, Non-Renewable Fossil Fuels, Karanj Oil.*

Introduction

The fossil oil reserves in the world are depleting at an alarming rate, but the demand for oil is growing many-folds each year as oil provides energy for about 95% of transportation. The largest oil consuming and producing countries of the world are given in Table 1 and Table 2 respectively. Table 3 depicts oil produced by OPEC and other countries. About a quarter of total oil reserves of the world lie in Saudi Arabia. It is estimated that by the year 2008, average oil production in the world will reach its highest level. After that it is believed that production will fall by 2-3% per year. Middle East Asia would contribute to 30% of total oil production till the year 2010, and by that time, oil resources of other nations would be on the verge of exhaustion. It is estimated that the share of the Middle East Asia would rise to 55 to 60% by the year 2020. By that time the prices of petrol and diesel would be so high that these commodities would probably be out of the reach of common man. On a pessimistic view, these fuels may wind up as near as year 2050. In India, the requirement of motor spirit is expected to grow from little over 7 MMT in 2001-02 to over 10 MMT in 2006-07 and 12.84 MMT in 2011-12. In respect of diesel (HSD), the demand is expected to grow from 39.81 MMT in 2001- 02 to 52.324 MMT in 2006-07 and just over 66 MMT in 2011-2012. The domestic supply of crude will satisfy only about 22% of the demand and the rest will have to be met from imported crude. The crude prices and availability are subject to great volatility depending upon the international situation, and therefore, attempts need to be made to reduce dependence on imports.

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Table 1: Largest Oil Consuming Countries (Year 2004)

Country	**Consumption** (Million barrels/day)
USA	20.7
China	6.5
Japan	5.4
Germany	2.6
Russia	2.6
India	2.3
Canada	2.3
Brazil	2.2
South Korea	2.1
France	2.0
Mexico	2.0

Table 2: Largest Oil Producing Countries (Year 2004)

Country	**Production (Million Barrels/Day)**
Saudi Arabia	10.37
Russia	9.27
USA	8.69
Iran	4.09
Mexico	3.83
China	3.62
Norway	3.18
Canada	3.14
Venezuela	2.86
UAE	2.76
Kuwait	2.51
Nigeria	2.51
Britain	2.08
Iraq	2.03

Table 3: Year wise Oil Production (Thousand Barrels/Day)

Year	**OPEC**	**Other Nations**
1970	23000	25000
1980	28000	36000
1990	23000	41000
2000	31000	43000
2004	32000	44000

The increase in the use of petroleum products will also proportionally increase the risks of health hazard. The poisonous gases emitted by the burning of this fuel will pose a big threat to the environment. The leakage of crude oil during transportation spells disaster for both the flora and fauna of the area and the cleaning operations are expensive.

This has prompted the scientists and researchers to look at alternative fuels. In bio-fuels the country has a ray of hope. Since India has more than 300 varieties of tree species whose seeds yield oil, it could overcome the twin problems of need for adequate energy resource and the need for requisite tree cover in the semi-arid rural areas by propagating seed oil based energy generation. Use of edible oils as fuel is practically and economically unviable, hence in India focus is on inedible oils as alternative sources of energy.

Needless to state, that the proposed path will be environmentally friendly and ecologically sound. The byproducts, i.e., tree residues, leaf litter and oilcakes will create additional opportunities for appropriate use in rural areas.

Oil from the seeds of Karanj (*Pongamia Pinnata*) tree was used as alternative to diesel in the present research work. Use of karanj as bio-fuel is not something new. It is reported that far back in 1930s, eleven vegetable oils including karanj oil, were used as substitutes for diesel in a study in Kolkata [5]. But the use of vegetable oils was not viable at that time, as fossil fuels were cheaper.

Gaseous fuels such as Natural gas, Bio-gas, Producer gas, Liquefied Petroleum Gas (LPG), Hydrogen (H_2), etc. are also promising alternative fuels. These are, in general, less polluting. In developing countries, diesel engines play a major role in the agricultural and transportation sector. Gaseous fuels cannot be used directly in conventional diesel engines even at a very high compression ratio because their self-ignition temperatures are quite high. Using pilot liquid fuel (diesel or vegetable oil and its derivatives) injection, gaseous fuels can be very conveniently used in dual fuel mode even in existing diesel engines. For the present work, LPG was utilized as the gaseous fuel, as it can be easily procured locally and is also convenient to handle.

Objectives and Scope of Investigation

The main objective of the present study was to gain comparative insight into the performance and combustion of dual fuel engines with respect to single fuel CI engines using renewable fuels to identify the optimal performance parameters. Such a study, it is hoped, will facilitate the use of karanj oil and its derivatives (biodiesel) as an alternative to conventional diesel fuel. In view of the above, research was undertaken with the following objectives:

- To undertake exhaustive literature survey regarding alternative fuels in CI engines.
- To prepare biodiesel (methyl esters of karanj oil) in the laboratory.
- To determine important fuel properties of karanj oil and karanj methyl ester.
- To establish experimental and instrumentation setup for carrying out long term tests on CI engine with different fuels over a wide range of operating parameters such as load, injection pressure, etc.
- To prepare baseline data by operating the engine on diesel, karanj oil and karanj methyl ester.
- Enabling the CI engine to operate in dual fuel mode (LPG being one of the fuels) by making appropriate provisions/alterations.
- To gain an insight into the performance and combustion of dual fuel engine using:
  - Gaseous fuel: LPG
  - Liquid fuel:
    - Diesel
    - Karanj oil
    - Blends of diesel and karanj oil
    - Karanj methyl ester
    - Blends of diesel and karanj methyl ester
- Experimental evaluation of engine performance and combustion characteristics with different fuels, including determination and comparison of different parameters such as brake thermal efficiency, brake specific fuel consumption, exhaust gas temperature and exhaust emissions.
- Analysis of the experimental data relating to engine performance and exhaust emissions, its appropriate graphical representation and drawing of relevant conclusion.

Conclusion

On the analysis of the work done, it can be safely concluded that K20 and B20 fuels can be conveniently used as substitutes for diesel. Running an engine in dual fuel mode requires no major structural modification in the engine and the performance achieved is comparable to that of diesel with increased advantage of less pollution in terms of lower Smoke density, HC and NO_x emissions.

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