Effect of Injection Pressure on the Performance and Emission Characteristics of Single Cylinder Diesel Engine Using Neem-Niger Biodiesel

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ABSTRACT

According to the present days, the concerns on climate change, the high fuel prices and the dwindling oil reserves and supplies have necessitated a strong interest in the research for alternative fuel sources. Biodiesel is an alternative renewable fuel that has gained massive attention in recent years. Studies on the physical properties of biodiesel have shown that it is completely miscible with petroleum diesel. Since the combustion of biodiesel emits hazards particulate matter and gases which is lower than petro diesel, Combustion of biodiesel and biodiesel blends have shown a significant reduction in particulate matter and exhaust emissions. So in this paper the use of pure biodiesel or biodiesel blends of Neem & Nyjer Oil in terms of performance and exhaust emissions has been studied in comparison to petroleum diesel at different injection pressure.

Keyword: - *Alternative fuel, Blends, Neem & Nyjer oil, Performance, Injection pressure.etc….*

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1. INTRODUCTION

The growing demand for fuel and increasing concern for the environment due to the use of fossil fuel have led to the increasing popularity of biofuel as a useful alternative and environmentally friendly energy resource. The increasing population of both the developing nations of the world, their steady increasing in the diesel consumption, the non-renewability of the fossil fuels as well as their environmental effects are some of the reasons that has made the biofuels as alternative and attractive. Diesel engines are the major source of power generation and transportation hence diesel is being used extensively ,but due to the gradual impact of environmental pollution there is an urgent need for suitable alternate fuels for use in diesel engine without any modification. There are different kinds of vegetable oils and biodiesel have been tested in diesel engines its reducing characteristic for greenhouse gas emissions.

Biodiesel (a mixture of fatty acid methyl esters) has become very attractive as a biofuel because of its environmental benefits as it has less air pollutants per net energy than diesel and is nontoxic and biodegradables because it is produced from renewable sources with high energetic efficiency, biodiesel yields from an estimated 90% to 40% more energy than the energy invested in producing it. Biodiesel derived from a wide variety of sources can be used as a direct substitute for petro-diesel fuels. They are several non-edible oil seed such as Karanja (Pongomia Pinnate), Jatropha (Jatrophacurca), Neem (AzadirachtaIndica) etc. Among these, AzadirachtaIndicais one of the largest producer neem oil and its seed contains 30% oil content. It is an untapped source in India. Implementation of biodiesel in India will lead to many advantages like green cover to wasteland, support to agriculture and rural economy and reduction independence on imported crude oil and reduction in air pollution.TheNeem oil plant is a fast growing plant with long productive life span of 150 to 200 years, its ability to survive on drought and poor soils at a very hot temperature of 44°C and a low temperature of up to 4°C.The crude neem oil was purchased from the market and it has to be transesterified which means that it has to be made operable in the engine. The process of transesterfication is nothing but the breaking the longer chain molecules into smaller chain molecules by means of heating the oil and some chemical reactions. The transesterication process donein this project is two stageprocess, i.e., crude oil is subjected to the acid and base catalyzed transesterification process. In addition to that there are some other process of transesterication process to the crude neem oil which produced less amount of yield. After the completion of the transesterication process, it will be subjected to the analysis of performance characteristics of the biodiesel in the diesel engine. The analysis of performance characteristics can be evaluated by changing the compression ratio operated on diesel engine. The performance characteristics such as brake thermal efficiency and brake specific fuel consumption for each compression ratio and the various blends of biodiesel are analyzed. Experimental determination of brake thermal efficiency and brake specific fuel consumption of diesel engine fuelled with biodiesel without changing the compression ratio was studied. Adding to that the emission parameters such as the smoke, NOx, carbon monoxide and the unburnt hydrocarbons of the diesel engines subjected to bio diesel without changing the compression ratio are studied. The emission parameters are analyzed by changing the compression ratio for the various blend are studied.

