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Performance and Emission Analysis of C.I. Engine using Biodiesels and its Blends

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Abstract: *In this study, performance and emissions of Palm oil biodiesel, karanja oil biodiesel and mixture of both in a diesel engine is experimentally investigated. The biodiesel used is produced by transesterification of vegetable oil and its blends with petro-diesel. Engine tests have been carried out with the aim of comparing performance parameters like power, brake thermal efficiency, specific fuel consumption and emissions such as CO, NOx, etc. Considerable reduction in exhaust emissions together with no significant loss in torque, brake power, brake thermal efficiency and brake specific fuel consumption make blends of used biodiesels the suitable alternative fuels for diesel without any engine modification and could help in facing the upcoming energy crisis and controlling air pollution*.

Keywords: *Biodiesel, Diesel engine, Karanja oil, Palm oil.*

I. Introduction

The current project work is concerned with performance testing as well as emission analysis of a 4 stroke 1 cylinder diesel engine using alternative fuels. Alternative fuels used are Palm Oil and Karanja oil and mixture of both (in equal proportions each). Blends of biodiesels used with diesel are 20, 40, 60, 80, and 100% by volume (10, 20, 30, 40, and 50% by volume in case of mixture). The readings are taken at Constant compression ratio.

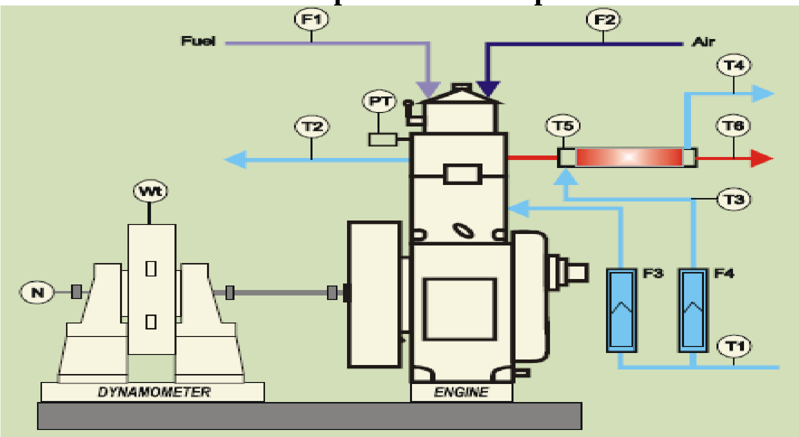
II. Previous Work

JawadNagi et.al [1]find out the results obtained from the survey reveal that palm biodiesel meets the combustion requirements of diesel engine combustion; however, it produces marginally low output characteristics compared to petroleum diesel. The case-study from the survey reveals that palm biodiesel has a number of advantages over petroleum diesel, namely: low fuel consumption, less concentration of exhaust gas emission, higher combustion pressure and longer combustion period. However, contrary to its advantages, palm biodiesel gives marginally low performance in terms of torque, thermal efficiency, and produces higher NOx emissions as compared to petroleum diesel.

Ramchandra S. Jahagidaret.al[4] on single cylinder DI diesel engine. Test where conducted on water cooled 3.75 kW diesel engine. Different fuel blends of Karanja biodiesel, diesel and Karanja biodiesel only where tested. Result shows that the break power of the engine was almost same for all the loads. However break thermal efficiency of the Karanja biodiesel where improved by 3 to 8%, Volumetric efficiency is also improved with reduction in exhaust gas temperature. Results obtained here shows that the Karanja biodiesel can itself directly used in the engine without any major modification. It is also observed that the blends of BK40 and BK 60 will have the optimum performance for the given conditions as explained earlier.

