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EXPERIMENTAL INVESTIGATION ON PERFORMANCE AND EMISSION CHARACTERISTICS OF DI- CI ENGINE FUELED WITH PREHEATED SHEA OLEIN BIODIESEL

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ABSTRACT

The world is searching for other alternative fuels due to the exhaust of fuel reserve resources as increase of diesel engines usage daily. Due to the increase of diesel engines there is damage, danger and threat to the global enivironment. A a result several researchers attempeted and investigated other fuels like biodiesels to meet the requirements of the present world to have low fuel consumption , high efficiencies and effect to the enivironment pollution to be negligible. Present work is carried on DI- CI engine fueled with Sheaolien biodiesel (SBD/B100), preheated shea olein biodiesel (SBDPH/B100PH) ,B20 (20% SBD+ 80% Diesel), B20PH and B0 (Pure diesel/PD) to explore the engine performance and emission charecterstics. The results noticed preheated shea olien biodiesel performance and emission charectrestics are almost similar to diesel fuel.

Key words: Engine, Shea olien biodiesel, Diesel, Performance and Emission.

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1. INTRODUCTION

The use of alternative fuels around the world got increased due to scarcity of oil resources . Using non edible, edible oils and animal fats bio diesels can produced. In the present work Shea olien methylester derived from shea olien oil is used to run the DI – CI enigne to explore the charecterstics of the engine. Shiyasharan Patel et. al [1] invetigated with diesel fuel, Jatropha bio-diesel, preheated Jatropha bio-diesel (PJBD), 80% preheated Jatropha bio-diesel-20% ethanol (PJBD80E20) fuels and he concluded that BTE decreases slightly whereas BSFC increases as the engine fuelled with PJBD80E20 as compare to neat diesel fuel at different load conditions. In the same testing condition, a slight decrease in CO and HC emission and significant reduction in NOx emission were observed, however, there is a slight increase in smoke emission was observed as compare to diesel fuel. Sumedh Ingle et. al [2] studied using methyl esters of palm oil as fuel in an engine and the results concluded that at blend B20 with preheating temperature 60^0C, Brake Specific Energy Consumption (BSEC) is lowest and highest exhaust gas temperature as compare to other blends, while neat diesel gives lowest smoke density. Ch. Satyanarayana et. al [3] examined the influence of key properties of pongamia biodiesel on engine performance, combustion, and emission characteristics of direct injection diesel engine and concluded a significant improvement in thermal efficiency was observed with preheated biodiesel , considerable reduction in NOx and CO emissions is observed with preheated biodiesel. Sagar Pramodrao Kadu and Rajendra H.Sarda [4] carried out experimental investigations on use of preheated neat Karanja oil as fuel in CI engine. Neat Karanja oil preheated to 30^oC, 70^oC and 100^oC is used for study and compared the results with diesel fuel at 30^oC. Result showed that significant improvement in engine characteristics were noticed with preheated Karanja oil. P.V Rao [5] investigated the effect of preheated Jatropha biodiesel on engine characteristics. The significant improvement was recorded in brake thermal efficiency with reduction in emissions (CO, HC and NO_X) with the admission of preheated fuel. M. Pugazhvadivu et. al [6] studied 3.7 kW constant speed diesel engine with preheated Mahua oil as fuel and observed improved engine performance decreased emissions with preheating Mahua oil. K.Srinivasa Rao et. al [7] investigated experiments on DI-CI engine with preheated chicken fat biodiesel and concluded that it can be used as alternative fuel.