Energy is the chief mover of economic growth, and plays a vital role in sustaining the modern economy and society. Energy crisis and environmental air pollution are of alarming concern worldwide. Hence energy security is an important global policy issue for more than four decades. Global energy markets have relied heavily on fossil fuels like coal, crude oils and natural gas which provides most of the world's supply of primary energy needs. Being nonrenewable, they brought with them global destabilizing price shocks. The extensive worldwide use of fossil fuels not only threatened to energy security but also resulted in serious environmental concerns – particularly climate change. One of the key challenges facing the world is how to meet the growing energy needs and sustain economic growth without contributing to climate change. Cleaner renewable sources of energy are the ultimate solution to the global energy crisis.

India faces a dreadful challenge in meeting its energy needs and in providing sufficient energy of preferred quality in various forms in a sustainable manner and at competitive prices. Renewable energy sources in general and bio-fuel energy in particular is capable of reducing our dependency on foreign import there by increasing the security of energy supply. The ethanol and biodiesel are the two liquid bio fuels that can replace/substitute gasoline /diesel respectively. The first use of vegetable oil in a compression ignition engine was first demonstrated through Rudolph Diesel who used peanut oil in his diesel engine. The long term use of vegetable oils led to injector coking and the thickening of crankcase oil which resulted in piston ring sticking. Therefore, vegetable oils are not used in SI engines because of endurance issues. Production and utilization of the bio fuel would generate the new economic opportunities in term of creation of job opportunities in rural areas in addition to the protection of the environment.

Different alternative sources for oil

Vegetable oil:

i. Coconut oil

Coconut oil is a widely used liquid biofuel that is clean, relatively cheap, easy to extract, non-toxic and aromatic.

As engine fuel, coconut oil can be used in three ways.

- As a direct substitute for petroleum diesel.
- As an additive to petroleum diesel or bio-diesel.
- As the base ingredient of bio-diesel.

ii. Sunflower oil

Sunflower is a high oil content seed and average yields can produce 600 pounds of oil per acre, considerably more than soybeans. There is a great deal of interest from local areas for construction of small processing facilities for sunflower biodiesel production. It is most important that processing equipment be analyzed very carefully for small 'press' only facilities. In most cases a portion of the oil is left in the by-product meal thereby reducing economic-efficiency.

iii. Jathropha

Biofuel development in India centres mainly around the cultivation and processing of Jatropha plant seeds which are very rich in oil (40%). The drivers for this are historic, functional, economic, environmental, moral and political. Jatropha oil has been used in India for several decades as biodiesel for the diesel fuel requirements of remote rural and forest communities; jatropha oil can be used directly after extraction (i.e. without refining) in diesel generators and engines. Jatropha has the potential to provide economic benefits at the local level since under suitable management it has the potential to grow in dry marginal non-agricultural lands, thereby allowing villagers and farmers to leverage non-farm land for income generation. As well, increased Jatropha oil production delivers economic benefits to India on the macroeconomic or national level as it reduces the nation's fossil fuel import bill for diesel production (the main transportation fuel used in the country); minimizing the expenditure of India's foreign-currency reserves for fuel allowing India to increase its growing foreign currency reserves (which can be better spent on capital expenditures for industrial inputs and production). And since Jatropha oil is carbon-neutral, large-scale production will improve the country's carbon emissions profile. Finally, since no food producing farmland is required for producing this biofuel (unlike corn or sugar cane ethanol, or palm oil diesel), it is considered the most politically and morally acceptable choice among India's current biofuel options.

iv. Palm oil

Palm oil is naturally reddish in color because of a high beta-carotene content. It is not to be confused with palm kernel oil derived from the kernel of the same fruit, or coconut oil derived from the kernel of the coconut palm (Cocosnucifera). The differences are in color (raw palm kernel oil lacks carotenoids and is not red), and in saturated fat content: palm mesocarp oil is 41% saturated, while palm kernel oil and coconut oil are 81% and 86% saturated fats, respectively.

v. Soybean oil

Soy biodiesel is better for the environment because it is made from renewable resources and has lower emissions compared to petroleum diesel. The use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide, and soot. The use of biodiesel does not increase the CO2 level in the atmosphere, since growing soybeans consumes also CO2. Biodiesel is also more biodegradable than conventional diesel. Studies at the University of Idaho have illustrated biodiesel degraded for 95 percent after 28 days compared to 40 percent for diesel fuel.

