A Review on Karanja Biodiesel as an Alternative Fuel for Diesel Engine

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ABSTRACT

Diesel engines have high thermal efficiency so they are widely used in light, medium and heavy duty vehicles and also for power generation**.** Bio-fuels are able to reduce net carbon dioxide (CO_2) and CO emissions. As Bio-fuels are made from renewable sources they are having environmental benefits. Bio-diesel is biodegradable and it can be used in most of the diesel engines by making some changes in the engine manifold. The various types of biodiesel used are Karanja, Jatropha, Mahua, etc. The another name for Karanja biodiesel is Pongamia Pinnata oil. Non edible Pongamia Pinnata (Karanja) biodiesel is blended with diesel to use as an alternative fuel for diesel engines. This oil is blended in varying proportions such as 10%, 20%, 50% and 100% with pure diesel. The Compression ratio, Injection pressure, Speed and load can be varied or additives can be used to check the performance and emission characteristics of Karanja biodiesel blends. By this method we can select the most suitable blend for diesel engine.

Keywords: Pongamia Pinnata, Engine Combustion and Performance, Efficiency

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1. INTRODUCTION

Due to increase in number of automobiles along with world population, the exhaust gas emissions of internal combustion engines become a big problem.Because of this air pollution also increases. Bio-fuels are produced by various chemical or natural processes from biological materials like plants, agricultural wastes, vegetable oils, animal fats tec. Biodiesel is renewable, oxygenated, non-toxic and Sulphur free fuel. It is the most suitable alternative fuel to diesel because of following reasons:

- Biodiesel is completely made up of natural sources, so it does not contain any sulphur, aromatic Hydrocarbons, metals.
- Biodiesel is an oxygenated fuel.
- It can be used in the existing engine without any changes in the engine.
- Emissions of carbon monoxide and soot reduce.

2. PROCEDURE FOR PRODUCING KARANJA BIODIESEL

Transesterification

In this process, alcohol is used (e.g. methanol, ethanol or butanol). This process is carried out in the presence of catalyst like Sodium hydroxide, Potassium hydroxide etc. Transesterification process can be explained with the help of following chart:

 ISSN: 2321-8169
669 –676

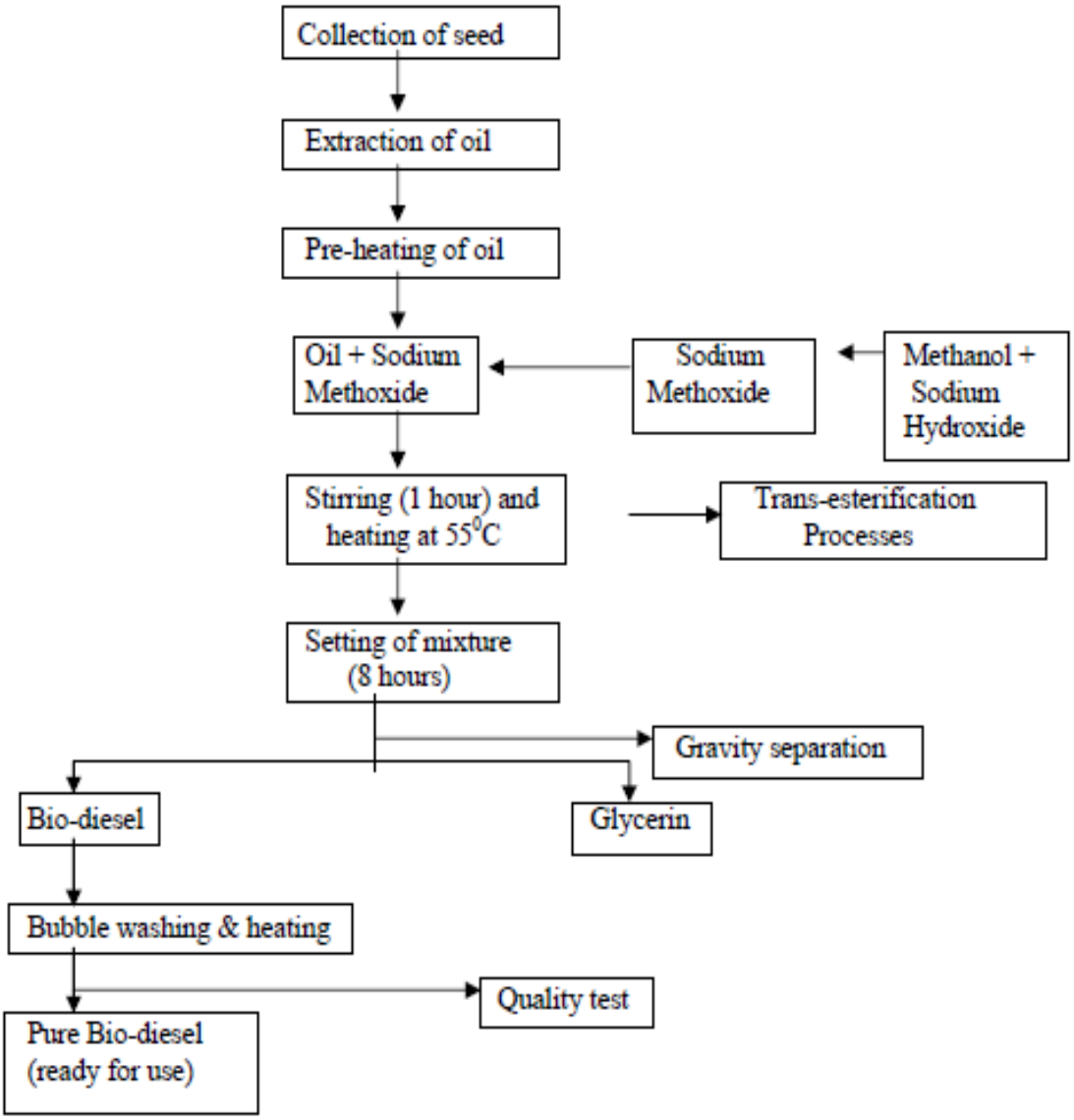

Fig. 2.1: Transesterification process

Karanja biodiesel can also be produced by Esterification process. Production pf biodiesel from Pongamia Pinnata oil involves following steps:

a) Blending
b) Micro-emulsification
c) Cracking
d) Transesterification

3. COMPARATIVE PROPERTIES OF PURE DIESEL AND KARANJA BLENDS

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669 –676

S.No.	Properties	Diesel	KB20	KB50	KB100
1.	Density at 15^{0}C (kg/m^3)	826	836	852	884
2.	Viscosity at 30^{0}C (cSt)	2.67	3.16	4.28	7.16
3.	Flash point (^{0}C)	63	80	102	172
4.	Fire point (^{0}C)	78	92	127	194
5.	Cloud point (^{0}C)	6.9	8.2	11.7	15.1
6.	Pour point (^{0}C)	3.2	3.8	4.7	5.8
7.	Calorific Value (MJ/kg)	42.00	40.788	38.97	35.94

Table 3.1: Properties of karanja biodiesel blends

4. COMBUSTION CHARACTERISTICS

4.1 RATE OF PRESSURE RISE V/S LOAD

From figure, it is observed that the rate of pressure rise increases for increase in loading conditions for all fuels. This happens because greater amount of fuel is injected at higher loading conditions. The value of rate of pressure rise for KB20 blend is higher than that off KB50 blend. Therefore, amount of karanja biodiesel in diesel is used to reduce engine noise level, to increasethe engine life and to obtain a smooth combustion process.

