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# PERFORMANCE IMPROVEMENT OF A DI DIESEL ENGINE WITH TURBOCHARGING USING BIOFUEL

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***Abstract*—Direct injection compression ignition engines have proved to be the best option in heavy duty applications like transportation and power generation, but rapid depleting sources of conventional fossil fuels, their rising prices and ever increasing environmental issues are the major concerns. Alternate fuels, particularly biofuels are receiving increasing attention during the last few years. Biodiesel has already been commercialized in the transport sector. In the present work, a turbocharged single cylinder DI diesel engine has been alternatively fuelled with biodiesel and its 20% blend with commercial diesel. The experimental results show that improvement in thermal efficiency, consumption of fuel, BSFC and reduction in NOx and HC emission. In the present investigation effect of turbocharging is studied on the performance of a direct injection diesel engine with the use of untreated karanja oil. Performance of the engine is evaluated in terms of break specific fuel consumption, Brake thermal efficiency and smoke Density.**

***Keywords— DI engine, Turbocharging, Biofuel, Renewable energy***

### *Introduction*

With the exponential growth of automotive vehicle population and increased stress on industrialization in developing countries, the impact of the twin problems of exhaust emission and the depletion of precious foreign exchange reserves for importing nonrenewable petroleum crude and products to keep the vehicles moving will indeed be very severe. Vegetable oils are mixtures of fatty acids-molecules that contain carbon, hydrogen, and oxygen atoms. Due to high viscosity of vegetable oils, they interfere with fuel jet penetration, atomization and results in higher fuel consumption and leaves gummy deposits on the engine components upon combustion. Due to high viscosity of vegetable oils, they interfere with fuel jet penetration, atomization and results in higher fuel consumption and leaves gummy deposits on the engine components upon combustion. It is well known that turbocharging improves combustion process of diesel engines .Increase in pressure and temperature of the engine intake reduces ignition delay resulting in a quiet and smooth operation with a lower rate of pressure rise. Thus turbocharging encourages the use of low grade fuels in diesel engines. Diesel along with Karanja curcas oil was used in a C.I. engine in dual – fuel mode operation. In the literature review carried out by the authors it is observed that no information is available on the performance of a DI diesel employing vegetable oils as fuel under turbocharged condition. So this investigation is running engine on biodiesel under turbocharged condition to improve combustion. Ramesh A, et al. [1] (2007) has underline the importance of of turbo charging by increase in the intake boost pressure improves the brake thermal efficiency of the engine with turbochrging. Conditions, the inlet boost pressures are higher for compensating the volumetric efficiency drop in normal engine. Barsic et al. (2007)[11] adopted a rotary fuel injection pump and with fuel flow adjusted to provide equal fuel energy input and observed that the engine power and thermal efficiency decreased slightly and emissions increased marginally. B. Tesfa,et al.[9] (2010) studied an experimental investigation has been carried out on the combustion and performance characteristics of a CI engine running with biodiesel under steady state operating conditions. the brake specific fuel consumption values for the engine running with biodiesel are higher than the engine running with normal diesel by a maximum of 14%. However, the thermal efficiency of the engine running with biodiesel is lower than engine running by diesel by 10%. Sharma M.P. et al. [6] (2013) they stated that significantly higher viscosities and moderately higher densities, lower heating values, rice in the stoichiometric fuel/air ratio due to the presence of molecular oxygen and the possibility of thermal cracking at the temperatures encountered by the fuel spray in the naturally aspirated diesel engines. M. Basinger ,et al. [5] (2009) their experimental results of the study to show how a combination of preheating the high pressure fuel line, advancing the injector timing and increasing the injector valve opening pressure allows this engine to efficiently utilize plant oils as a diesel fuel substitute. C.D. Rakopoulos, et al.[2] (2012) , they performed turbocharged diesel engine in order to investigate the formation mechanisms of nitric oxide (NO), smoke, and combustion noise with turbo charging blend decreased significantly exhaust gas opacity but increased notably NO emission.

### *Experimental Setup*

A single cylinder, 4 stroke diesel engine of 5.2 kW rated power is considered for the purpose of experimentation. The schematic layout of the experimental setup is shown in the fig. The engine is connected with turbocharger at its exhaust. The observation reading are taken at no load, 3kg, 6kg and 9kg as a full load .At each of these loads performance parameter are recorded, tabulated and plotted. Reading is taken diesel with turbo charger, diesel without turbocharger, biodiesel with turbocharger, biodiesel without turbo charger. In the calculation mass calorific value is taken as 43000 KJ/kg and specific calorific value is taken as 38532 KJ/kg.

