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Performance and Emission Analysis of Ci Engine Using Honge and Waste Plastic Based Biofuel

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Abstract: **Energy is an important input in all sectors of a country's economy. Till date, the world in general and India in particular mainly depends on petroleum products as the energy source. Alternative fuels are the candidate fuels of the present and the future. More and more vehicles are switching over to alternative fuels worldwide, indicates a sure sign of their need. This work is mainly focused on using raw honge oil and waste plastic oil as alternative fuel in a CI engine. In the first phase of the study, different properties of honge oil and waste plastic oil fuels were evaluated and compared with that of neat diesel. In the second phase of the study, performance and emission parameters of neat diesel, diesel-honge oil blend (D80H20), diesel-plastic oil blend (D80P20), honge-plastic oil blend (H70P30) were analyzed at 180 bar, 200 bar and 220 bar injection pressure. The experimental results reveal that, better performance and emission characteristics among the biofuel blends at 200 bar injection pressure and that at 220bar for honge plastic oil blend.**

Keywords: Energy, alternative fuel, honge oil, plastic oil, injection pressure.

INTRODUCTION:

Alternative fuel is any material or substance, other than petroleum, which is consumed to provide energy to power an engine. Biofuel are rapidly growing interest for reason of energy security, diversity and sustainability as well for greenhouse gas mitigation. Fuels can be extracted from different kinds of seeds and vegetables, which have fuels properties close to diesel. The main purpose of choosing alternative fuel is that conventional fuels are going to run out, to reduce pollution, to protect against global warming, to save money, can reuse waste and life of engine. Pongamia pinnata also known as honge is a fast growing leguminous tree with the potential for high oil seed production and added benefits of an ability to grow on marginal land. These properties support the sustability of these plants for large scale vegetable oil production needed for sustainable biodiesel industry. Plastic have become an indispensable part in today's world, due to their light weight, durability and energy efficiency coupled with faster rate of production and design flexibility, these plastics are employed in entire industrial and domestic fields. Plastic can be converted to oil by the process called pyrolysis.

II. OBJECTIVES AND METHODOLOGY

Many researchers have conducted Performance tests on various biodiesel blends in order to optimize the blend concentration for long term usage in CI engines. In which, Maximum thermal efficiency and minimum specific fuel consumption are observed for a blend range of 10-20%. Hence the experiments are limited to B20 blend only.
The following objectives are drawn up for this work:
• To prepare biodiesel from raw honge oil and raw plastic oil.
• To characterize the test fuels.
• To evaluate performance characteristics viz., BTE, BSE of CI using blends of biodiesel at various injection pressure.
• To evaluate emission characteristics viz., UBHC, CO, NOx of CI using blends of biodiesel at various injection pressure.
To achieve the above mentioned objectives, following methodology is adopted and followed carefully so as to get the accurate and reliable results.
• The experiments are conducted at No load, 25%, 50%, and 75 % of full load condition with raw honge oil and waste plastic oil biodiesel blends.
• The experiments are conducted at the designed injection pressure of 180 bar and Injection angle of 270 bTDC and studied the performance and emission parameters.
• Similar experiments are conducted at 200 and 220 bar injection pressures (IOP).
• Standard exhaust emission tester is used to measure the emissions and are tabulated and plotted and compared with standard diesel fuel performance.
• The conclusions are drawn based on the results obtained.

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III. OIL EXTRACTION

HONGE OIL EXTRACTION

First the Honge seeds were collected and the oil was extracted from the seeds by expeller pressing. Fig 1 shows the experimental setup of expeller pressing machine.

Figure 1: Expeller pressing

Figure 2: Honge oil

PLASTIC OIL EXTRACTION

First the waste plastic was collected and made to cut into smaller pieces in range of 0.5 to 2 inches by scissor and was cleaned with detergent to remove dust particles and later processed in the oil extraction pyrolysis process,as shown in Fig 3. The reactor with tire was heated electrically up to 4750C with Ni-Cr wire electric heater. Besides, a nitrogen hole was used in the pyrolysis chamber to provide uniform heating across the cross-section of the reactor chamber and to create inert environment in the pyrolysis chamber. There was no output at low temperature range and the process was carried out between the temperature ranges of 3300C and 4900C in the reactor for about two hours The vapor products of pyrolysis were carried out through two condensers. The condensers were cooled by water and the condensed bio-oil was collected into two collectors. The non-condensed gas was flared to the atmosphere and the char was collected from the reactor after completion of pyrolysis cycle.