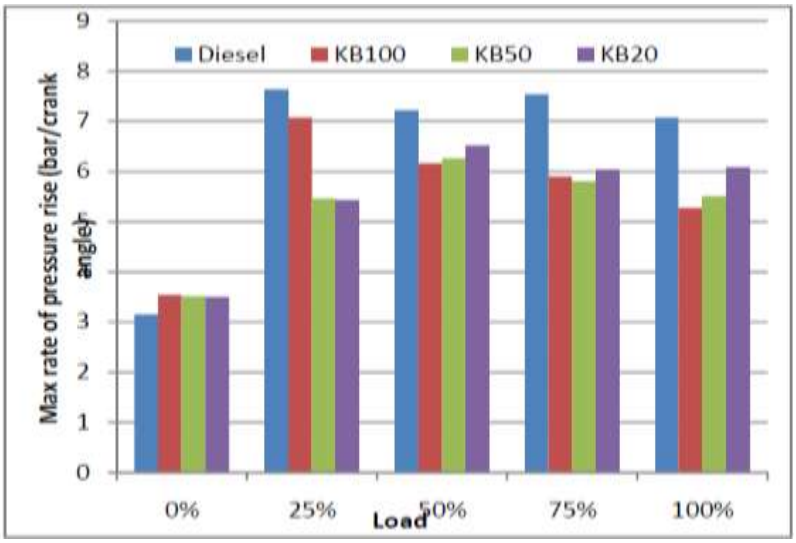

Fig. 4.1: Rate of pressure rise v/s load

4.2 HEAT RELEASE RATE V/S LOAD

The value of heat release rate is higher for pure diesel than Karanja Biodiesel Blends at 25%, 50%, 75% and at full load conditions. The Karanja Blends have low heat releaserate because they have lower calorific value.

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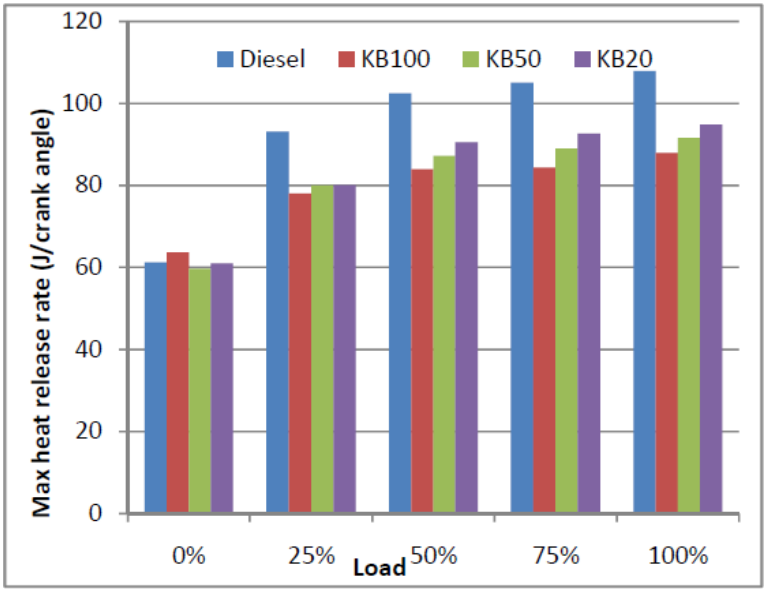

Fig. 4.2: Heat release rate v/s load

4.3 MEAN GAS TEMPERATURE V/S LOAD

If value of mean gas temperature is high, then more amount of NOX will be formed. Hence, to reduce the emissions of NOX and thus to decrease the air pollution, value of mean gas temperature should be very less. At loading conditions like 25%, 50%, 75% and full load conditions, the pure Karanja Biodiesel and its blends have high value of mean gas temperature than that of pure diesel.While at no load condition, pure diesel has high value of mean gas temperature as compared to other Karanja blends. The reason behind it is that the Karanja biodiesel contains 10% more amount of oxygen than the pure diesel. Therefore, proper combustion takes place and it gives the high value of mean gas temperature.