ENGINE SPECIFICATION*:*

| **Manufacturer-** | **KIRLOSKAR OIL ENGINE LTD PUNE, INDIA** |
|---|---|
| TYPE | -Single Cylinder, 4 Stroke Water Cooled Diesel Engine |
| RPM | -1500 |
| ENGINE NO.- | 18.1093/8158 |
| R.P.M.- | 1500 |
| Bore | -87.5mm |
| Stroke | -110mm |
| Cooling | -Water Cooled Engine |
| Displacement | -661.5cc |
| BHP | -7 bhp |
| KW | -5.22 |
| Compression ratio- | 17.5: 1 |
| Injection pressure | -200 bar |
| Dynamometer | -Prony Brake Dynamometer |
| Manufactured In | -K.I.T.S. Workshop |
| Effective length of the Brake Arm | -370mm |

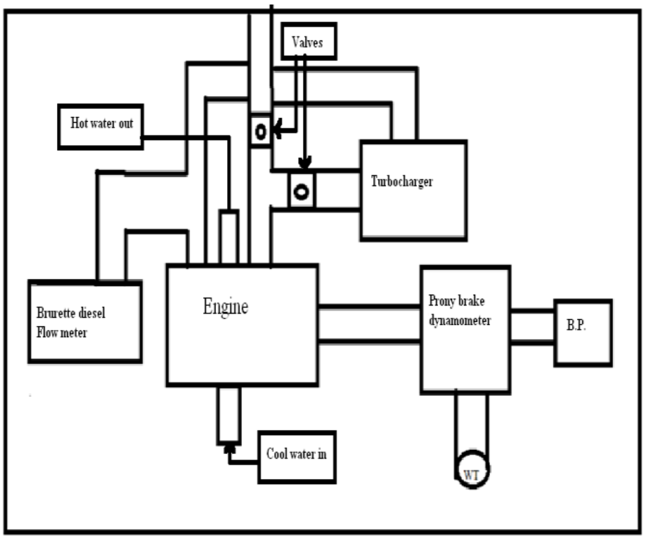
TURBOCHARGER:

| | |
|---|---|
| Make: | Mahindra and Mahindra |
| Model: | MDI 3000TC |

### *Testing*

For the calculations of performance parameters the engine first run in without turbocharger with diesel and biodiesel at 1500 rpm and different loads (no load, 3kg, 6kg, and 9kg) are taken.

*Dia.-Experimental Setup*




*dia : Schematic diagram*

### *Result and disscution*

1) The brake thermal efficiency of engine without turbocharger on diesel on 9 kg load and at 1500 rpm was found to be 22% and with turbocharger was found to be 23.11%.

2) We have found that thermal efficiency of engine on diesel with turbocharger increased by 1.11%.

3) The brake thermal efficiency of engine without turbocharger on biodiesel on 9 kg load and at 1500 rpm was found to be 18.23% and with turbocharger was found to be 21.30%.

4) NOx and HC emission reduced with the help of turbocharger.

5) We have found that efficiency of engine on biodiesel with turbocharger increased by 3.07%.

6) Fuel consumption on diesel on 9 kg of load at 1500 rpm was 11.4*10-4 and when on with turbocharger it was 5*10-4.

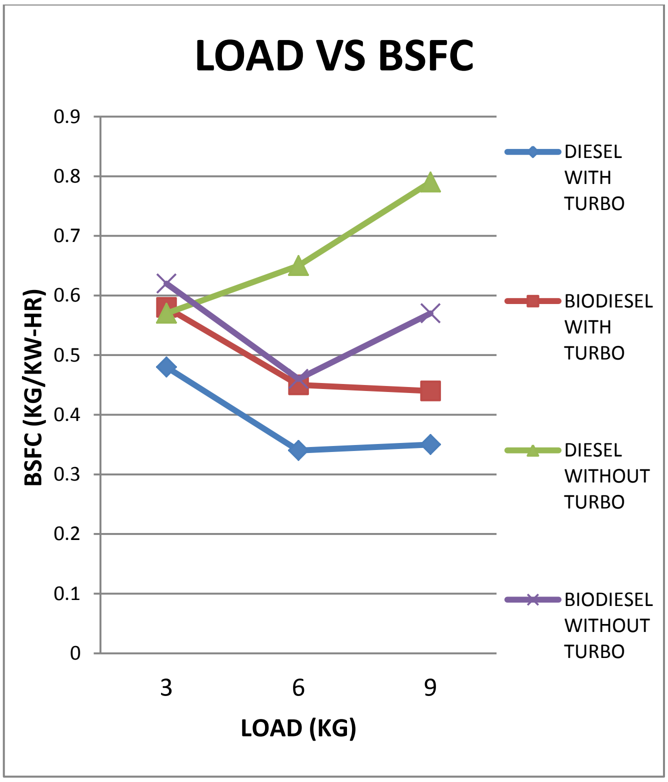
7) The consumption of diesel fuel was decreased about 50-60% with turbocharger.