Figure 3: Extraction of plastic oil by pyrolysis process

IV. CHARACTERIZATION OF FUEL

After the extraction of oils the properties of oil were tested. Blending was done with Diesel 80% and Honge 20% (DHO), Diesel 80% and plastic oil 20% (DPO) and Honge 70% and plastic oil 30% (HPO) and the properties of the blends were evaluated. The blending is done based on the observations of the characterization of fuels. Diesel 80% and Honge 20% (DHO), Diesel 80% and plastic oil 20% (DPO) gave better results and Honge 70% and plastic oil 30% (HPO) is done in order to lower the overall viscosity of blends.

Table 1. Properties of Test Fuels

Property	Diesel	Honge oil	Plastic oil	DHO	DPO	HPO
Calorific Value (kJ/kg)	44800	40760	41153.5	44000	44065	40877
Viscosity @40°C, cst	4.16	38.2	1.98	10.84	3.72	27.33
Flash point (°C)	58.5	225	15	91.8	52	162
Fire point (°C)	67.2	230	20	99.7	58	167
Density (kg/m^3)	844.9	924	747	887	860	871

V. EXPERIMENTATION

The experimental work carried out for the objectives, requires an engine test set-up adequately instrumented for acquiring necessary data. The test setup consisted a Kirloskar, single cylinder, 4-stroke, water-cooled diesel engine having a rated output of 7.5 kW at 1500 rpm and a compression ratio of 17.5:1. The engine was coupled with an eddy current dynamometer to apply different engine loads. The photographic views experimental setup is as shown in Figure 4.

Figure 4: Diesel Engine Test Rig Figure 5: Exhaust Gas Analyzer

The test bed is fully instrumented to measure the various parameters such as flow, load, and pressure etc., during the experiments on the engine. DELTA 1600-L of MRU make Exhaust gas analyzer is used to find the NO_x (ppm), CO (%), CO_2 (%), O_2 (%), HC (ppm) emissions in the exhaust. Experiments were conducted with neat diesel at the designed injection pressure 180bar, 200bar and 220bar at rated speed of 1400 rpm and 17.5 compression ratio. The engine was started by hand cranking with diesel fuel supply and it is allowed to get its stabilized working condition. Cooling water maintained about 300 liters/hour and water flow pressure to eddy current dynamometer is maintained between 1 to 1.5 bar throughout the experiments, water flow pressure is maintained by means of 1/4th hp external water pump. The software is run and operated in online mode with a specific filename.

To record the data online, software is logged every time and data will be stored in the computer hard disk, which can be retrieved as and when required. Experiments were conducted at 180, 200 and 220 bar injector opening pressures. Using the test fuel blends three different calibrated injectors for injection pressure 180, 200 and 220 bar were used to change the injection pressure. The injection pressure was varied from 180 bar to 220 bar in steps of 20 bar for optimum bio diesel blend and the performance of the engine was analyzed.

VI. RESULTS AND DISCUSSION

PERFORMANCE PARAMETERS:

1. Brake Specific Fuel Consumption (BSFC)

The variation of BSFC with BP at three different injection pressure for diesel, DHO, DPO and HPO. It has been observed that the BSFC for all the blended fuels was marginally lower than neat diesel fuel at all injection pressures. It was noted that, the lowest value of BSFC for the fuel tested was found to be at 200 bar injection pressure except for HPO blended fuel for which the lowest value of BSFC was found at 220 bar due to high viscosity of HPO blend.

2. Brake Thermal Efficiency (BTE)

The variation of BTE with BP at three different injection pressures for diesel, DHO, DPO and HPO. It has been observed that the BTE has increased with increase in applied load for all fuels. This is due to reduction in heat loss and increase in power with increase in load. It has been observed that the BTE is high at 180 bar injection pressure. This is due to coarse spray formation and poor atomization and mixture of fuel during injection. By increasing the injection pressure to 200 bar, the BTE of biofuels has improved convincingly. It has also be seen that further increase in injection pressure to 220 bar has resulted in decrease in the BTE except for the blend of HPO fuel. This is because at higher injection pressure the size of fuel droplets decrease drastically. Thus a very fine fuel spray will be injected in to the combustion chamber, because of this penetration of fuel spray reduces and momentum of the fuel droplets will reduce which might increase the delay period in the combustion. It has also been noted that, the highest value of BTE for all the blends of DHO and DPO was found to be at 200 bar injection pressure and for HPO the highest value of BTE was found to be at 220 bar.

EMISSION PARAMETERS

1. Unburnt Hydrocarbon (UBHC)

The variation of UBHC emission with BP at different injection pressures for diesel and different blended fuel. Unburnt hydrocarbons are the result of incomplete combustion of fuel. It has been observed that diesel has the highest UBHC emission at all loads indicating that the heavier hydrocarbon particles that are present in Diesel fuel increase UBHC emissions. Biodiesel contains ester linkages in the constituent molecules so that it is an oxygenated fuel. Thus more oxygen is available to burn the hydrocarbons so that UBHC emission in the exhaust is substantially lower. It has be noted that, the lowest value of UBHC emission for all fuels tested was found to be at 200 bar injection pressure. It has also be seen that as the injection pressure is increased to 220 bar there is an increasing trend in UBHC emissions which may be because of finer fuel spray which reduces momentum of the droplets resulting in less complete combustion except that of HPO blend fuel for which the lowest value of UBHC emission was found to be at 220 bar injection pressure.