SoniS.Wirawanet. al[5] his study is devoted to the performance and emission evaluation of automotive diesel engine as affected by palm biodiesel fuel utilization. The concentration of palm biodiesel used in the test was ranged from B0 (pure petro-diesel), B10, B20, B30, B50 and B100 (pure biodiesel). The engine performance was evaluated through torque, power, and specific fuel consumption, while the emission was evaluated through carbon monoxide (CO), hydrocarbon (HC), particulate matter (PM), carbon dioxide (CO2), and NOx pollutants. The result shows that higher content of palm biodiesel can reduce the emission of CO, HC, PM, and CO2. It was found that the addition of biodiesel could increase the power and torque. Furthermore, NOx also decreased when the content of palm biodiesel increases, which is in contrast with those generally found in the previous non palm biodiesel studies.

III. Experimental Setup



Schematic representation of engine test setup

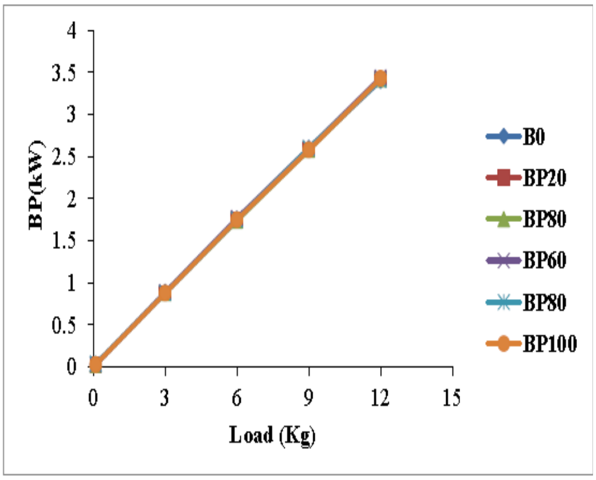
Product	VCR Engine test setup 1 cylinder, 4 stroke, Diesel (Computerized)
Engine	Make Kirloskar, Type 1 cylinder, 4 stroke Diesel, water cooled, power 3.5 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm, 661 cc, CR 17.5, Modified to VCR engine, CR range 12 to 18
Dynamometer	Type eddy current, water cooled, with loading unit
Propeller Shafts	With universal joints
Fuel Tank	Capacity 15 lit with glass fuel metering column
Calorimeter & Pump	Pipe in pipe, Mono-block Pump
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Rota meter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Overall dimensions	W 2000 x D 2500 x H 1500 mm

Engine Set-up Specifications

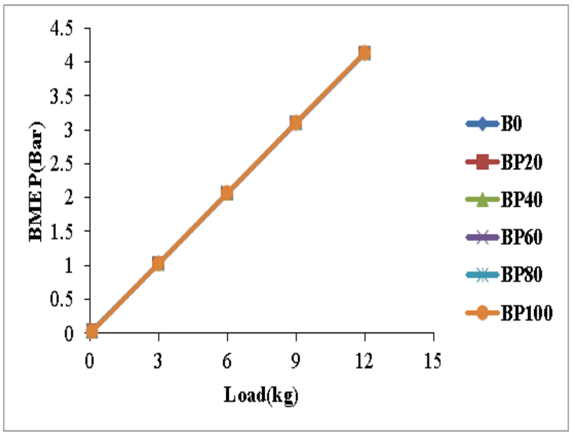
IV. Results

It is observed that as the load increases, the temperatures T2, T4, T5, T6 increases accordingly. It is also observed that fuel flow increases with increase in load. Following results are observed for all the blends of Biodiesels used i.e. Palm Oil (BP %), Karanja (BK %), and mixture of both (BPK %) (20%, 40%, 60%, 80%, 100%).