- Animal oil:

Animal fats and oils are lipid materials derived from animal. Physically oils are liquid at room temperature and fats are solid. Chemically, both fats and oil are composed of triglycerides although many animal parts and secretions may yield oil, in commercial practice, oil is extracted primarily from rendered tissue fats obtained from livestock animals like pig, chickens and cows. Dairy products also yield popular animal fat oil.

The reference number should be shown in square bracket [1]. However the authors name can be used along with the reference number in the running text. The order of reference in the running text should match with the list of references at the end of the paper.

1.1 Problem Statement

In existing diesel engine/internal combustion engine,Biodiesels are used with constant parameters of engine such as C.R. and I.P. So we can't get best output or results for particular use of that biodiesel.So in this project we are going to check at which injection pressure we get best results or output like performance and emission characteristics of internal combustion engine.

1.2 Objectives

The main objectives of this project are furnished below:

1. To identify the source to collect raw material i.e. Neem and Nyjer seeds.
2. To carry out the filtration of both Neem and Nyjer oil and obtain clarified oil out of it.
3. To successfully produce neat biodiesel from it using transesterification process.
4. To blend the neat bio diesel with regular diesel and obtain the blended fuel samples.
5. To study the properties such as density, calorific value, viscosity, flash point, fire point etc. of the blended fuel samples.
6. To successfully run performance tests and emission tests on compression ignition engine for different blend samples at different injection pressure.
7. To compare the performance of blended fuel with that of diesel in order to distinguish effect of different blends on performance.
8. To generate cost analysis of the entire process in order to know the economic feasibility of the concept in reality.
9. To successfully arrive at a conclusion and put light on future possibilities and scope in this particular sector.

2. EXPERIMENTATION PROCEDURE:

1. Check for all electrical connections and proper earthing for the equipment's.
2. Ensure water in the main water supply tank.
3. Ensure selected fuel about 2 litre in quantity in the fuel supply tank and fuel knob on regular position.
4. Maintain the water flow rate throughout the experiment.
5. Start electric-supply to the computer through the stabilizer and open the engine software.
6. Start electric power supply to the 5-gas analyzer.
7. Start the engine by rotating the handle and operating the decompression lever. Let the engine run on the minimum load and gas analyzer to get warmed up simultaneously.
8. Change fuel properties (calorific value and specific gravity) in the software in the reconfigure option as per the fuel selected for test.

9. Choose run option in the software. Run the engine for fifteen minutes so that engine gets, stabilized. Ensure that gas analyzer have reached their default display and then turn the fuel supply switch to metering position. Choose log option of the software. After 1 minute the display changes to input mode then enter the values of water flows in cooling jacket and calorimeter and then the file name (applicable only for the first reading) in the software. The first reading for the engine gets logged for the no load condition. Turn the fuel knob back to regular position.
10. Open the handle of the exhaust connection for inserting the gas sample probe of the 5-Gas analyzer. Insert the probe. Choose NO_x mode of the instrument from the display. After the reading is stabilized get the print out by choosing the print option. Note the fuel name and torque value on the print out for future reference.
11. Change the torque gradually by rotating the loading knob and observing in the monitor for torque value. Allow the engine to run for 10 minutes for stabilization at new torque. After stabilization again turn the fuel knob to metering position and choose the log option from software. After one minute after the fuel logging is over, feed the cooling water and calorimeter flow rates and turn back the fuel knob to regular position. Take the reading of 5-gas analyzer as mentioned above. Also fuel flow rate for 10cc of fuel is also noted down.
12. Repeat the procedure for different torque values.
13. Reduce the torque to minimum position (no load condition) gradually ensuring that the RPM is are not shooting beyond 1500 RPM and allow the engine to stabilize.
14. Save the files with appropriate names.
15. Put off the engine and computer.
16. Allow the water pumps to be on for 15 minutes so that engine gets cooled down and then put off the water flowing valves

2.1 Engines and Dynamometer Specification

The photograph of diesel engine with pressure thermocouple for sensing exhaust gas temperature as shown in FIG. It is of single cylinder, four stroke, water cooled, and compression ignition engine with a bore of 80mm and stroke 110mm. Fuel is supplied to the fuel pump by gravity feed, through the fuel tank and paper element filter. The engine can be started by hand cranking using decomposition lever.

