

# A Study On Diesel Engine Using Waste Cooking Oil With Biotic Additive

**R A Raaj Kumar<sup>1</sup>, SriramSrinivasan<sup>2</sup>, M Varshini<sup>3</sup>, Divakar Shetty A S<sup>4</sup>**

<sup>1,2</sup> Under Graduate Students, Department of Mechanical Engineering, Amrita School of Engineering, Amrita VishwaVidyapeetham, Bangalore, India.

<sup>3</sup> Graduate Student, Department of Mechanical Engineering, Amrita School of Engineering, Amrita VishwaVidyapeetham, Bangalore, India.

<sup>4</sup> Assistant Professor, Department of Mechanical Engineering, Amrita School of Engineering, Amrita VishwaVidyapeetham, Bangalore, India.

**Abstract:** In the present paper the work is done based on the experimentation of biodiesel blends using diesel and waste cooking oil with and without adding cow urine as additive in various proportions. The properties such as the flash point, fire point, kinematic viscosity and the calorific values of the blends with and without additive are determined. Then all the biodiesel blends are used as fuel separately in the diesel engine. The emission characteristics and the performance parameters are evaluated. From the results, it was observed that the blends with additive as shown slight improvement in performance but significant reduction in emission. Fuel consumption was more for the higher percentage blends with respect to increasing brake power. Brake thermal efficiency was higher in 50% for the both the blends with and without additive. It can be concluded stating that the same procedure can be followed with various blend ratios in order to differentiate and find the optimum blend as an alternative fuel.

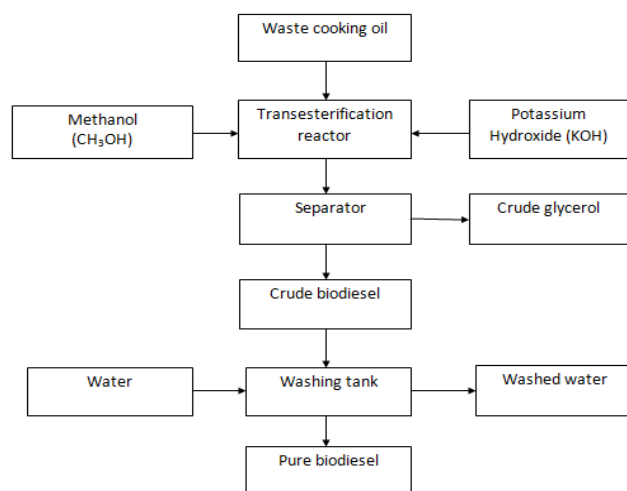
Keywords: Biodiesel, cow urine, emission, blends, waste cooking oil.

## 1. Introduction

Ever since the invention of the steam engine mankind has been keenly looking into the prospects of usage of fossil fuels. After the discovery of oil and methods of fractional distillation to obtain gasoline, it has become one among the freely available fuels to power many inventions including automobiles. All these fuels are products of carbon fossils and thus their residue is sincerely evident. When gasoline burns, it emits pollutant gases like NO<sub>x</sub>, CO<sub>2</sub>, SO<sub>x</sub>, and HC [1-4]. With no alternative in place and increasing demand of fuel, without regret we continue to utilize resources never looking back at consequences. A few of the consequences are global warming, environmental degradation, flora fauna extinction and much more [5]. To prevent untoward incidents and retrospect in to gasoline usage a resourceful alternative are bio diesels [6-7]. They are considered to have to have insignificant consequences [8]. With less content of hydrocarbons it is a cleaner fuel compared to gasoline and it can easily be prepared from fatty oils by the process familiar as esterification [9]. It is a liquid fuel notated by B100 if it is unblended. Alike gasoline bio-diesel can be used to fuel CI engines [10]. The preparation of bio-diesel essentially requires trans-esterification process [11-12]. The process flowchart for the bio-diesel production is shown in fig 1. Used cooking oil can be refined into different types of bio-diesels used for power generation [13]. Combustion of bio-diesels have been observed to emit meagre CO content hence contributing to reduce carbon footprint [14]. Recycling of cooking oil



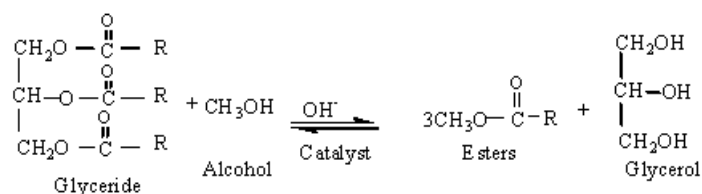
ensures it is a renewable source [15]. This work is extended to using a biotic additive i.e. cow urine. A profound reason for its usage is the presence of Urea and other elements such as sulphur, nitrogen, ammonia, iron, phosphate, uric acid, copper. The research work carried out on bio-kerosene stove using cow urine as additive has shown reduction in CO and hydrocarbons [16].



