EFFECT OF ADDITIVES ON PERFORMANCE AND EMISSION CHARACTERISTICS OF SINGLE CYLINDER ENGINE USING VEGETABLE OIL BLENDED WITH BIODIESEL AS FUEL

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Introduction: India is having vast wastelands available for forest plantation. The proper propagation and cultivation of forest trees like Jatropha, honge, mahua and utilizing the same for producing bio diesel, our nation can change the backward and poor area into very prosperous and developing areas within a decade time. Non-edible oils can prove alternatives to edible oils for bio diesel production. Further, local growth associated in crushing and marketing encourages the entrepreneurs to start small industries to produce raw or finished goods. This is one of the factors that contribute to the concept of sustainable rural areas where environment and people are independent where India could be world lenders in supply of oil. According to a survey conducted in 2002, twelve most important and abundant non-edible oil-bearing trees produce 97 lakh tones of seeds per year, of which only 12% is utilized. These twelve species of trees are Neem, Mahua, Undi, Jatropha, Castor, Kusum, Plu, Dhupa, Nahor, Kokum and Sal.

Biodiesel, a diesel fuel substitute that can be made from a variety of oils, fats, and greases, is of interest to farmers for a number of reasons: It can provide an additional market for vegetable oils and animal fats; it can allow farmers to grow the fuel they need for farm machinery; and it can decrease U.S. dependence on imported oil since fuel feedstock can be grown domestically.

Objectives of the project:

- To identify the source to collect the raw materials i.e. Pongamia oil
- Extraction of Pongamia oil.
- Production of biodiesel from Pongamia oil (transesterification).
- To blend the neat bio diesel with vegetable oil and obtain the various blends.
- To study the fuel properties such as calorific value, viscosity, flash point etc. of the blended fuel samples.
- To carry out the performance analysis and emission tests on Diesel engine for different blends vegetable oil and biodiesel samples.
- To carry out the performance analysis and emission tests on Diesel engine for different blends of vegetable oil and biodiesel samples by varying the percentage of additives in blends of biodiesel.
- To compare the results of the performance and emission characteristics tests obtained for all the above blended fuels.
- To conclude that the diesel engine can also run with SVO blended with biodiesel up to 20 % blend without any additives in engine and can run up to 40 % with additives.
- Optimization of percentage of additives in the blends for better performance.
- To successfully arrive at a conclusion and put light on future possibilities and scope in this particular sector.

Methodology involved in project:

The different stages of works are explained as follows:

Stage 1: Extraction of Pongamia oil

- The oil collected should be first purified by hand picking of coarse and floating impurities.
- It will be later heated to 100 °C to remove all its moisture contents and it will be strained which in turn filtered it. To obtain purified oil /clarified oil.
- Purified oil is used for experimentation.

Stage 2: Free fatty acid test

- 10ml of is propanol is taken in a flask.
- 3-4 drops of phenolphthalein indicator is added to propanol.
- 1 gram of Pongamia oil is then added to propanol and phenolphthalein indicator mixture.
- KOH (0.01) solution is allowed drop by drop to the Pongamia oil solution till the solution become pink for 5-10sec and then disappear.
- KOH (0.01) solution consumed to get pink color is noted down. Depending on the amount of KOH (0.01) consumed fatty acid present in the oil is decided.

**Stage 3: Production of Biodiesel by Transesterification Process**

Transesterification process will be carried out for the purified SVO by a 2 stage process depending upon the FFA Test results which involves

- Acid catalyzed Transesterification
- Base catalyzed Transesterification

**Acid catalyzed Transesterification:** Pongamia oil extracted from the pongamia seeds consist of high FFA contents which were causing the transesterification difficulty. This is a type of reaction that takes place in the presence of methanol (30%) and sulphuric acid (0.5%) at 60°C with constant stirring (500-600 RPM), helps in the separation of impurities which were dissolved in the methanol as an upper layer and oil in the lower layer. The oil is separated and taken for 2nd stage.

**Base catalyzed Transesterification:** The settled lower layer of the earlier stages having low FFA is used as a raw material for this stage. The product of earlier stages i.e. pure triglycerides is made to react with methanol (30%) and catalyst, KOH (11.22 gms) for 2.5 - 3 hours at 60°C with constant stirring rate. The lower portion containing glycerol and other impurities are removed and further excess of alcohol and other impurities present are removed by water wash process. The water wash product then heated above 110°C in order to remove the moisture content present in the POME.

**Stage 4: Testing for properties and Preparation of Blends**

- Testing for fuel properties like Density, Specific gravity, Viscosity, Calorific Value, Flash Point and Fire Point of i) Vegetable oil ii) Biodiesel
- For Standard fuel properties, the tests are conducted at Bangalore Test House Bangalore
- Properties of blends such as B10,B20,B40 for SVO & Biodiesel and checked for layer formation

**Stage 5: Experimental works carried out**

Experimental works will be carried out on single cylinder, 4-stroke, DI computerized diesel engine coupled with Eddy current Dynamometer, situated at our institution R&D Lab for performance and emission parameters of the engine. The exhaust emissions are measured using AVL DIGAS 444 gas analyzer. The Blends of different combinations of fuels are as follows.

- Different blends of Straight Vegetable oil (SVO) and Biodiesel
- Addition of various percentage additives in blends of various proportions.

**Results and Conclusions**

The detailed conclusions drawn from the present investigation are discussed as follows some of the important conclusions are presented and are listed as follows.

- BSFC was found to increase by 6% when compared with blends of P40+BD60 and pure biodiesel (BD100).
- BSEC was found to be increased by 10.2% when compared with of P40+BD60 and pure biodiesel (BD100).
- BTE was reduced by 11.5% when compared with of P40+BD60 and pure biodiesel (BD100).
- As the blend increases the EGT also increases. For full load EGT increased by 7.8% when compare with pure biodiesel.
- In emission test we found that CO reduced 38%, HC was reduced by 47.3% and NOx increased by 26.3%.
- Additives improved the fuel blend regarding density and viscosity which in turn improved atomization and showed better combustion characteristics through higher engine brake power, lower BSFC and higher BTE.
- Among the additives Diethyl ether showed highest improvement through its less density and viscosity profile with quite a high calorific value.
- Regarding emission characteristics additives showed quite a good development of CO and NOx emission.
- It is revealed from the experiment that Diethyl ether is quite effective regarding emission and performance even when they are used only about 10 % as additives.
- Brake thermal efficiency increases with increasing in additive percentage in Biodiesel and it is lower in case of pure Biodiesel.
- BSFC is highest for pure Biodiesel at all loads because of high density, high volatility and low heat content of Biodiesel but with increasing percentage of additives BSFC decreases because of better combustion.
- CO and HC emissions are highest for diesel and lowest for pure Biodiesel because of higher oxygen content. It is also concluded that with increasing additives in Methyl ester both CO and HC tends to decrease.
- NOx emissions are found highest for pure Biodiesel because of high viscosity, high volatility and low heat content as compared to that of diesel. It is seen that NOx additions decreases with increase in percentage of additives to the Biodiesel.
Exhaust gas temperature is found highest for pure Biodiesel. This may due to high combustion temperature of Biodiesel because of high oxygen content. It is seen that exhaust gas temperature decreases with increase in additive percent in Biodiesel.

Scope for future work

- There is a chance of pre-heating the SVO and blending it with the biodiesel and additives
- One can carry out the same work studies on the C. I. D. I. engine by varying compression ratio, modifying fuel injection timing
- Similar tests can be conducted on multi cylinder heavy duty diesel engine used in transportation and agriculture.

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