2 Carbon Monoxide (CO)

The variation of CO emission with BP at three different injection pressures for diesel and the blended fuels it has been evident that, the engine emits more CO using Diesel as compared to that of blended fuels under all loading conditions. Carbon monoxide is a toxic combustion product resulting due to incomplete combustion of hydrocarbons. In the presence of sufficient oxygen, CO is converted in CO_2. Biodiesel is an oxygenated fuel and that itself contains some contents of oxygen which helps in more complete combustion hence CO emissions are reduced in the exhaust. It has been noted that, the lowest value of CO emission for all fuels tested was found to be at 200 bar injection pressure except that of HPO blend fuel for which the lowest value of CO emission was found at 220 bar injection pressure. It has also be seen that as the injection pressure of DHO and DPO blended fuels is further increased to 220 bar there seems to be an increasing trend in CO emissions which may be because of less complete combustion resulting in higher unburnt hydrocarbons.

3. Oxides of Nitrogen (NOx)

The variation of NOx emission with BP at three different injection pressures for the three blended fuels it has be seen that the NOx in the exhaust emission are the combination of nitric oxide (NO) and nitrogen dioxide (NO2). The formation of NOx is highly dependent on in-cylinder temperature, oxygen concentration in the cylinder and on engine technology. Oxides of nitrogen are mostly created from nitrogen in air and in fuel blends. In addition to nitrogen atoms, the fuel may contain ammonia (NH_3) and hydrogen cyanide (HCN), which would contribute to a minor degree in the NOx formation. In general, the NOx concentration varies linearly with the load of the engine. As the load increases, the overall fuel-air ratio increases resulting in an increase in the average gas temperature in the combustion chamber and thus higher NOx. It has be seen that NOx were lower at 200 bar injection Pressure and for HPO blend the NOx is lower at 220 bar injection pressure. A lower emission of NOx at this injection pressure may be due to decrease in the engine exhaust temperature. The higher emission of NOx at injection pressures of 180 bar and 220 bar are the result of higher exhaust temperature for DPO and DHO blends.

VII. CONCULSION

From the results of this work it is clear that injection pressure has remarkable effect on performance and emissions of honge oil and waste plastic oil fueled Diesel engine. The honge biodiesel has higher viscosity and density than that of diesel, whereas the plastic oil has lower viscosity and marginally lower density that that of diesel. These are the main properties of the fuel which influence the spray characteristics and hence the combustion is greatly affected. Increasing the injection speed by increasing the injection pressure will result in better atomization and hence the better mixture formation. It is evident from the discussion that by increasing the normal injection pressure from 180 bar to 200 bar resulted in the better performance and lower emissions.

The following conclusions are drawn from the present work.

• Raw honge oil and waste plastic oils are successfully used as fuels in CI engine without any fuel modifications in blending (DHO, DPO and HPO) with diesel.

• Tests are conducted for various injection pressures (180 bar, 200 bar and 220 bar). The optimum values of performance, emission and combustion are obtained at injection pressure of 200 bar for DHO and DPO blend at that at 220bar for HPO blended fuel due to higher viscosity of honge oil.

• The emissions like UBHC, CO are comparatively lower for Biodiesel blends compared to Diesel. But NOx is marginally higher when compared to Diesel.

• In an agricultural dominated country like India with considerable cultivable lands experiencing frequent draughts, the use of oil derived from waste plastic may significantly contribute to the energy security and green environment.

Hence it is concluded that the biodiesels from raw honge and waste plastic oils blended with Diesel can be successfully used in CI engines without major engine and fuel modifications based on better performance, better combustion, lower carbon monoxide and hydrocarbon emissions and marginal higher NOx emissions.

VIII. SCOPE FOR FUTURE WORK

• The study of performance and emissions of CI engine with variation of compression ratio for all these fuel combinations.

• The study of performance and emissions of CI engine with variation of engine speed for all these fuel combinations.

• This work is carried out in a single cylinder engine for which satisfactory results are obtained. These experiments shall be carried out on multi cylinder engine. Performance and emissions of multi cylinder engine shall be compared with single cylinder engine.

• Performance and emissions tests with these fuels can be carried out in an adiabatic engine by insulating the piston crown, cylinder liner and cylinder head, the gases in cylinder will become much hotter and hence more work can be extracted from them.

• Stability analysis for waste plastic oil blends for long duration could be conducted.

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