**Figure 1.** Production of Bio-diesel

## 2. Methodology

This project has been performed to find a perfect blend of the bio-diesel which can be used in the diesel engine as fuel. The cooking oil filtered to remove impurities. The impurities originate due to their usage of cooking oil in the kitchen. These oils will have higher viscosity and hence should be esterified to obtain the bio-diesel. The purified cooking oil is used in the preparation of the blends. The blend proportions are of 10DWCO, 20DWCO, 30DWCO, 40DWCO, 50DWCO, 10DWCOA, 20DWCOA, 30DWCOA, 40DWCOA and 50 DWCOA. The different blends of 10DWCO, 20DWCO, 30DWCO, 40DWCO and 50DWCO with additive as well as without additive are prepared on the volume basis. Here 10DWCO is a mixture of 10% of waste cooking oil with 90% of diesel. Similarly 10DWCOA is a mixture of 10% esterified waste cooking oil and 90% of diesel with 10% of cow urine. The biodiesel blends are prepared on the volume basis. The blends are prepared for net content 1 litre. Firstly trans-esterification process is done by mixing NaOH and methanol.



Then slowly the purified cooking oil is added and stirred in a mechanical stirrer at a temperature of 50 – 60°C for 2 hours. The same procedure is followed for the production of bio-diesel with additive but during trans-esterification process. 20% of additive is added the esterified oil and methoxide and stirred for about 5 – 6 hours and then kept for settling. After settling, the upper part liquid is separated and used for the blend preparation.

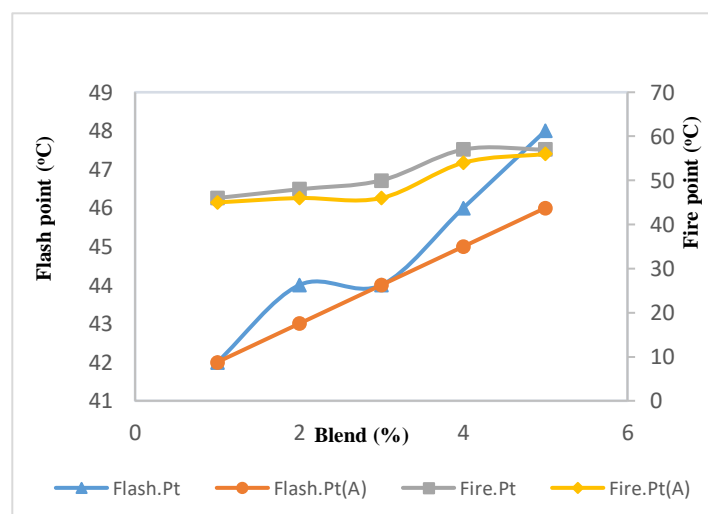
### 3. Experiment Specification

Blends so prepared are were tested in a CI engine. The engine is a kirloskar single cylinder diesel compression engine. One litre of pure diesel is used to perform tests like emission test and the performance .The emission test of CO, CO<sub>2</sub>, HC and oxygen are done using an emission gas analyser.The performance test was performed for various speeds and the time taken for 10 grams of fuelconsumption, temperature of exhaust gas are noted. As for the chemical characteristics of the blends prepared ,the flash point, fire point, kinematic viscosity and the calorific value are determined using Cleave land open cup tester, Say bolt viscometer and bomb calorimeter. The same procedure is done for all the blends and the values are tabulated.

### 4. Results and Discussions

#### 4.1 Flash and fire point:

The flash and fire point of the fuels were determined using Cleave land open cup tester. The fig.2 shows the flash point and fire point of the bio-diesel blends with and without bioticadditive. What is evident from the plot is that, with increase in the percentage of waste cooking oil the flash and fire point increases. This is due to the presence of vegetable oil that is present in the bio-diesel which is less volatile when compares to gasoline. The boiling point of oil is more compared to that of gasoline and the boiling point is more because of the density of the oil and the high viscous forces which act on it.



