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Experimental Investigation of Datura Stramonium Biodiesel

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ABSTRACT

Energy demand is increasing due to the increase in the population growth in India and in the world at large. It has become apparent and to go as per the plan for the production of biodiesel to make a substantial contribution to the future energy demands with respect to the domestic and industrial economies. The use of non-edible plant oils is very significant because of the great demand for edible oils as a food source. Moreover, the edible oil feedstocks costs are far expensive to be used as fuel. Therefore, the production of bio-diesels from non-edible oil is an effective way to overcome all the associated problems with edible oils. However, the potential of converting non-edible oils into bio-diesels must be well examined because the physical and chemical properties might differ from each other, hence they need furthermore research on this. To dispose of these issues, thinking about the elective assets. Biodiesels, in view of no awesome oils, animals' fat ratio and tiny fishes are guests. The examinations on the impact of biodiesels on its strength and weakness highlights of diesel energy power engines. More viscosity consistency is found as the pure use of datura stramonium plant seeds oil straight in an engine that is expelled by transforming it into biodiesel by the trans-esterification process. Fuel highlights like calorific values, flashpoints and cetane numbers of biodiesel and biodiesel-diesel blends were discovered its properties are similar to diesel fuel. Performance comes about to uncover that a large portion of the biodiesels, has given 4.84% higher brake thermal efficiency and high brake specific fuel consumption. The NOx is less in some load condition and HC, slightly higher than diesel fuel.

Keywords— *Biodiesel, Trans-esterification, Energy*

1. INTRODUCTION

The awareness of energy issues and environmental problems is associated with the burning of fossil fuel has encouraged. Many researchers are investigating the possibility of using alternate sources of energy such as biofuels instead of crude oils and the derivatives of it. Among all of them, biodiesels seem to be more interesting for many reasons such as it is biodegradable and have minimum toxicity, it can be easily replaced with the fossil fuels in various different kinds of application such as in boiler's and in IC engines without any major's modification. It was observed that minor decrease in the performance, almost zero emission of sulfate, aromatic compound and other chemical substances can be reduced that is hazardous to human life and our environment.

The development of the vegetable oil-fueled engines was made by Sir Rudolf Diesel in the early 1900s. However, the full exploration of biodiesels came in the 1980 s. As the results of renewing interests in renewable source of energy for reducing greenhouse gas emission, and for making the reduction in the use of fossil fuels. Biodiesels are defined as the monoalkyl esters of long fatty chain acids, that are derived from vegetable oil or animals' fat and alcohols with or without the catalyst reaction. Compared to diesel fuels, biodiesel produces no sulfur, very less carbon dioxide, less carbon monoxide, particulate matter, smoke & hydrocarbons emission, and much more oxygen. Moreover, free oxygens lead to complete combustion and reduce emissions. Biodiesels are one of the promising alternative fuels which have gained attraction globally. Basically, it is defined as the mono-alkyl ester of long fatty chain acid that is derived from renewable biomolecules sources.

Table 1: Problem and cause in the use of Biodiesel as fuel

Problem	Cause
Choking of injector on piston and head of the engine.	The high viscosity of raw oils, unburned fuel, poor combustion.
Carbon deposited on the piston head of an engine.	The high viscosity of oils, incomplete combustion of fuels.

Advantages of Biodiesel:
(a) It is renewable energy efficient.
(b) It displaces petroleum-derived diesel fuels.
(c) It can be used in most of the diesel equipment with no or minor modifications.
(d) It can reduce global gas emissions.

2. TRANSESTERIFICATION PROCESS

Transesterification process that is used to convert bio-oil into biodiesel. It's a chemical process of transforming large, branched triglyceride molecules of the vegetable oils and fats into smaller, straight-chain molecules, almost similar in size to the molecules of the species present in diesel fuel. It is the most common production method and is the purest form of biodiesel production where vegetable oils and animal fats are used as feedstocks. The reaction of the oil with alcohol forms biodiesel and glycerol that can be a continuous process. This process more easily meets biodiesel fuel standards.