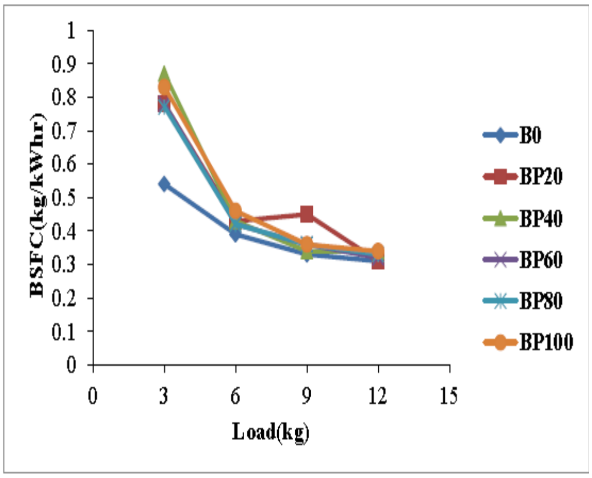
PERFORMANCE ANALYSIS GRAPHS
For constant compression ratio (CR = 17.5)
1) Palm Oil
(i) Brake Power vs. Load



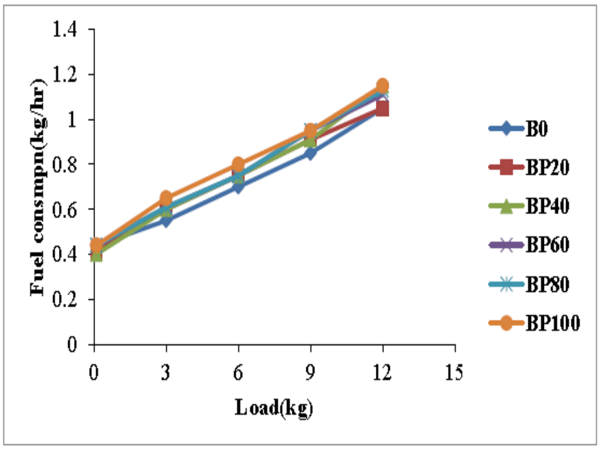
(ii) Brake Mean Effective Pressure vs. Load



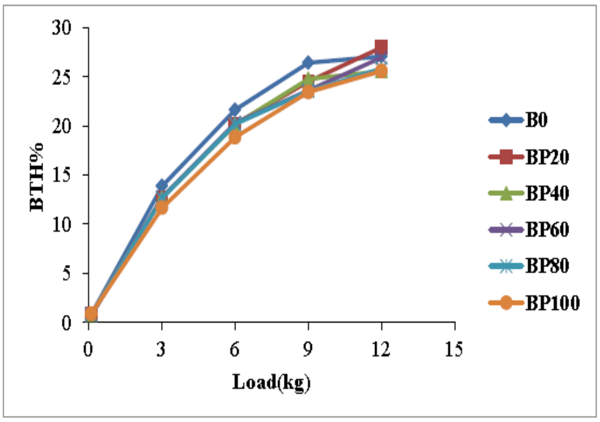
(iii) Brake Specific Fuel Consumption vs. Load