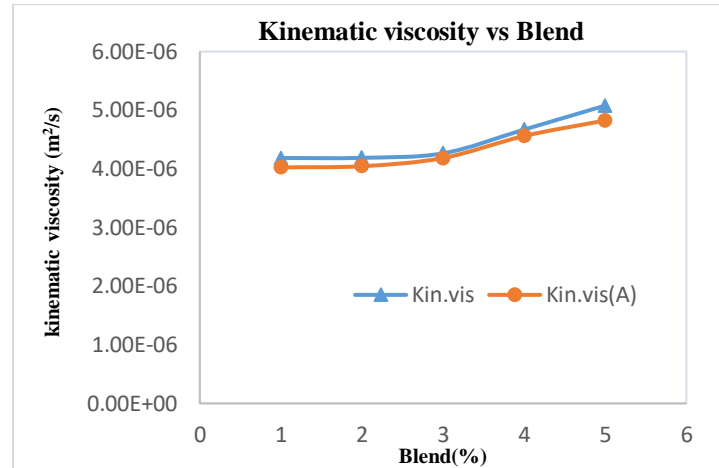
**Figure 2.** Flash point and fire point of blends

The flash point of blend with additive varies linearly whereas the blend without additive does not vary linearly. The blend with additive has lower fire point than the blend without additive. The flash point of the additive mixed blend varies linearly because of the presence of urea and other particles from the biotic that will cause uniform heating and ensure the absence of glycerol content thereby reducing the viscosity.

#### 4.2 Viscosity:

The fig.3 depicts the kinematic viscosity of the blends with and without additive with respect to the blend percentage. Comparing both the plot, blends with additive showed less viscosity compared to that of blends without additive viscosity. The reason for the lesser viscosity in the blend with biotic

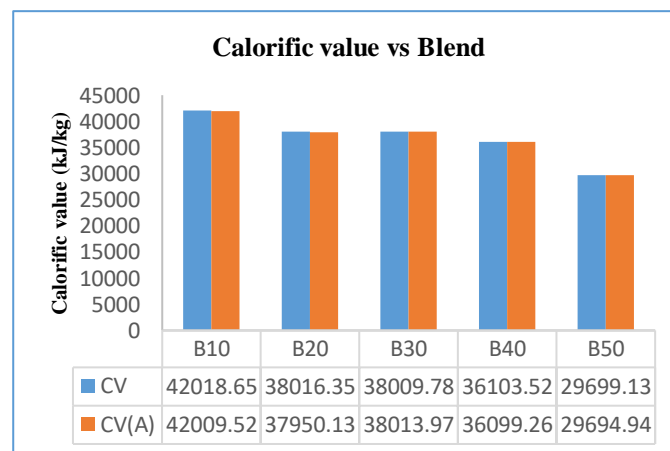
additive could be the acidic nature of the additive which would contribute to the removal of the post esterified glycerol content present in the biodiesel. This is later removed using a filter and a separation funnel.



**Figure 3.** Kinematic viscosity of blends

#### 4.3 Calorific value:

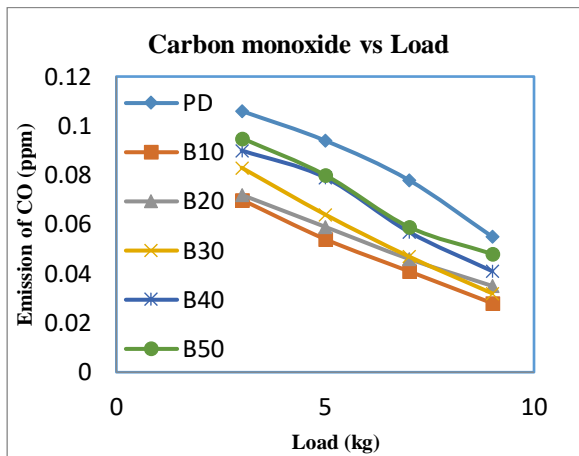
The calorific values reduces on increasing waste cooking oil proportion in the blends. The lower calorific value of waste cooking oil is the reason for decreasing calorific values.