The Following Reaction takes place:

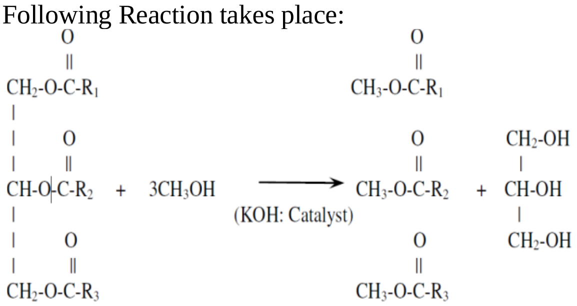

Fig. 1: Transesterification Reaction

2.1 Free Fatty Acids, Moisture Content, and Water Content

The Water and Free Fatty Acids are the critical contents for the trans-esterification reactions. The catalyst used in the process of production of biodiesel depends upon the Free Fatty Acids contents. More alkali catalyst is required if Free Fatty Acids content is more than 1%. An increase in viscosity can cause if the presence of water formation is there. Free Fatty Acids and water always produces a negative reaction in the process of trans-esterification. Many types of research had done with feedstocks having high Free Fatty Acids contents. However, in most cases, alkaline catalysts are used.

2.2 Types and Catalyst Concentration

The selection of a catalyst is important for the design of a sustainable Trans-esterification process. A commonly used catalyst in this process is Homogeneous catalyst, heterogeneous catalyst, and enzymatic catalyst. Presently homogeneous catalysts are mostly used. And the use of homogeneous alkaline catalysts is limited to batch mode processing. Sensitivity to Free Fatty Acids is the main difficulty in homogenous catalyst and water and resulting saponification phenomenon.

2.3 Along with Sodium Hydroxide (NaOH)

These colorless solids are strong prototypical base. It is having many industrial applications, and most the application exploits its reactivity toward acid and it is in corrosive nature. By reacting sodium hydroxide with impure potassium, we can find Potassium hydroxide in pure form. They are sold as translucent pellets, which become tacky when it comes in contact with the air because KOH is hygroscopic. Consequently, typically KOH contains amounts of water and as well as carbonates. Its dissolutions in water are very strong exothermic reactions which means this process gives off the significant heat.

2.4 Reactions Temperature, Mixing Intensity and Time

It is important to mention some important variable process variables of production of biodiesel from vegetable oil such as the methanol - oil ratio, reaction time, mixing intensity and temperatures. The molar ratios of alcohol and triglycerides are an important variable that affects the yields of biodiesel in the Trans-esterification reactions. The Trans-esterification reactions will complete within an hour using a methanol - oil molar ratio of 6:1 at the temperature of a reaction of 60.0 °C. The optimum temperatures for the Trans-esterification of various types of oil are 65.0°C, with most reaction being complete within 30 mins at this temperature, whereas at 25.0°C. The significantly lower yield was obtained even after the one hour of the reaction. The rate of the trans-esterification reactions of vegetable oils with alkaline methanol solution strongly depends upon the rate of mass transfer at the interface between the glycerol & methanol and oil ester phases. Normally lower reaction rates were observed in the transesterification process because of poor dispersion of the methanol and oil phases. The optimum stirring rate was in the range of 1000 rpm using both motionless as well as high shear mixers.

2.5 Diesel engine Emissions

The diesel engine offers the possibility of combining very high thermal efficiency with very low emission, and their good fuel efficiencies result in low carbon dioxide $(CO)_2$ emission. The main problem for diesel engines is the emission of nitrogen oxides (NOx) and other particulates and these two pollutants are the trade against each other in many aspects of engine designs. The high temperature in the combustion chamber helps to reduce the emissions but produces a high level of nitric oxides (NO). Lowering the peak temperature in the combustion chamber will reduce the amount of NO production but increases the soot formation. For better air-fuel is the key to lower emission. The NO produced rapidly oxidizes to NO2 called NOx. NOx combines with hydrocarbons or with volatile organic compounds in the presence of sunlight to form low-level ozone. This all leads to form smog.