8) Fuel consumption on biodiesel on 9 kg of load at 1500 rpm was 7.3*10-4 and when on with turbocharger it was 6.25*10-4.

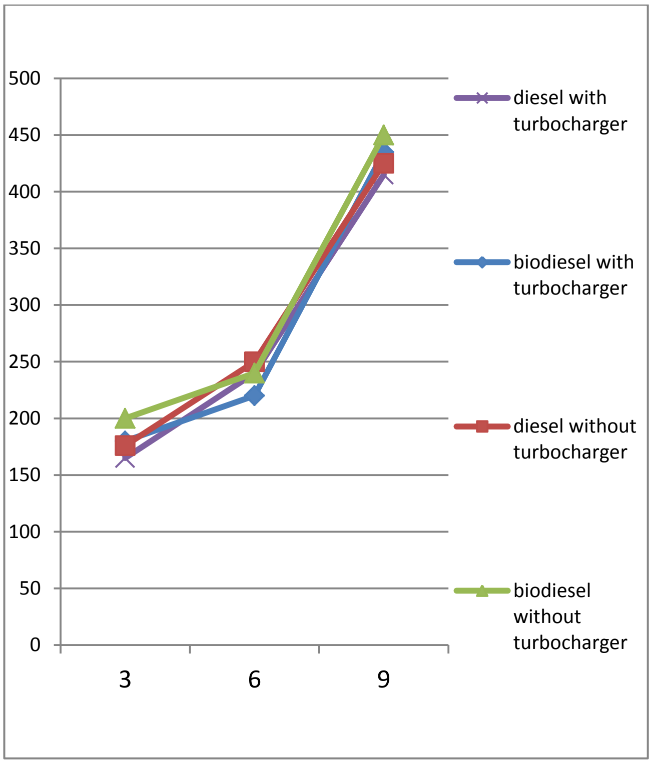
9) The consumption of diesel fuel was decreased about 20-30% with turbocharger.

10) The brake specific fuel consumption on 9 kg load at 1500 rpm for diesel without turbocharger found to be 0.79kg/kw-hr and with turbocharger it found to be 0.35kg/kw-hr.

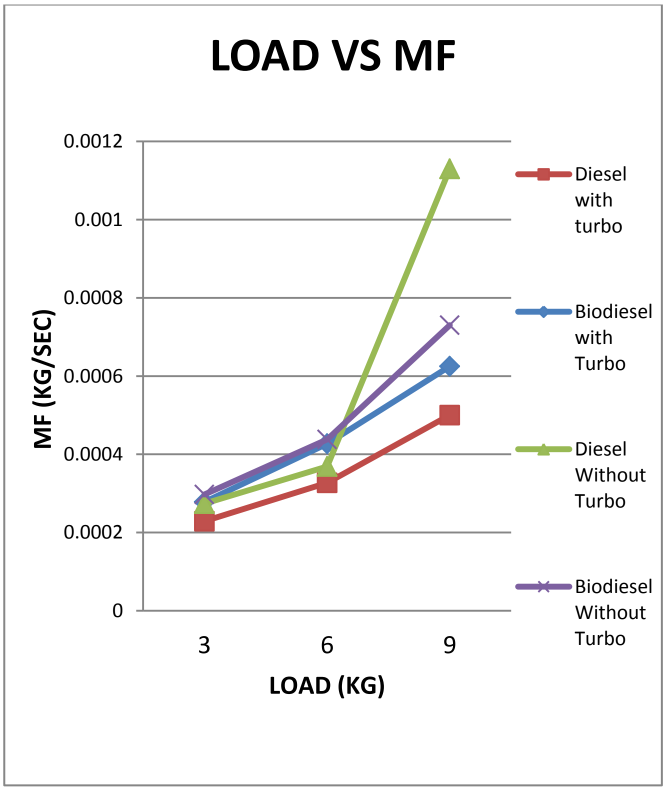
***Comparison on basis of performance curve***