(iv) Fuel Consumption vs. Load

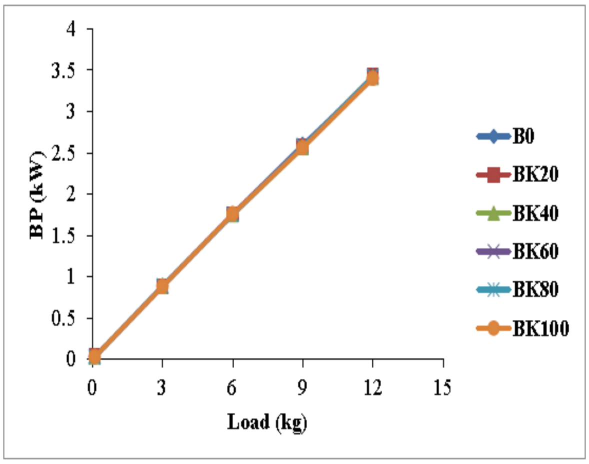


(v) Brake Thermal Efficiency vs. Load

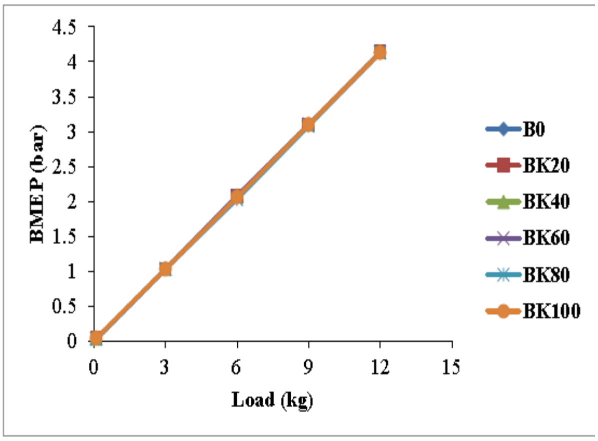


2) Karanja Oil

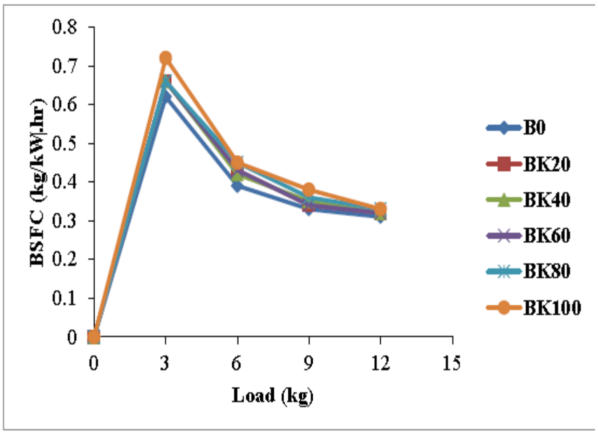
(i) Brake Power vs. Load



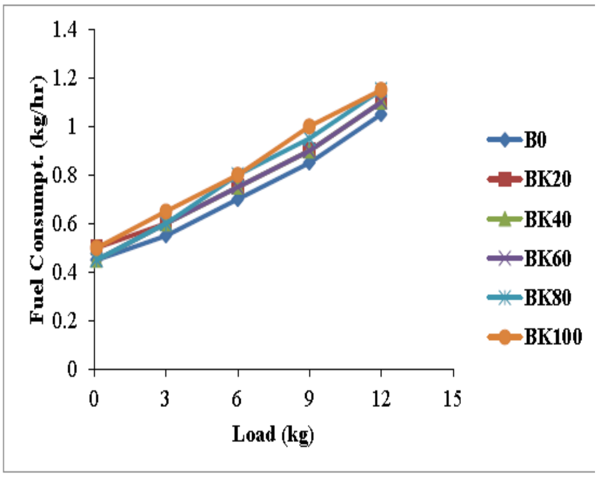
(ii) Brake Mean Effective Pressure vs. Load



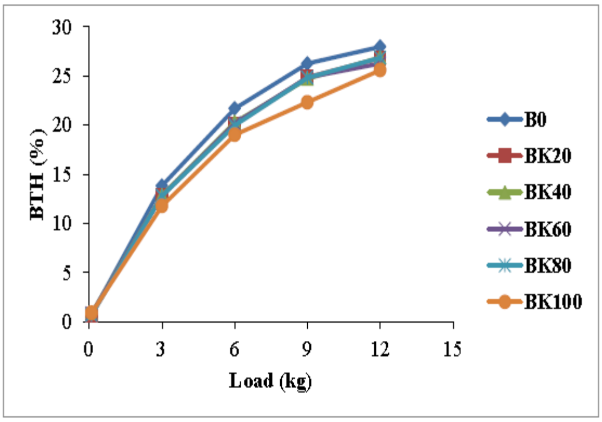
(iii) Brake Specific Fuel Consumption vs. Load