Table 2: Literature Review Comparison Table

Reference	1			3		6		
Injection Rates	200	220	240	195	210	200	220	240
Increase in pressure	5.22%	3.9%	2.63%	4.74%	5.09%	3.25%	2.9%	1.43%
Reduction in HC emission	24.7%	29.51%	27.98%	38%	40.14%	17.1%	12.88%	9.0%

2.6 Datura Stramonium

Datura stramonium is also known by the English names jimsonweed, It is a plant in the nightshade family. Its origin is Central America, and it has been introduced in many world regions also. It is an aggressive invasive weed in temperate climates across the world. Datura stramonium has been used in various treatments of traditional medicines or drug abuse as well as it is taken as an entheogenic ally for intense visions. It contains tropane alkaloids that produce the hallucinogenic properties and may be toxic.

2.7 Datura Stramonium Seeds

A few select matured plants show in figure 2 that are in green in color are taken from which the seeds are obtained. Seeds, as shown in figure 3, are stored in shade for 3 weeks. Shrunken, weightless and boring seeds are rejected. Seeds then are ready for further process of the oil preparation process. The seeds collected from the dried fruit bunches that fall off the plants from coastal parts of Tamil Nadu. There will be usually three seeds in the fruit pockets. These plants are mostly found in coastal and arid regions of Andhra Pradesh and Tamil Nadu.

Fig. 2: Dried Datura Stramonium Seeds

Fig. 3: Dried Datura Stramonium Seeds

3. METHODOLOGY

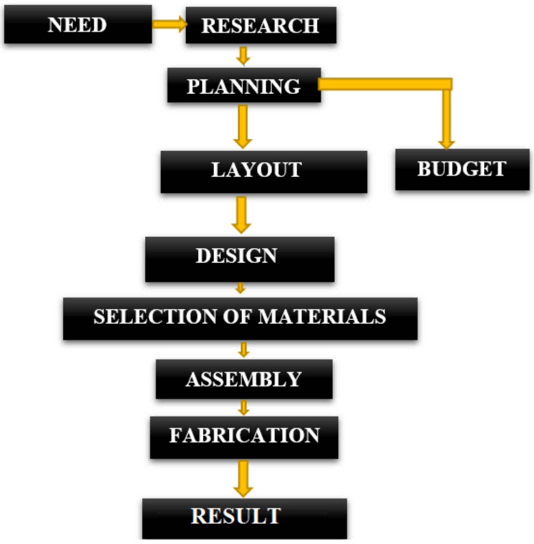

Fig. 4: Project Methodology Chart

4. EXPERIMENTAL WORK

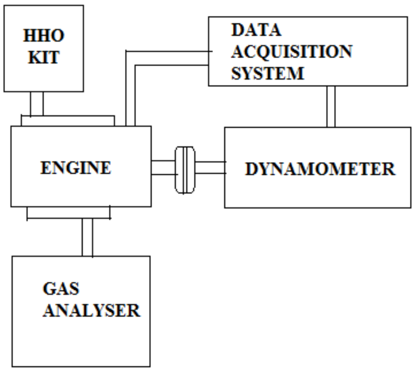

Fig. 5: Block Diagram of Experimental Setup

Table 3: Engine Specification

Bore & Stroke	87.5 & 110 mm
Rated power	5.2 KW @ 1500 rpm
Compression ratio	17.5:1
Connecting rod length	234 mm
Crank radius	60 mm
Capacity	661 cc
Aspiration	Natural
Type of injection	Direct injection
Type of operation	Four Stroke

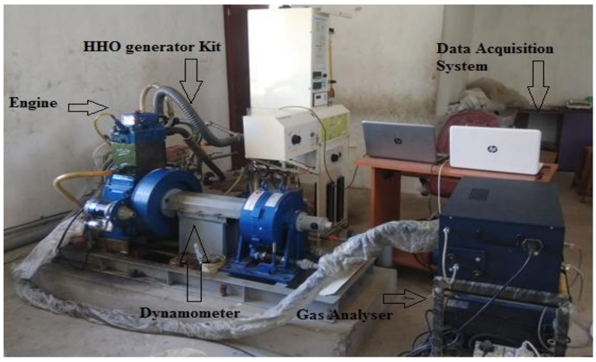

Fig. 6: Actual Experimental Setup

5. RESULT AND DISCUSSIONS

The performance characteristics were done at various load conditions using datura biodiesel as additive fuel with diesel fuel in diesel engines discussed below.