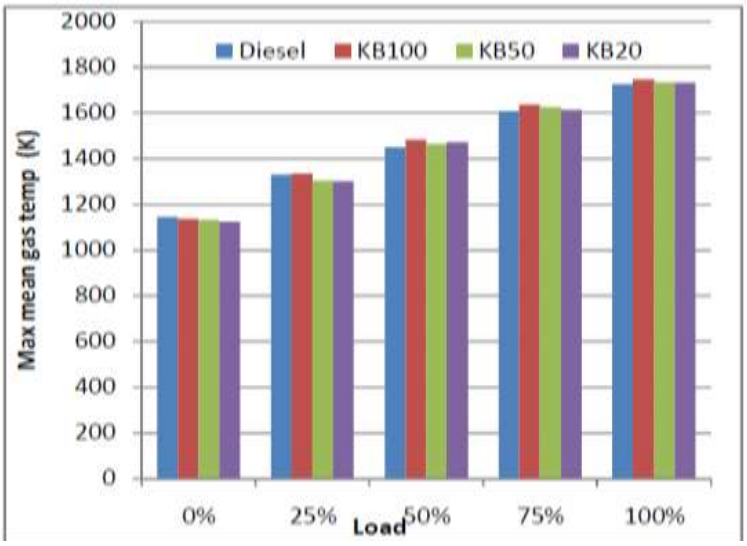

Fig 4.3: Mean Gas Temperature v/s Load

5. PERFORMANCE CHARACTERISTICS

5.1 BRAKE THERMAL EFFICIENCY

The pure Karanja biodiesel and its blends KB20, KB50 have high thermal efficiency than pure diesel at 25% load. The pure diesel and Karanja have same brake thermal efficiency at 50% load. Similarly, KB50 and KB75 have same thermal efficiency. But at 75% of load Karanja biodiesel records less value of brake thermal efficiency. This is because, the Karanja biodiesel have low calorific value than diesel.

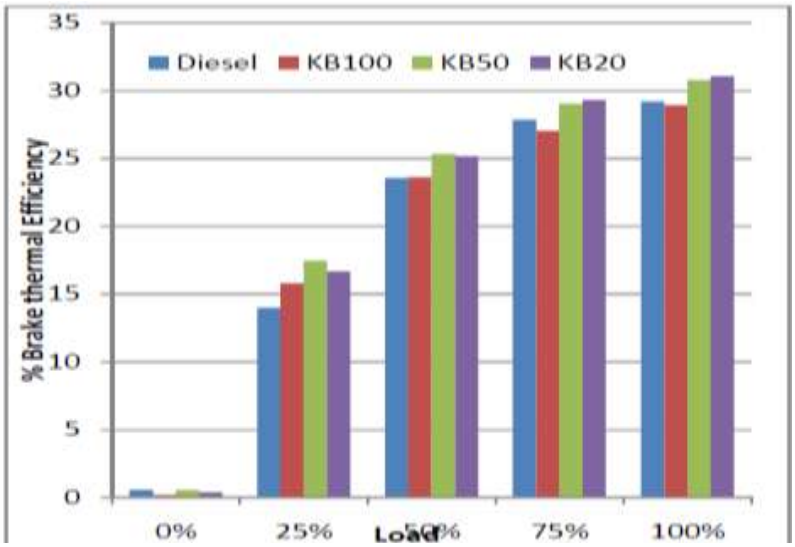

Fig 5.1: Brake thermal efficiency v/s load

5.2 FUEL AIR RATIO

KB100 have high value of fuel air ratio than all other Karanja biodiesel blends as well as pure diesel for all loading conditions that is 25%, 50%, 75% and full conditions. This occurs because Karanja biodiesel have higher density than diesel and also lower calorific value than pure diesel.