(iv) Fuel consumption vs. Load

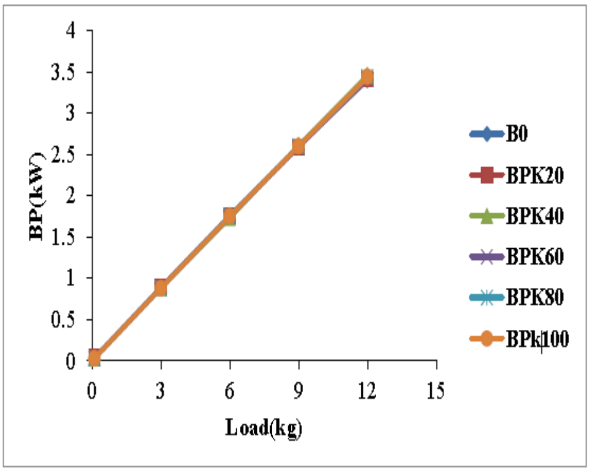


(v) Brake Thermal Efficiency vs. Load

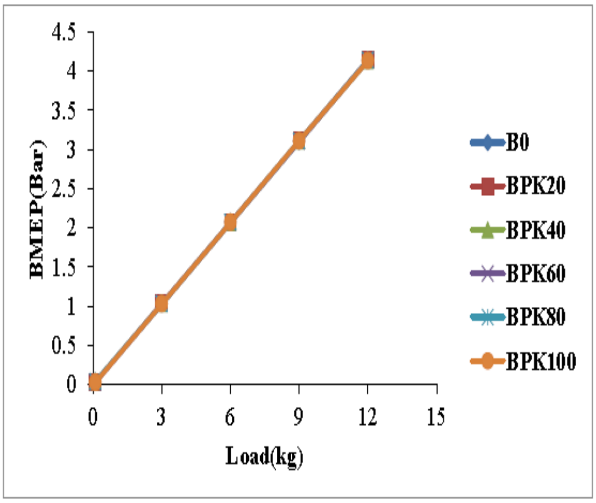


3) Mixture of Palm Oil and Karanja Oil

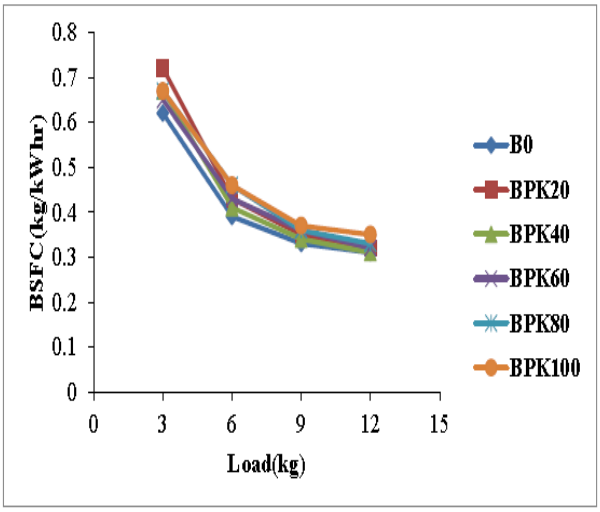
(i) Brake Power vs. Load



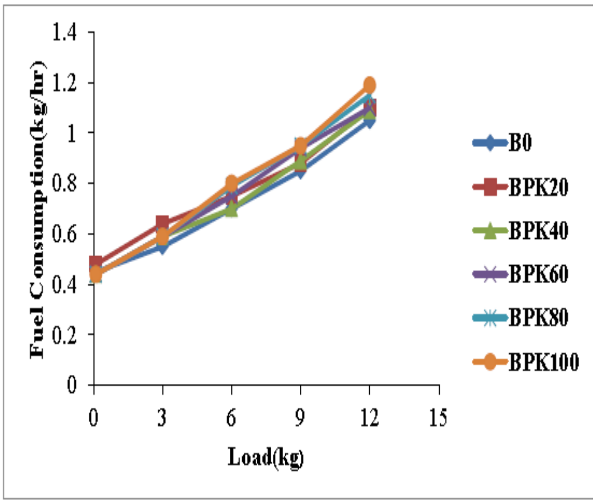
(ii) Brake Mean Effective Pressure vs. Load