2. EXPERIMENTAL SETUP

The experimental setup used in this work for testing consist of 4-S DI-CI single cylinder kirloskar engine which is naturally aspirated water cooled provided with eddy current dynommeter for loading and it is connected with pressure sensor and crank angle measurements. The exhaust gas analyser of indus make & PEA 205 is used to measure emissions. The details of the engine and exhaust gas analyser specifications are mentioned in the table 1 and table 2.The set up of the engine is shown in the figures 1 and 2. The exhaust gas analyser is shown in the figure 3. Shea olein biodiesel (SBD) produced from transestification was used as fuel for conducting tests on DI-CI engine. Shea olien biodiesel viscosity is more than viscosity of pure diesel so its viscosity is decreased by blending and also by preheating the fuel. The various properties of the shea olien biodiesel are shown in the table 3. The properties of Sheaolein biodiesel are similar to purediesel. The viscosity varation with temperature is shown in the figure 4. The Viscosity of B100 at 40^0C is 4.42cSt and at 50^0C is 2.56cSt nearer to the viscosity of pure diesel at room temperature. The viscosity of B20 at 40^0C is 2.98cSt and it is almost nearer to the viscosity of pure diesel B0 room temperature.The engine was tested with B0 (Pure Diesel), B20 (20% SBD + 80% Diesel) , B20PH , B100 (100%SBD) , B100PH to study the performance and emission charecterstics of 4-S DI- CI engine at different loads of 0.93kW (1/4 load), 1.86kW (1/2 load), 2.79kW (3/4 load), 3.72kW (full load). The engine maintained to run at constant speed of 1500 r.p.m and allowed sufficient time to acquire steady state condition to note down the readings in all tests.

Table 1 Specifications of the Engine

Manufacture	Kirloskar Oil Engine
Eninge	Single Cylinder 4- Stroke DI- CI
Admission of air	Naturally aspirated
Bore X Stroke	80 mm X 110 mm
Compression Ratio	16.5 : 1
Max power	3.72kW @ 1500rpm
Pressure Sensor	Piezo electric type with 0.1 bar resolution
Crank Angle	1 Degree Resolution
Dynomometer	Eddy Current Dynomometer
Method of Cooling and Starting	Water Cooled and Manual Starting

Figure 1 Engine Set Up

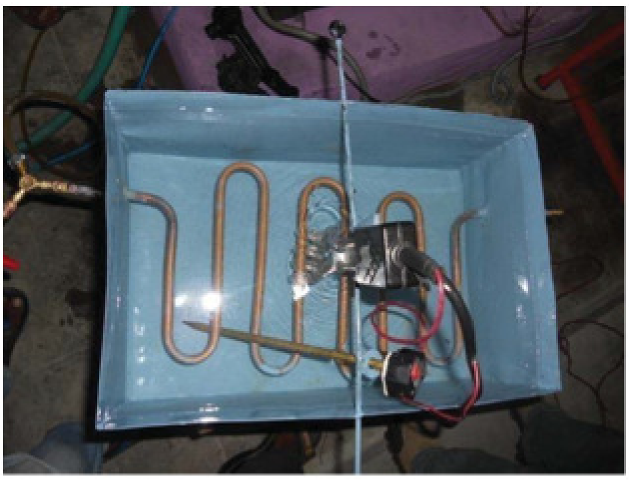

Figure 2 PreHeating Set Up

Table 2 Exhaust Gas Analyzer

Exhaust Gas analyzer make : Indus		
Emission type	Range	Resolution
NOx	0-5000 ppm	1 ppm
HC	0-15000 ppm	1 ppm
CO	0-15.0 %	0.01 %

Figure 3 Exhaust Gas Analyser

Table.3 Properties of fuels

Property	Unit	B0 (Diesel)	B20	B100 (SBD)	ASTM standards
Density	g/cc	0.831	0.84	0.877	0.87 – 0.89
Kinematic viscosity at 40^0C	cSt	2.58	2.98	4.42	1.9 – 6.0
Flash Point	^{o}C	50	-	131	130 min
Calorific Value	kJ/kg	42500	42300	41612	37500