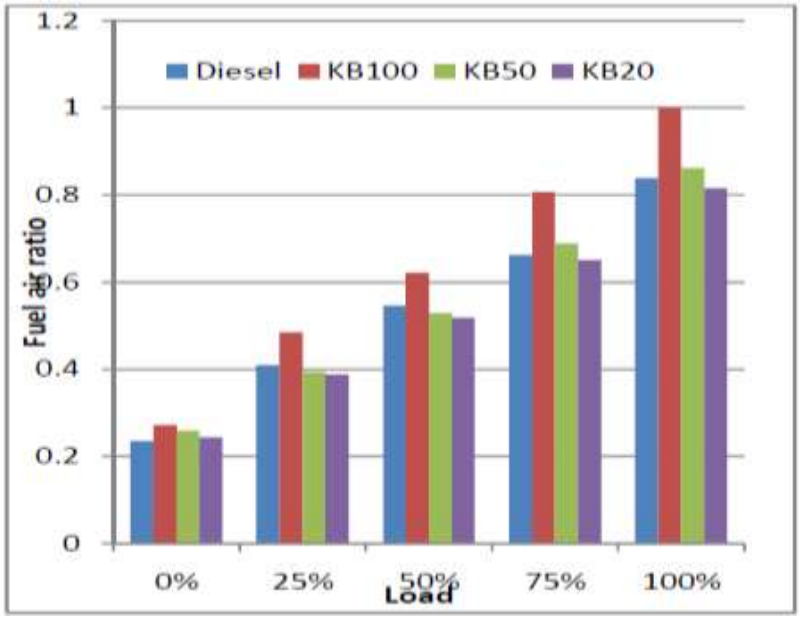

Fig 5.2: Fuel Air Ratio v/s Load

5.3 HEAT EQUIVALENT TO USEFUL WORK

From graph, it is observed that heat equivalent to useful work is increased if the loading conditions are increased. But KB100 gives less values of heat equivalent to useful work than pure diesel for all loading conditions. The reason for this is that the KB100 have more calorific value than pure diesel. At high loading conditions, the performance of biodiesel blends is near to the pure

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669 –676

diesel on basis of better combustion. This is due to more amount of oxygen is present in biodiesel blends and also reduced friction losses.

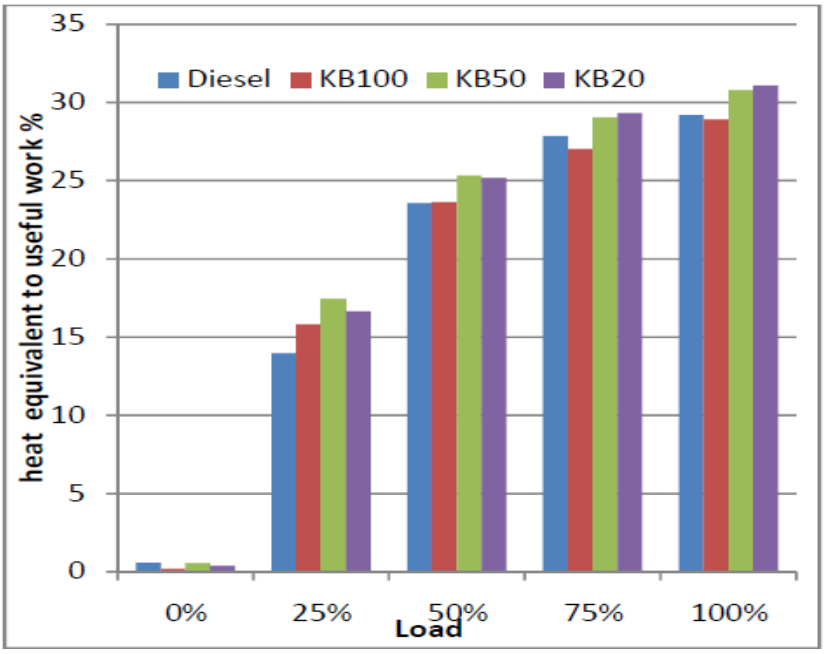

Fig. 5.3: Heat equivalent to useful work

6. DIESEL ENGINE IN DUAL FUEL MODE WITH KARANJA BIODIESEL AND LPG

6.1 FUEL CONSUMPTION V/S LOAD

The graph shows that the value of fuel consumption is more for pure biodiesel. If LPG is mixed with it then it reduces the fuel consumption. Hence it is cleared from the graph that at high loading conditions, dual fuel mixture (i.e. Karanja biodiesel + LPG) is more effective. At all loading conditions fuel consumption for pure diesel is less than pure biodiesel. While at low loads dual fuels have better fuel consumption than pure diesel.