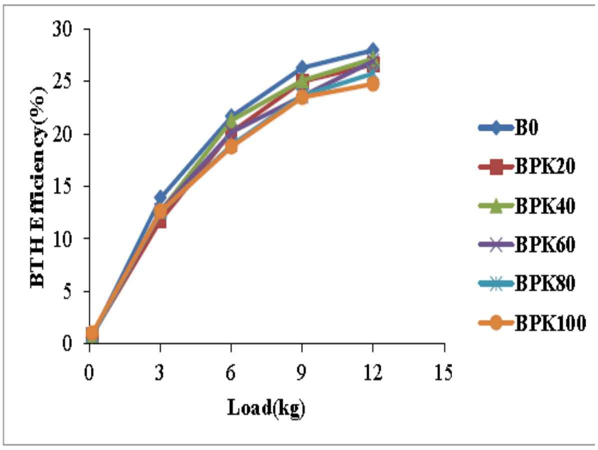
(iii) Brake Specific Fuel Consumption vs. Load



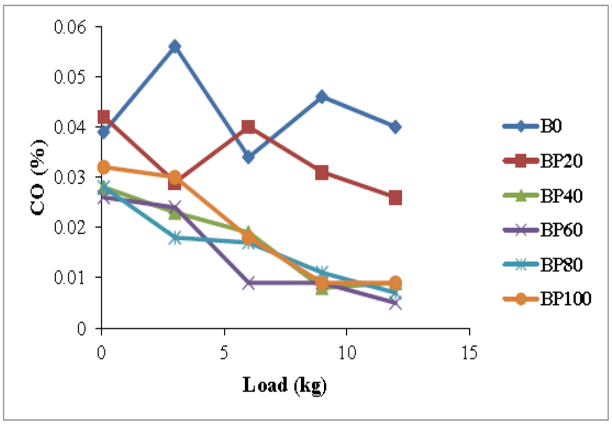
(iv) Fuel Consumption vs. Load



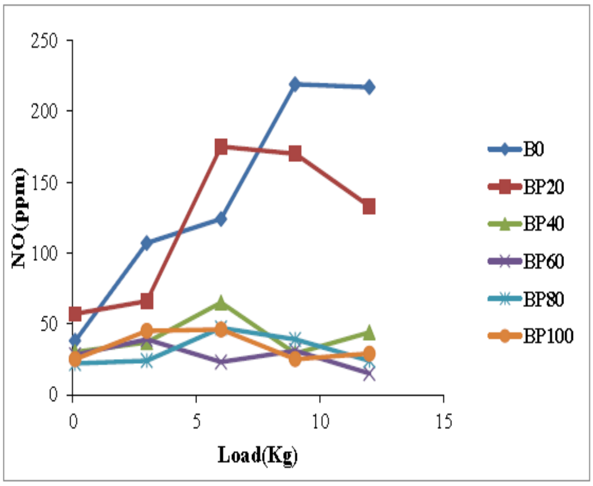
(v) Brake Thermal Efficiency vs. Load



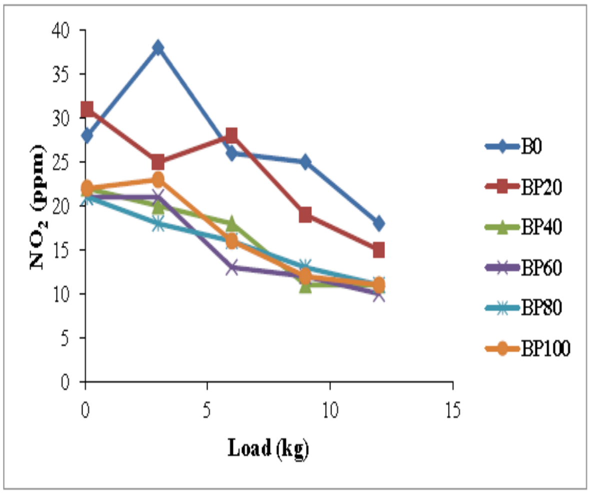
EMISSION ANALYSIS GRAPHS
For constant compression ratio (CR = 17.5)
1) Palm Oil
(i) CO vs. Load