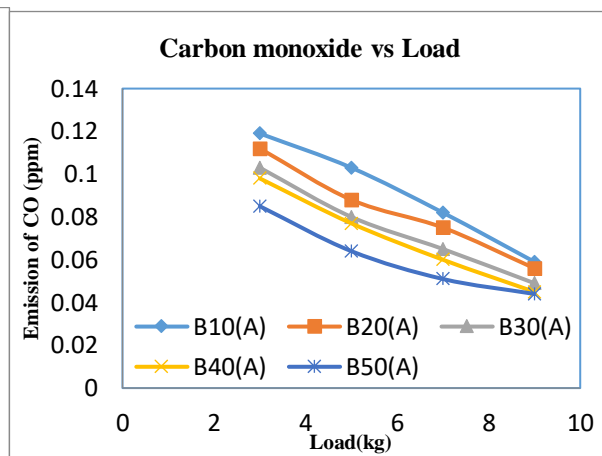
**Figure 4.** Calorific value of blends

#### 4.4 Gas analyser:

The emission test was done using a gas analyser in which CO, CO<sub>2</sub> and the UBHC are determined. Fig.5 shows that pure diesel has the highest CO emission compared to other biodiesel blends. On comparing all the blends, increasing in blend percentage the emission of carbon monoxide decreases. The reason for decreasing carbon monoxide by increasing blend percentage is due to higher oxygen content in waste cooking oil. Due to the presence of unsaturated fat content that is present in the waste cooking oil the oxygenation occurs and helps the blends.



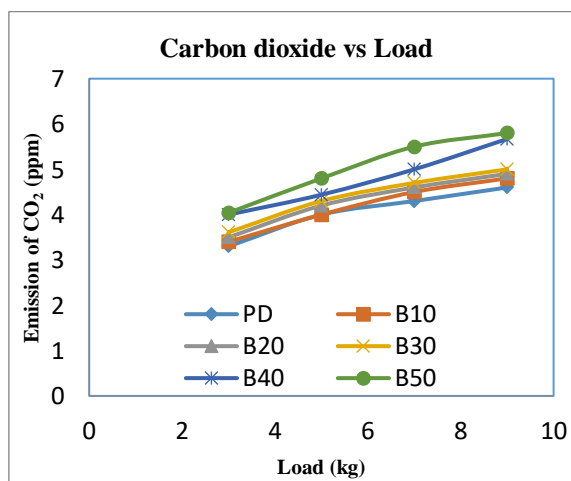
**Figure 5.**Emission of Carbon monoxide for blends without additive



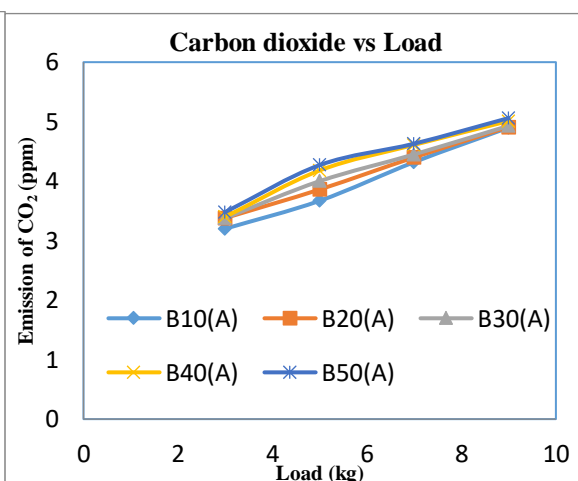
**Figure 6.**Emission of Carbon monoxide for blends with additive

The fig.6 shows emission of CO for blends with additive. According to the plot, B50 has least emission compared to other blends. 10% blend has the highest emission value. Decreasing the blend percentage CO emission decreases with respect to brake power. When compared to blends without additive, blend 50% showed less emission in blend with additive. Due to the addition of additive there is decrease in result.

The fig.7 shows the carbon dioxide emission characteristics. 50% blend results in highest emission of carbon dioxide and pure diesel showed the least emission of CO<sub>2</sub>.