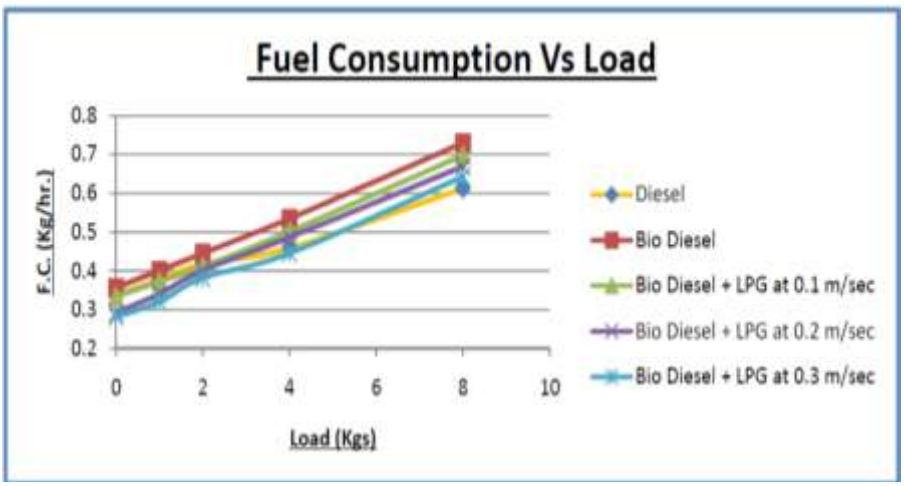

Fig. 6.1: Fuel consumption v/s load

6.2 BRAKE SPECIFIC ENERGY CONSUMPTION V/S LOAD

Brake specific energy consumption (BSEC) means the energy required for the fuel to generate per unit of brake power. Pure diesel and Pure biodiesel have better BSEC than dual fuel.

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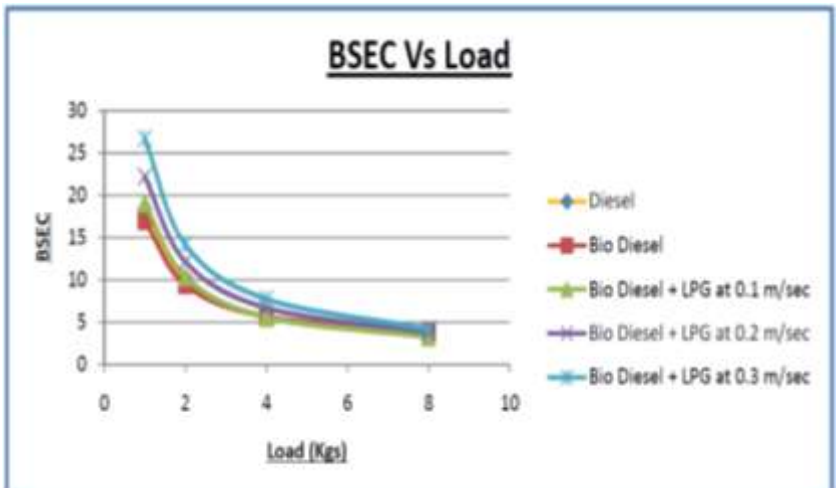

Fig. 6.2: BSEC v/s load

6.3 BRAKE THERMAL EFFICIENCY V/S LOAD

Brake thermal efficiency (BTE) is the energy given by fuel which is converted to brake power. It is a dimensionless number. It varies linearly with brake power and inversely with energy content of fuel. If brake power increases, brake thermal efficiency also increases. At all loading conditions, value of BTE for pure biodiesel and diesel is high. If the amount of LPG in biodiesel isincreased, then BTE decreases.