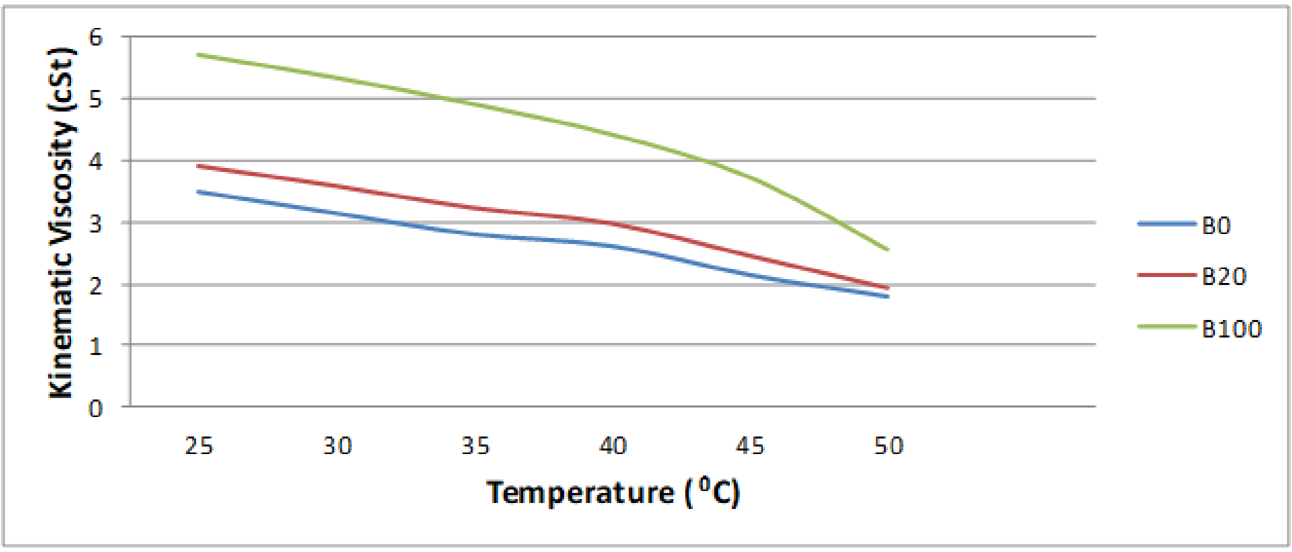

Figure 4 Variation of viscosity with temperature

3. RESULTS AND DISCUSSIONS

4-Stroke Single cylinder DI- CI engine performance characteristics BTE, BSFC, BTE, EGT and Emission Characteristics Oxides of Nitrogen, CO and HC were investigated and the results were discussed as follows.

3.1. Brake Specific Fuel Consumption

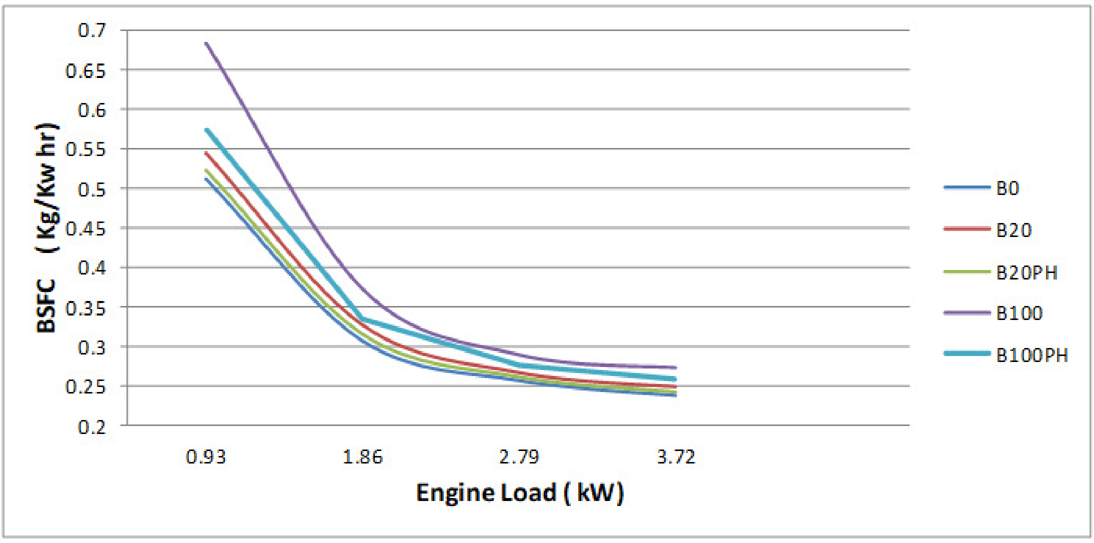

Figure 5 Variation of Brake Specific Fuel Consumption with Engine Load

The variation of Brake Specific Fuel Consumption with engine load for different fuel blends is shown in the figure 5. It is investigated that BSFC decreases for all blends with increase of load. The BSFC of B100 is more than B0 at all loads because of more visous and having less calorific value than PD, but B100PH is less than B100 at all loads. B100PH of BSFC is less at all loads than B100 due decrease of viscosity and this may leads to fine atomization and increasing of atomization of the fuel.