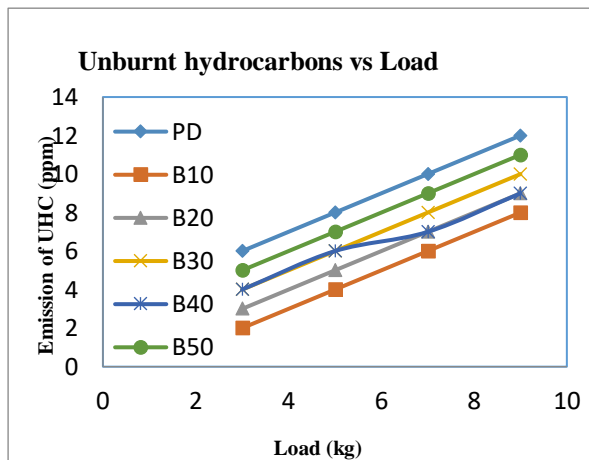
**Figure 7.**Emission of Carbon dioxide for blend without additive



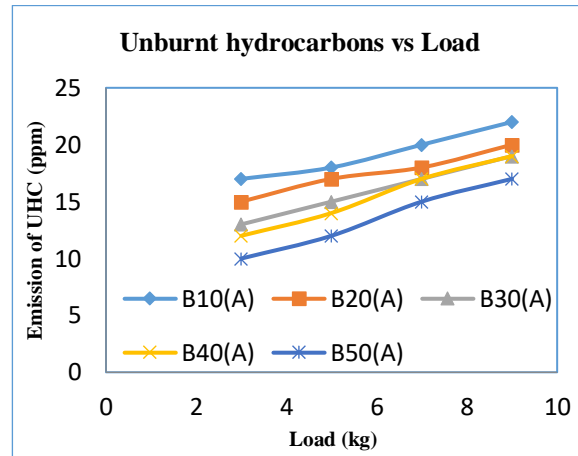
**Figure 8.**Emission of Carbon dioxide of blends with additive

Fig.8 results the emission of CO<sub>2</sub>. When comparing these results with blends without additive, the blends with additive showed better results. Blend 10% has the least emission of carbon dioxide and blend 50% has high emission. Increasing trend in the blend percentage increases the emission with respect to increase in load.

The emission of unburnt hydrocarbons is plotted in fig.9 and Fig. 10 The emission of UBHC is reduced significantly by increasing the waste cooking oil. However for the higher load it increased.



**Figure 9.** Emission of Unburnt hydrocarbons for blends without additive



**Figure 10.** Emission of unburnt hydrocarbons of blends with additive

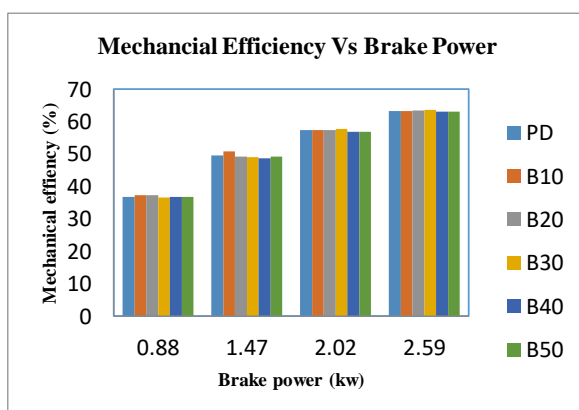
The unburnt hydrocarbon shows less emission when the blend percentage increases with respect to increasing trend in load. As shown in Fig 10 the blends show slightly increase in emission values for respective blends. All the blends show a characteristic linear curve except the blend of B40. Also that the graph of HC emission with additive depicts increased PPM. This can be articulated due to the presence of impurities which do not undergo combustion. The presence of these impurities can be traced back to the biotic additive that was added.

## 5. Performance Parameters

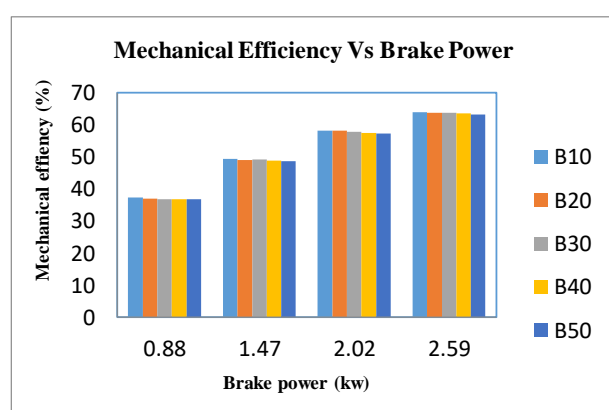
Performance parameters which are elaborated by Brake specific fuel consumption, mechanical efficiency, and Total specific fuel consumption are evaluated with respect to brake power.