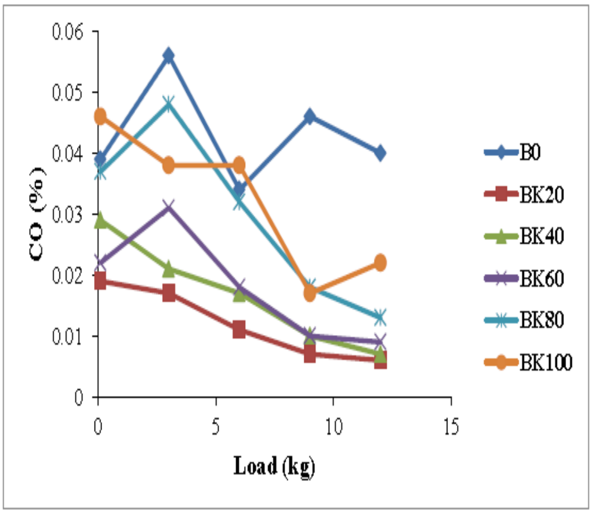
(ii) NO vs. Load



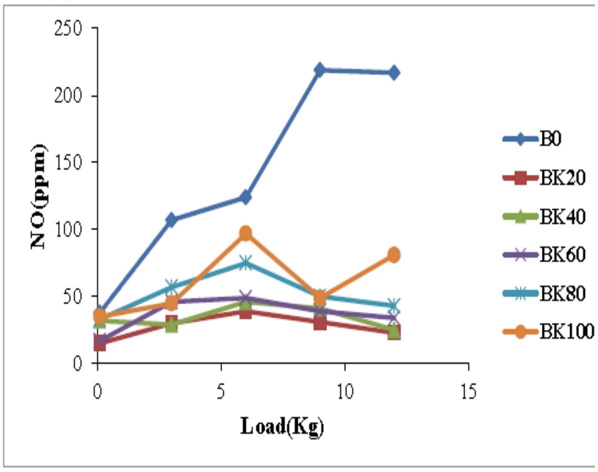
(iii) NO2 vs. Load



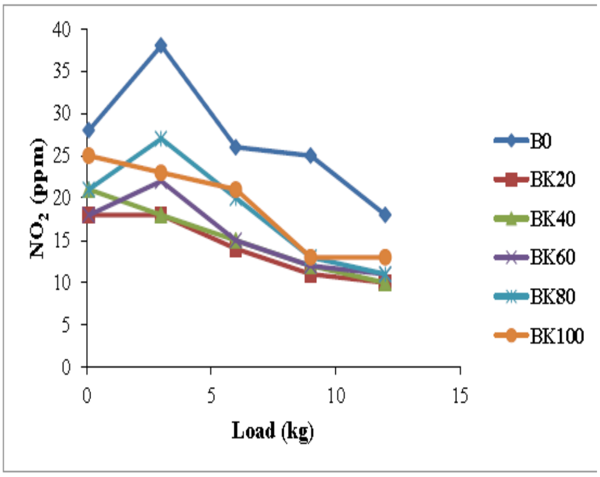
2) **Karanja Oil**
(i) CO vs. Load



(ii) NO vs. Load

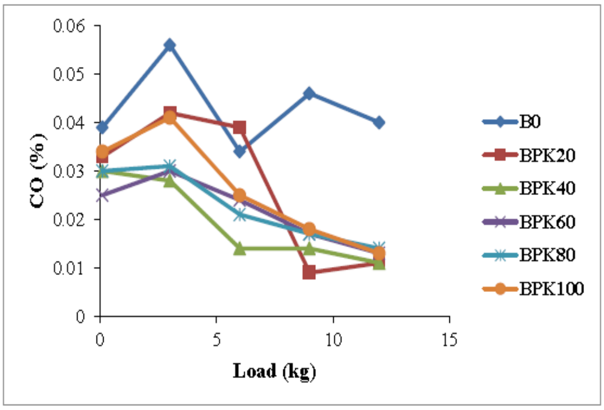


(iii) NO2 vs. Load

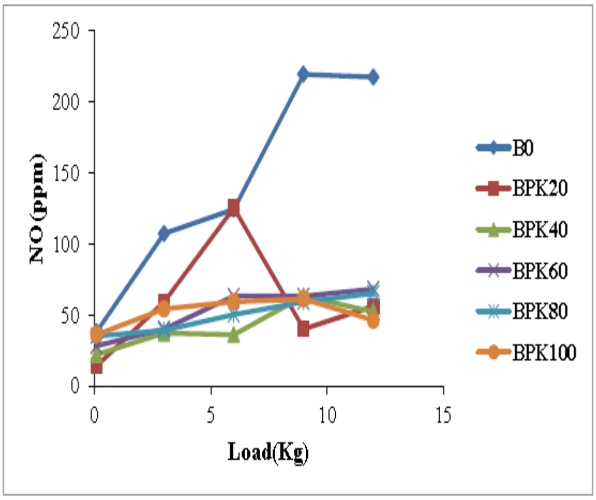


3) **Mixture of Palm Oil and Kranja Oil**

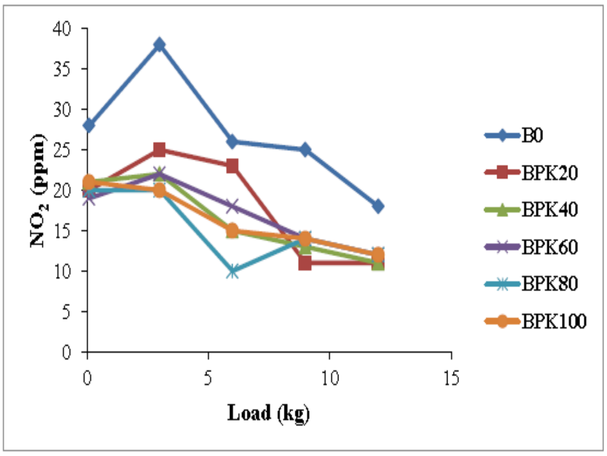
(i) CO vs. Load



(ii) NO vs. Load



(iii) NO2 vs. Load



V. Conclusion

A. PERFORMANCE ANALYSIS OF C.I. ENGINE

Considering the results obtained from the tests on engine it can be concluded that:

- The brake power, BSFC and mechanical efficiency for biodiesels at varying loads with constant compression ratio are almost similar to that of diesel. Hence, there is no significant loss in power.
- For constant compression ratio BP20 is most efficient blend which gives same Power and BTH efficiency.
- For constant compression ratio BK20 and BK40 are most efficient blends.
- For constant compression ratio BPK40 is most efficient blend.
- For the variable compression ratio engine CR=17.5 is most suitable compression ratio which gives maximum Brake Power and BTH efficiency.

Thus, it suggests that there is no degradation in performance of the C.I. engines running on biodiesel.

B. EMISSION ANALYSIS OF C.I. ENGINE

Considering the results obtained from the emission tests it can be concluded that:

- For biodiesel mixtures CO, NOx emissions are lower than that of diesel fuel. As the amount of biodiesel in the blend increases, the amount emission gases decreases.
- BP60 gives minimum CO, NOx emissions.
- BK20 gives minimum CO, NOx emissions.
- BPK40 gives minimum emissions.

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