3.2. Brake Specific Energy Consumption

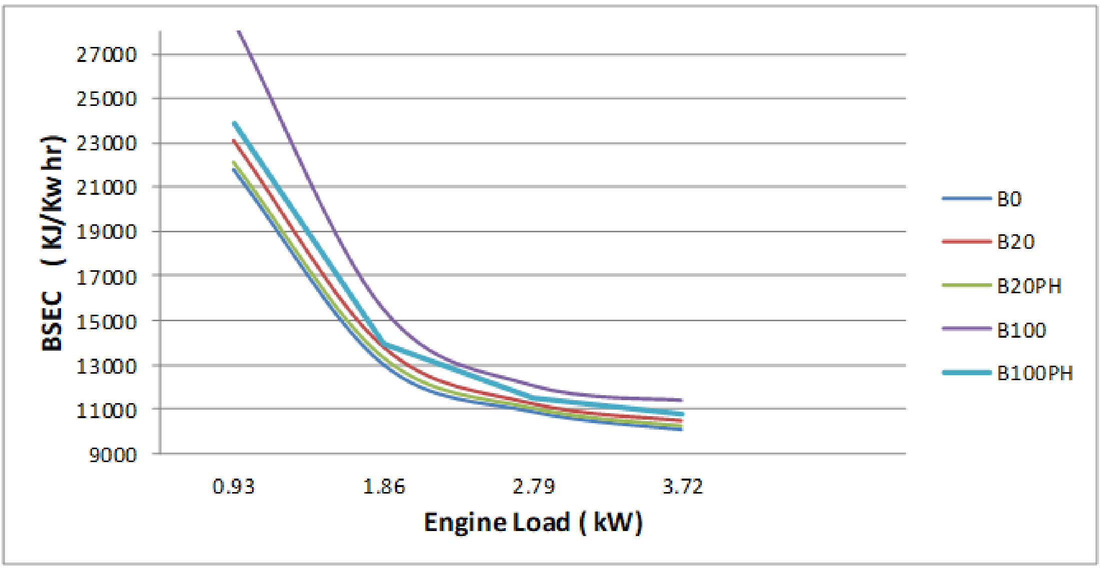

Figure 6 Variation of Brake Specific Energy Consumption with Engine Load

The variation of Brake Specific Energy consumption with engine load for different fuel blends is shown in the figure 6. Brake Specific Energy Consumption is the equivalent fuel energy to produce unit brake power. As BSEC is directly depends on the BSFC it is observed that it followed the same trend and as the load is increasing the BSEC got decreased for all blends. The BSEC of B100 is greater than B0 at all loads, but the BSEC of B100PH is less than B100 because of due to decrease of viscosity. The lowest values are recorded at full load for all blends B0, B20, B20PH, B100 and B100PH.