### 5.1 Mechanical efficiency:

The mechanical efficiency of the blends without additive is plotted in fig.11 the efficiency of the blends showed almost similar values with less difference. At high brake power, the efficiency is high where 10% blend and pure diesel showed high efficiency compared to other blends.



**Figure 11.** Mechanical efficiency of blends without additive

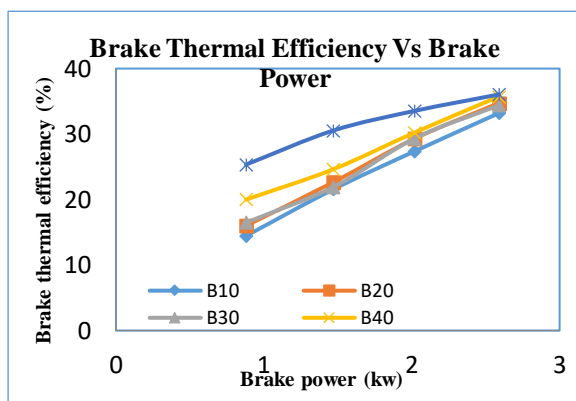


**Figure 12.** Mechanical efficiency for blends with additive

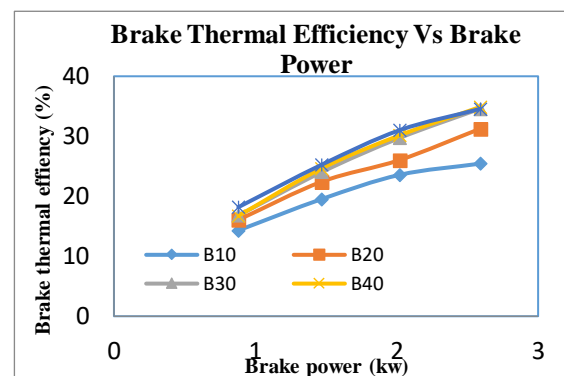
Mechanical efficiency for the blends with additive is plotted in graph fig. 12 Similar to that of blends without additive, the blends with additive shows the similar plots. Almost the efficiency are similar to respective blends. The efficiency of the blends in increase trend shows increase in mechanical efficiency with respect to brake power.

### 5.2 Brake Thermal Efficiency:

BTE is defined as break power of a heat engine as a function of the thermal input from the fuel. It is used to evaluate how well an engine converts the heat from a fuel to mechanical energy. Due to inefficiencies such as friction, heat loss, and other factors, thermal efficiency are typically much less than 100%. The plot of BTE is showed in fig.13 .50% blend results the highest brake thermal efficiency. With increasing percentage in blend, the efficiency also increases with respect to brake power. In 10%, 20% and 30% blends leads to similar curve when plotted.



**Figure 13.**Brake thermal efficiency vs brake power with additive

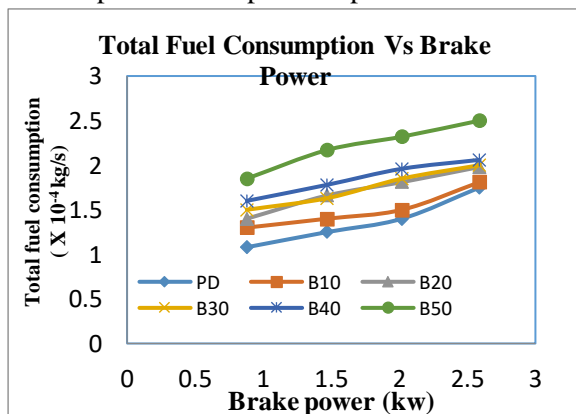


**Figure 14.**Brake thermal efficiency vs brake power without additive

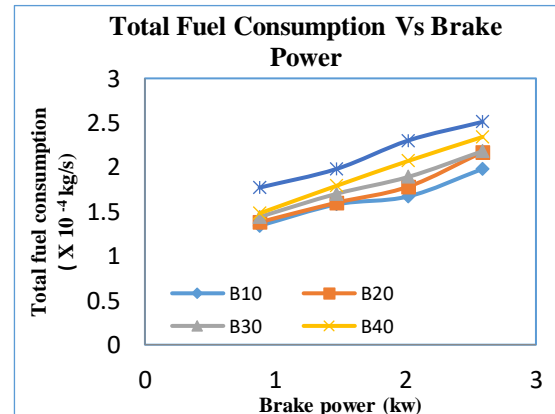
Brake thermal efficiency of blends with additive is plotted in the graph fig.14. For the increasing percentage of blends, the BSFC increases gradually with respect to brake power. Comparatively the start point of all the blends is with little difference.