5.1 Performance parameters

The below figure 7 shows the difference of the brake thermal efficiency for the different fuel blends like DME 5%, DME10%. DME 15%, DME 20% and DME 25% with different load conditions in diesel engines. The increase in the load conditions increases the brake thermal efficiency also. At the DME 5%. 10%, 15% and 25% of different blends are similar brake thermal efficiency up to 50% load conditions but once it reached to 75% and 100% load conditions we noticed that it is lesser efficiency compare with neat diesel fuel but, the DME 20% given the high brake thermal efficiency at the 75% and 100% load conditions which account of 4.84% increase compared with the pure diesel fuel.

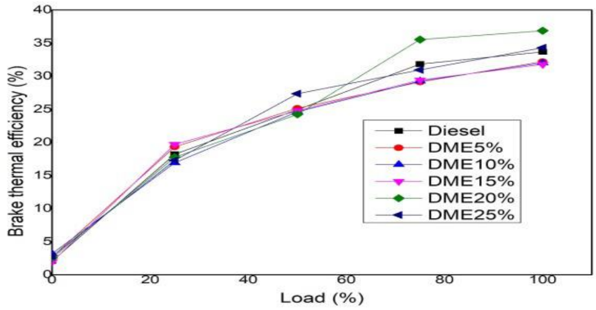

Fig. 7: Brake Thermal Efficiency Vs Load

5.2 Brake Specific Fuel consumption

The below figure 8 shows the difference of the brake specific fuel consumption for the different fuel blends like DME 5%, DME10%. DME 15%, DME 20% and DME 25% with different load conditions in a diesel engine. The increasing the load conditions will also increase the brake specific fuel consumption. At the DME 5%, 10%, 20%, and 25% of different blends are having higher fuel consumptions when compared with the neat diesel fuel in all load condition, but the DME 15% and 50% load conditions give less fuel consumption near 2.12% when compare with the pure diesel fuel.

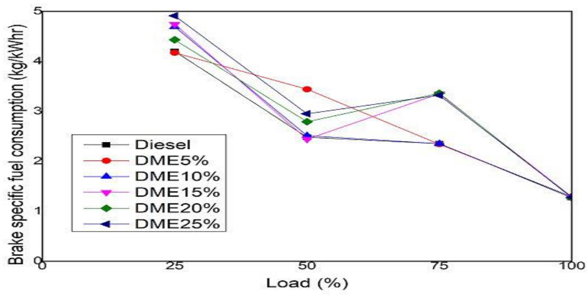

Fig. 8: BSFC Vs Load

5.3 Emission characteristics

5.3.1 Oxides of nitrogen: The difference of the oxides of nitrogen for the different fuel blends like DME 5%, DME10%. DME 15%, DME 20% and DME 25% with different load conditions in the diesel engine are shown in the fig. 4.3. The increase in the load conditions increases the oxides of nitrogen level simultaneously, the DME 15%, 20% and 25% at 50% load conditions give high NOx level when compare with the neat diesel fuel. At the DME 5%. 10%, blends are fewer oxides of nitrogen level from the initial stage to full load conditions when compare with pure diesel fuel.

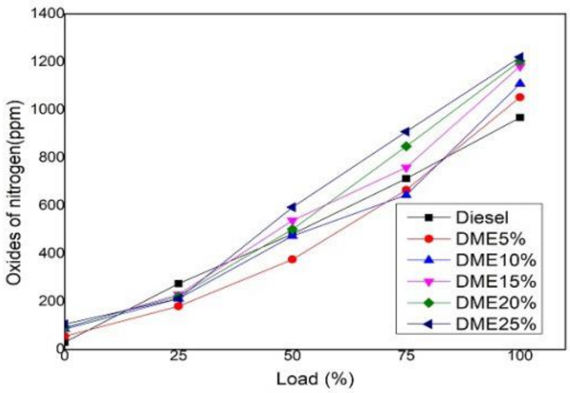

Fig. 9: NOx Vs Load

5.3.2 Carbon Monoxide: The carbon monoxide emission shows the difference of the carbon monoxide for the different fuel blends like DME 5%, DME10%. DME 15%, DME 20% and DME 25% with different load conditions in the diesel engine as shown in the fig. 4.4. The increasing load conditions increase the carbon monoxide level simultaneously, the DME 15%, 20% and 25% at 50% load conditions onwards give high CO level when compare with neat diesel fuel. At the DME 5%. 10%, blends are less carbon monoxide levels from the initial stage to full load conditions when compare with pure diesel fuel.