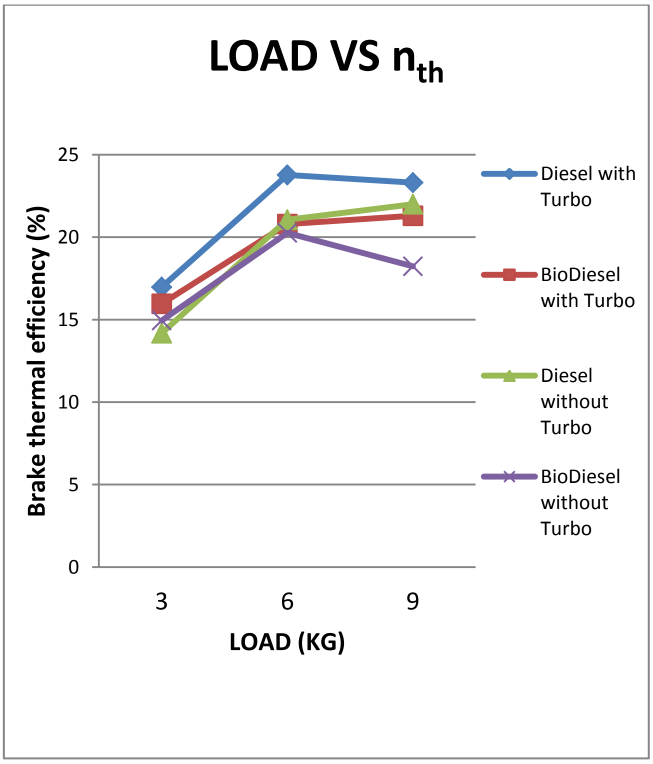

`Graph 1:load vs bsfc




Graph 2 ;Load vs Exhaust temp

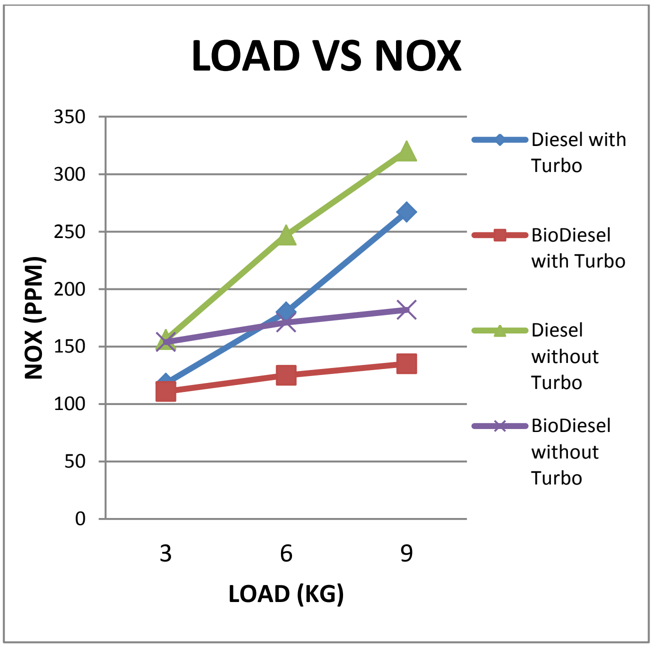



Graph 3 : Load vs mass of fuel

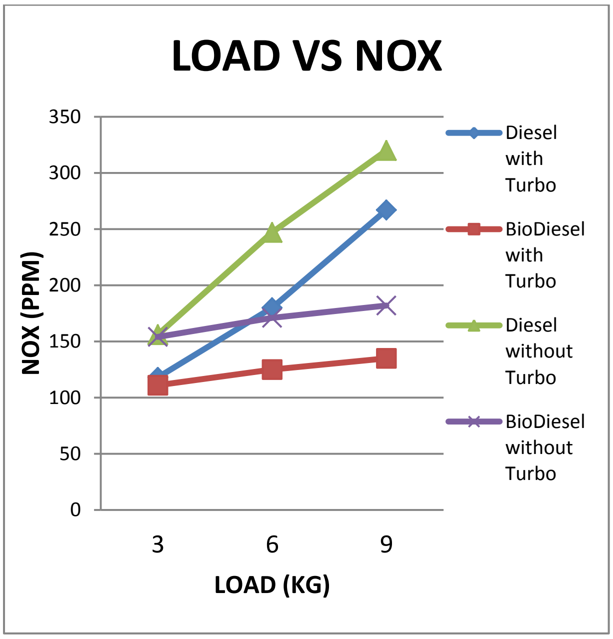



Graph 4 Load vs Brake thermal Efficiency

***Exhaust Emissions Testing***




Graph No 5: Load Vs Hydrocarbon




Graph No 6: Load Vs NOx

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