### 5.3 Total fuel consumption:

TFC is quantity of fuel consumed by the engine per unit time. It is found by using the time taken for difference in 10 readings in the diesel engine. The TFC is shown in fig.15. B50 showed higher TFC compared to other blends. The total fuel consumption increases in increase in Almost B20 and B30 showed same curve adjoining themselves. It is been clearly seen that biodiesel blends have higher fuel consumption as compared to pure diesel.



**Figure 15.**Total Fuel consumption of blends without additive

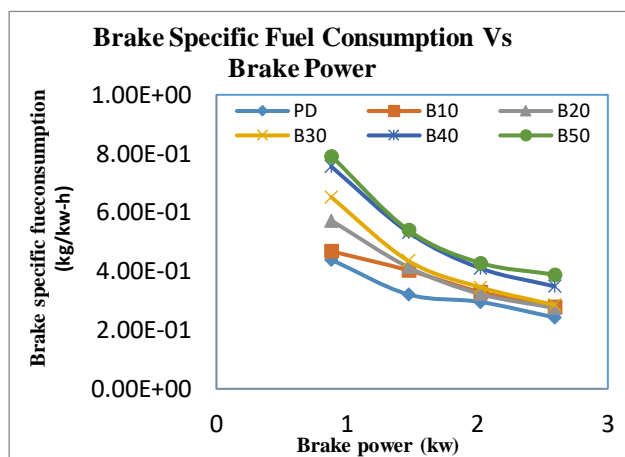


**Figure 16.** Total Fuel consumption of blends with additive

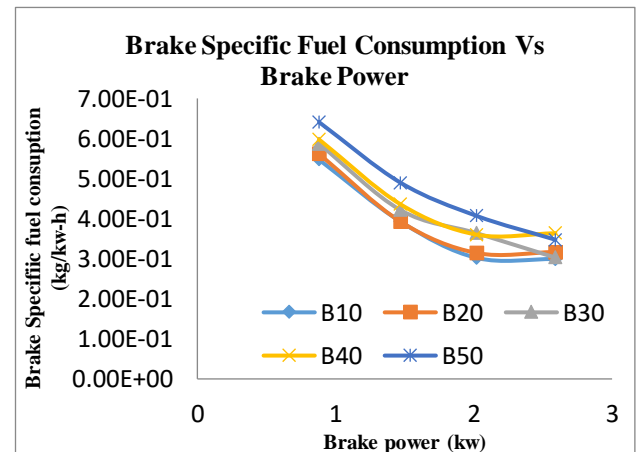
Fig.16 is plotted for total fuel consumption for the blends with additive. The total fuel consumption of blend 50% is higher than other blends and blend 10% showed less fuel consumption comparatively to other blends.

#### 5.4. Brake specific fuel consumption:

BSFC can also be represented by the ratio of total fuel consumption to the brake power so developed. Pure diesel has less BSFC compared to blends. As shown in fig.17, with increase of blends percentage the brake specific fuel consumption decreases gradually with respect to increase in brake power. In some case the BSFC will decrease and then increases.



**Figure 17.** Brake specific fuel consumption vs Brake power without additive.



**Figure 18.** Brake specific fuel consumption for blends with additive.

The BSFC values are plotted in the fig.18 at particular blend, the blends without additive and blend with additive shows almost similar plots. But for the blends with additive, blend 50% showed the highest fuel consumption with respect to brake power. Blend 10% and blend 20% are similar in the plot curve.

## 6. Conclusion

The experiment work for the diesel engine was done using the biodiesel blends without and with additive. The performance and emission tests were determined by plotting the values. From the results it was observed that the blends without additive and blends with additive showed similar variations but the values were different. On comparing the CO and CO<sub>2</sub> emission, the blends with additive showed good results. In the case of unburnt hydrocarbons, the blends without additive showed less emission compared to that of blends with additive. Mechanical efficiency of all the blends were similar with very little difference. Fuel consumption was more for the higher percentage blends with respect to increasing brake power. Brake thermal efficiency was higher in blend 50% for the both the blends with and without additive. It can be concluded stating that the same procedure can be followed with various blend ratios in order to differentiate and find the optimum blend as an alternative fuel.



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