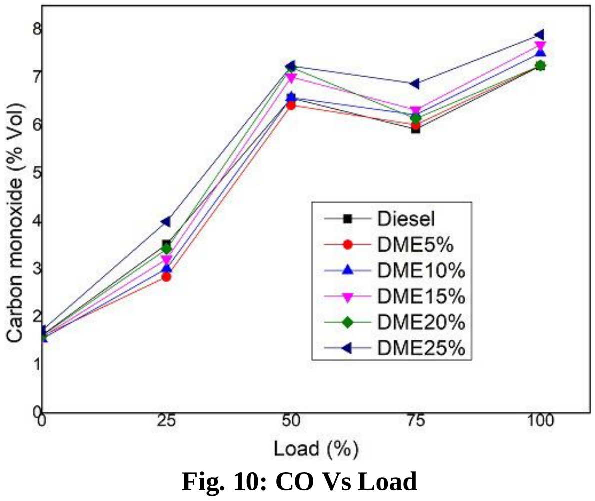

Fig. 10: CO Vs Load

5.3.3 Unburned Hydrocarbons: The unburned hydrocarbon emission figure 11 shows the difference of unburned hydrocarbon emissions for the different fuel blends like DME 5%, DME10%. DME 15%, DME 20%, and DME 25% HC level when compared with neat diesel fuel. At the DME 5%. 10%, blends are a little bit equal to diesel fuel from initial load condition to final load condition when compare with neat diesel fuel with different load conditions in the diesel engine. The increasing in the load conditions increases the unburned hydrocarbon level due to incomplete combustion. Simultaneously, the DME 15%, 20% and 25% at 50% load conditions onwards give a high HC level when compare with neat diesel fuel.

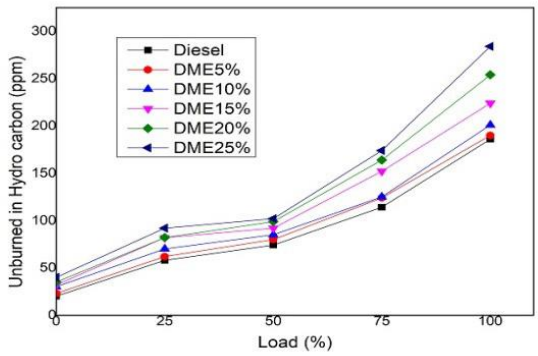

Fig. 11: Unburned Hydrocarbon Vs Load

6. CONCLUSIONS AND FUTURE SCOPE

6.1 Conclusion

- Datura Stramonium seeds were collected and sun-dried, then bio-oil was extracted with the help expeller. 330 ml of oil was extracted from 1 kg of seed.
- Since FFA content is less than 2%, Palmyra palm biodiesel was chosen. Trans-esterification is the most common method for converting the bio-oil into biodiesel, because of the cost-effective and faster production process.
- KOH is readily available which is used as a catalyst for the reaction, at the time of reaction KOH plays a significant role in the transesterification process. It is always advisable to do trans-esterification for fresh expelled oil rather than stored bio-oil. Oil to biodiesel conversion efficiency obtained by the transesterification process is 95%.

6.2 Future Scope

- Blend ratio can be increased in future experiments.
- A flow rate of HHO gas can be increased to have a better advantage of it during combustion processes.
- Injection pressure can be increased up to 300 bar, the performance and emission characteristics can be analyzed in the future. Injection timing can be modified either advance or retard and the combination of the above parameters can experiment.
- Various other blends of biodiesel can experiment.
- Obtained biodiesel may substitute in the place of diesel.

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