3.3. Brake Thermal Efficiency

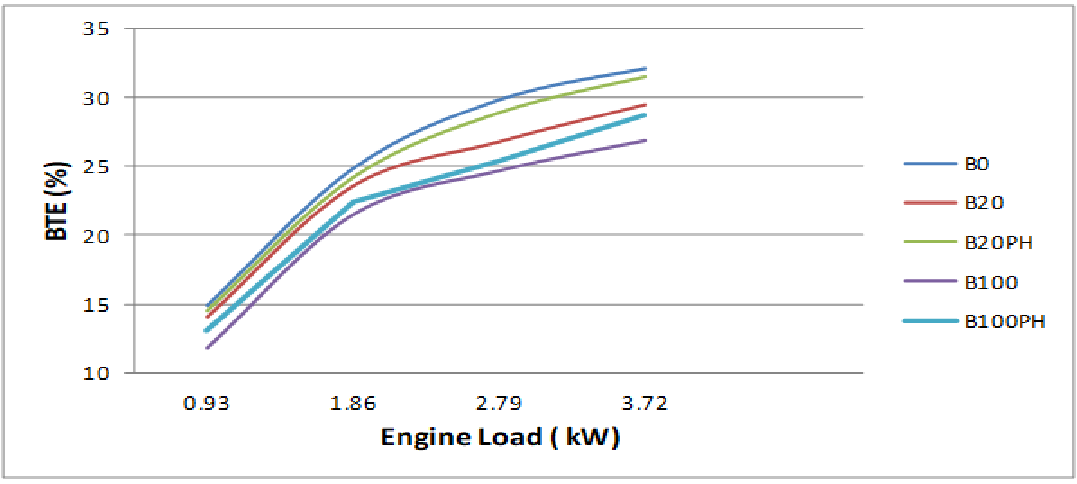

Figure 7 Variation of Brake Thermal Efficiency with Engine Load

Variation of Brake Thermal Efficiency with engine load for all fuel blends is shown in the figure 7. The Brake Thermal Efficiency increases with engine load for all fuel blends. BTE of B20PH is very nearer to B0. The BTE of B20PH and B100PH are lesser than BTE of B0 but, BTE of B20PH is more than B20 and BTE of B100PH is more than B100 may be because while preheating the fuel its viscosity is decreasing and fine atomization is taking place by reducing the droplet size there by increasing the surface area of the fuel for complete combustion.

3.4. Exhaust Gas Temperature

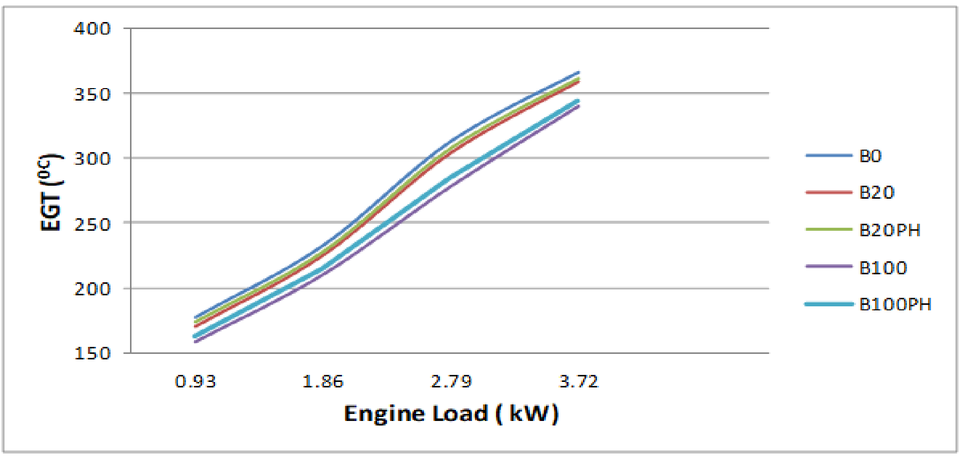

Figure 8 Variation of Exhaust Gas Temperature with Engine Load

The variation of Exhaust Gas Temperature with engine load for all fuel blends is shown in the figure 8. The Exhaust Gas Temperature increases with engine load for all fuel blends. The EGT of pure diesel B0 is more than all fuel blends at different loads. This happened may be due to pure diesel (B0) having heating value more than other fuel blends. It is observed that EGT of B20PH and B100PH are recorded lesser values than the corresponding EGT values of B20 and B100.