Fig -1: Compression Ignition Engine Set Up Used For Experimental Purpose

First the experimentation is performed with diesel (for getting the base line data of the engine) and then 100% biodiesel i.e. B100 and blends of different percent volumes of Biodiesel B20, B40, B60, B80 were carried out. The performance of the engine is evaluated in terms of brake thermal efficiency, brake specific energy consumption, exhaust gas temperature, and emission of the engine is analyzed (HC, CO, CO2, O2 and NOx)

Table -1: Engines and Dynamometer Specification

SLNO	PARAMETERS	SPECIFICATION
1	Type	TV 1 (Kirloskar made)
2	Power	3.5 kW
3	Speed	1500 RPM
4	Nozzle opening pressure	200 bar
5	Number of cylinders	Single cylinder
6	Number of strokes	Four stroke
7	Fuel	Diesel
8	Compression ratio	16.5:1
9	Cylinder diameter(Bore)	87.5mm
1	Stroke length	110mm
1	Dynamometer Arm Length	185mm

2.2 Measurement of Parameter Regarding Engine Performance And Exhaust Emission:
The Computerised CI engine set up along with a high-speed digital data acquisition system was supplied by Flow and force engineers, Bangalore, India. An eddy current dynamometer, a piezoelectric transducer and digital type temperature sensor was calibrated and used in the setup by Flow and Force engineers.
Following parameters will measure from the experimental CI engine setup.
1. Brake power
2. Fuel consumption
3. Exhaust gas temperature
4. Cooling water temperature (inlet and outlet)
5. Speed of the engine
6. Exhaust gas analysis (NOx, CO2, UBHC, CO and O2)

3. MEASUREMENTS OF EMISSIONS:

Emission from the diesel engine can be classified into some categories as those from the gasoline. But the level of emission in these categories varies considerably. A sample of diesel exhaust may be free from smoke, smog and have no unburnt hydrocarbons or they may be heavy smoke led and heavy concentration of unburned hydrocarbons.
Smoke is defined as visible product of combustion which is due to improper burning of the Fuel. It originates in the combustion cycle in a localized volume of rich fuel-air mixture, any amount of smoke formed, depends on the air-fuel ratio, type of fuel and air pressure. In general, the smoke of diesel engine is of the two types,