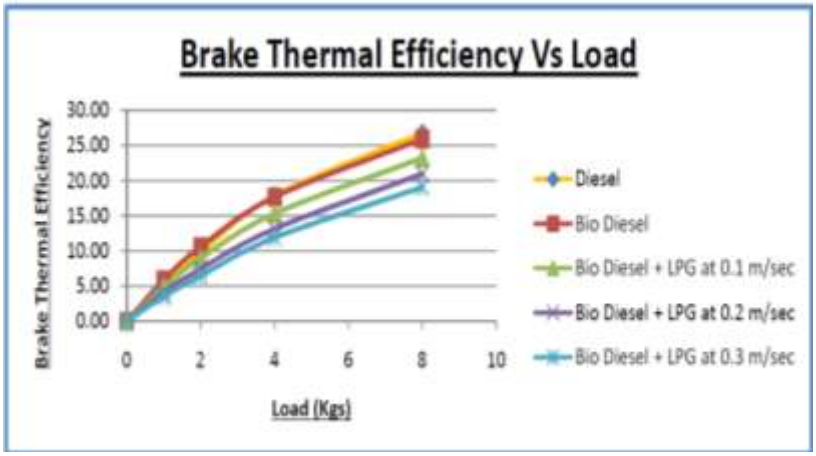

Fig. 6.3: BTE v/s load

6.4 EXHAUST GAS TEMPERATURE V/S LOAD

Exhaust gas temperature (EGT) is directly proportional to load. The value of EGT is more for dual fuel mode. This is because quantity of air required for combustion in combustion chamber is less and heating value of LPG is high.

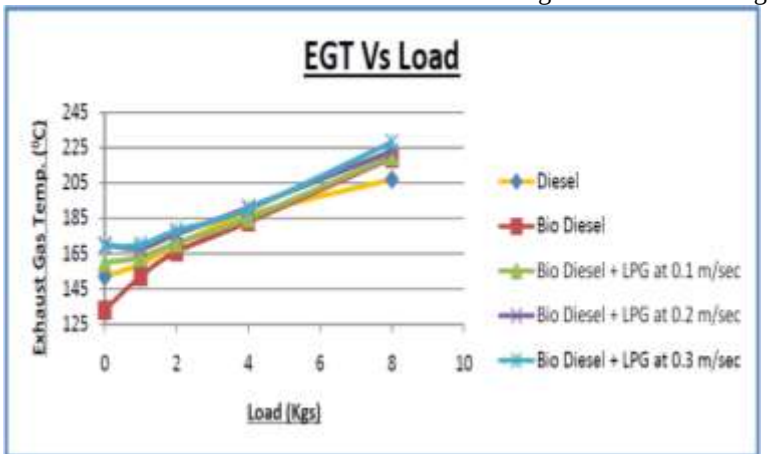

Fig. 6.4: EGT v/s load

7. CONCLUSION

- The physical properties like density, fire point, cloud point are almost similar for the Karanja biodiesel blend KB20 and pure diesel. But the values of density, fire point, cloud point for blends KB50 and KB100 are very much different than the pure diesel. Only theCalorific value of pure diesel is more than that of KB20, KB50 and KB100 blends.

- The rate of pressure rise for pure diesel are more than the pure karanja biodiesel and its blends. This shows the smooth combustion process. Because of this engine noise level reduces and the engine will have more life.

- The value of heat release rate for pure diesel is more than the Karanja biodiesel blends. Because Karanja biodiesel blends have 10-12% more oxygen content than diesel. The fuel air mixing rate decrease due to high value of viscosity and density resulting inferior atomization and vaporization.

- For KB100 mean gas temperature is more than the other Karanja blends and pure diesel. So this gives more amount of NOX emission. This is because the KB100 has 10-12% more content of fuel bound oxygen than diesel which contributes better combustion of diesel engine.

- For all loading conditions i.e. 25%, 50%, 75% and full load conditions, the value of fuel air ratio is lower for KB20 blend than pure diesel.

- The KB20 has high value of heat equivalent to useful work than pure diesel at 50%, 75% and full load.

- Fuel consumption, Brake specific energy consumption and Brake thermal efficiency are low in dual fuel mode. As the calorific value of LPG is high and it is less used so, BTE decreases.

- Only the value of exhaust gas temperature is more in dual fuel mode. High temperature inside the combustion chamber can harm engine parts and decreases mechanical properties of the engine. Therefore, cooling systems are needed in dual fuel mode.

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