3.5. NOx Emissions

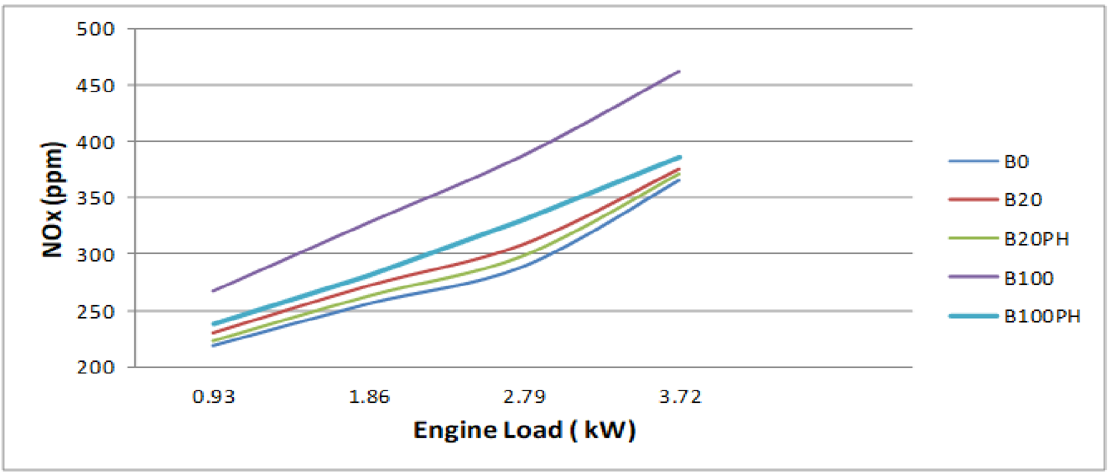

Figure 9 Variation of NOx with Engine Load

The Variation of NO_X emissions varying with engine load for all fuel blends is shown in the figure 9. The NO_X emissions observed that increased as the load got increased and this happened for all fuel blends may be due to the presence of more oxygen content in shea olien biodiesel. The NO_X emissions B20, B20PH, B100 and B100PH are more than pure diesel B0 but the NO_X emissions of B20PH recorded lesser values than without preheating fuel of B20. Similarly B100PH NO_X emissions are lesser than B100. It is investigated that NO_X are reduced by preheating of the fuel.

3.6. CO Emissions

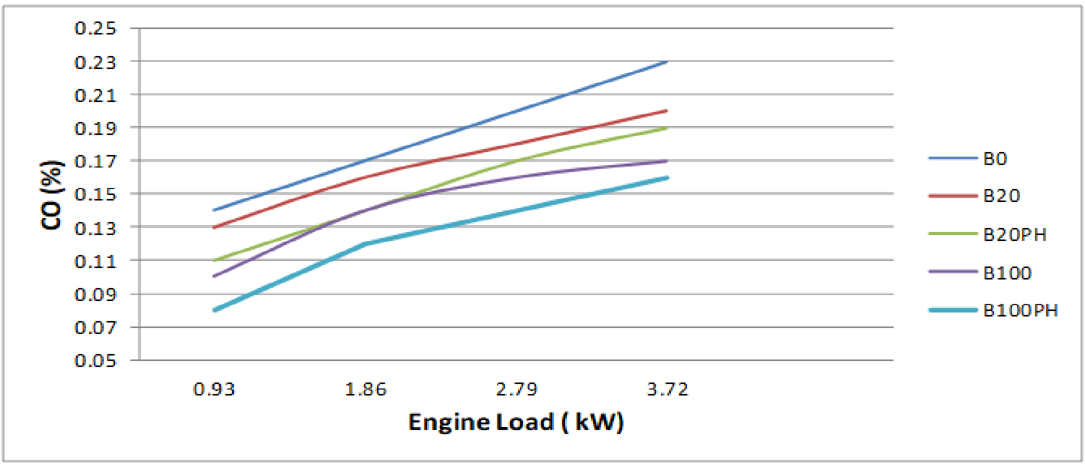

Figure 10 Variation of Carbon monoxide Emissions with Engine Load

Figure 10 shows the variation of Carbon monoxide emissions with varying engine load for all fuel blends. The CO emissions increased for all fuel blends as the engine load is increased. The CO emissions of B20, B20PH, B100, B100PH are lesser than pure diesel (B0) due to the presence of more oxygen content in biodiesel and further the CO emissions decreased due to reducing of viscosity by preheating the fuel. At full load the recorded values of CO emissions of B0, B20, B20PH, B100 and B100PH are 0.23, 0.2, 0.19, 0.17 and 0.16.