- Blue white smoke
- Black smoke

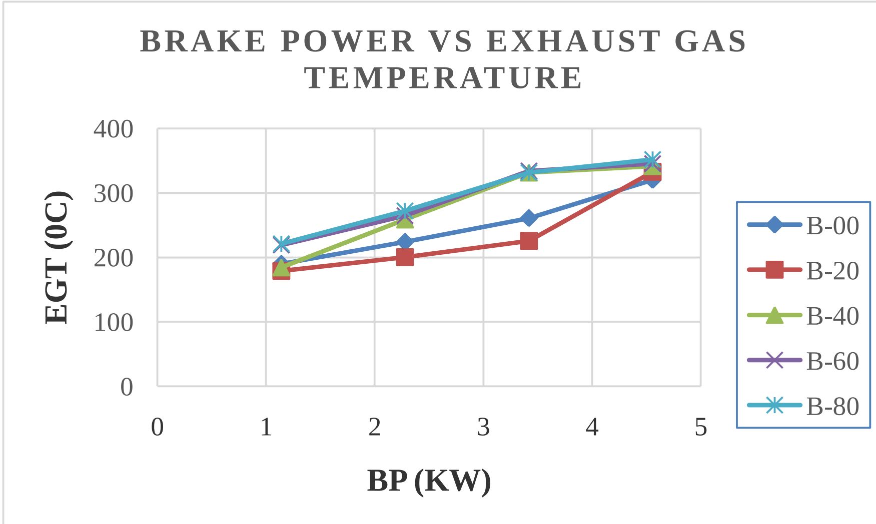

Chart -1: Variation Exhaust gas temperature with Brake power

3.1 Carbon-monoxide Emissions (CO):

Variation of CO emissions with engine loading for different fuel is compared in Fig. The minimum CO produced was found in B100 and it was observed that a reduction of 50% ,as compared to diesel. Also it is observed that the CO emissions for biodiesel and its blends are lower than for diesel fuel. These lower Co emissions of Biodiesel blends may be due to their more complete oxidation as compared to diesel.

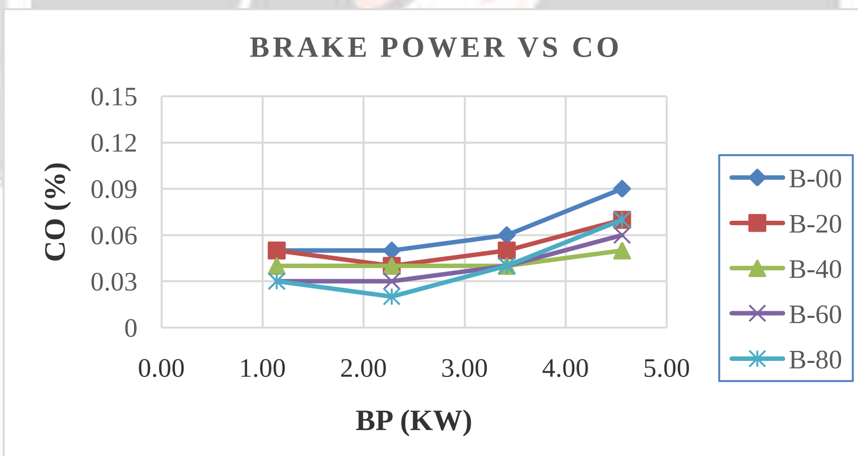

Chart -2: Variation Carbon Monoxide with Brake power

Carbon monoxide emissions from a diesel engine mainly depend upon the physical and chemical properties of the fuel. The bio diesel itself contains 11% of oxygen which helps for complete combustion. From Figures it is found that the amount of CO is increase at part loads and again greater increase at full load condition for biodiesel. The carbon monoxide emission increases when fuel air-ratio becomes grater. The CO emission for fuels used at full injection pressure is approximately 32% lower than the diesel. The lowest CO emission was observed at 190 bar

4. CONCLUSIONS

The overall studies based on the production, fuel characterization, engine performance and exhaust emission of Neem and Nyjer oil biodiesel and its blends B20, B40, B60, B80 were successfully carried out. The following conclusions can be drawn:

- The density of biodiesel is 0.8879 gm/cc and it is more than fossil diesel.
- The CV of B100 was found to be 36281.14 KJ/kg and the CV of different blends was also determined according to ASTM standards. The CV of blends was found to be less than the fossil diesel (44000 KJ/Kg).
- The variation of brake thermal efficiency at various loads. The brake thermal efficiency slightly increases with increasing load. Among the blend B40 shows improved brake thermal efficiency than the other blends and diesel. Hence, this blend was selected as the optimum blend for further investigations and long-term operation.
- The specific fuel consumption decrease with increase in load among the blend B40 shows same fuel consumption at initial load and increase at next load compare to diesel.
- Engine performance of biodiesel and their blends are similar to those of diesel fuel. Performance of diesel engines varies with composition of blend used.
- Bio diesel fuel and their blends produce about lesser carbon monoxide (CO) and unburnt hydrocarbon (UHC) emissions than diesel fuel, while nitrogen oxide($NO_{X)}$ emissions are higher than diesel fuel.
- BTE is higher when B40 blend is operated on 210 bar injection pressure.But BSFC is gets decreased as the injection pressure gets decreased.
- So from above research we can conclude that up to certain limit of increase in injection pressure can shows better results than lower injection pressure in internal combustion engine.

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