3.7. HC Emissions

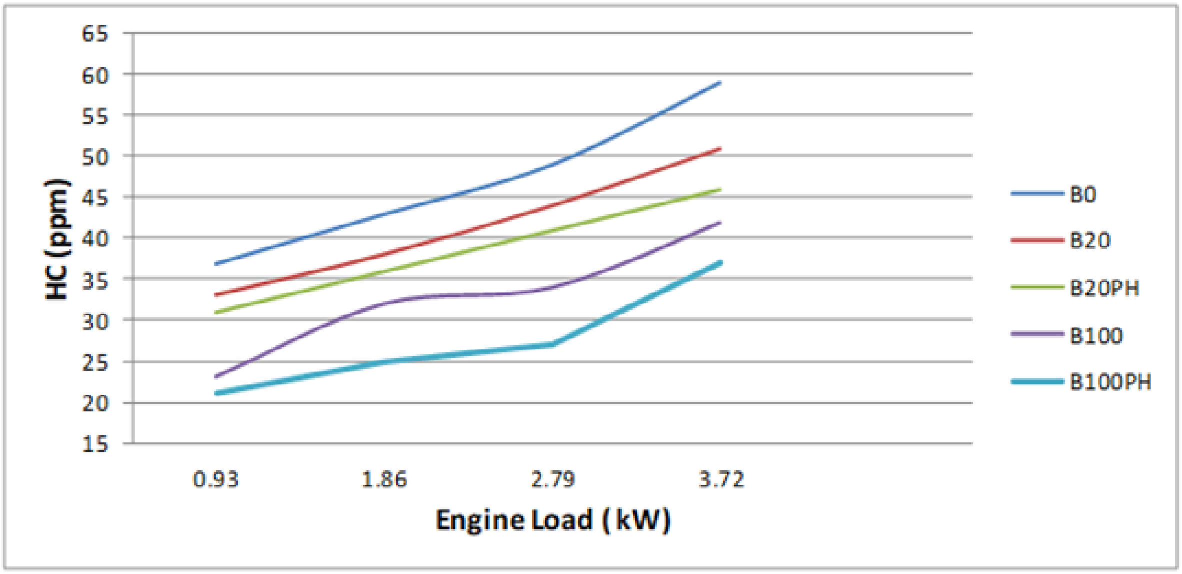

Figure 11 Variation of Hydrocarbon Emissions with Engine Load

Figure 11 shows the Hydro Carbon emissions at different engine loads for all fuel blends. The HC emissions increases as the engine load is increased and this happened for all fuel blends B0, B20, B20PH, B100 and B100PH. The HC emissions of Sheaolien biodiesel (B100), Sheaolien blend (B20), preheated Sheaolien biodiesel (B100PH) , preheated Sheaolien blend (B20PH) recorded lesser values than Pure diesel (B0) and this is due to the inherent presence of oxygen content in biodiesel. B100PH and B20PH are investigated that HC emissions are less than the corresponding HC emissions of B100 and B20 this is because of due to preheating viscosity got reduced and better spray pattern there by efficient combustion of the fuel takes place.

4. CONCLUSIONS

A single cylinder four stroke engine was operated successfully with preheated sheaolien biodiesel and the conclusions are as follows:

- BSFC was found maximum for sheaolien biodiesel and minimum for pure diesel. Preheating of sheaolien biodiesel and its blends reduces BSFC.
- BTE of sheaolien biodiesel is slightly less than pure diesel. When engine is fuelled with preheated B100PH and B20PH , BTE is higher than B100 and B20.
- EGT is low for B100 and B100PH compared to petroleum diesel B0. This may be due to lesser calorific value.
- The NOx emissions of B100 are higher than all fuel blends but preheated biodiesel NOx emissions are lesser than un preheated biodiesel.

- CO and HC emissions were lower for sheaolien biodiesel. The diesel engine fuelled with preheated biodiesel the CO and HC emissions were further lowered.

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