Experimental Investigations on 4-Stroke D.I Diesel Engine by Using Various Alternate Fuels and Biodiesel Blended

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ABSTRACT: The aim of this experimental investigation is to arrive at an alternative fuel for the existing direct injection diesel engines considering a few factors that have been given as the limitations in the previous researches. The investigation reports of biodiesel fuel research revealed that there was reduction in the brake thermal efficiency and increase in the oxides of nitrogen (NO_x) emission. In this present research work has been used various different vegetable oil like Polanga oil, Soap Nut oil, Tung oil, Nerium oil etc., which convert into biodiesel by using transestrification process. In this experimental investigation work the performance and emission parameters of diesel and various other biodiesel blends ratio were blended B10, B20, B30, B40, B50 and B60. The aim of this phase was to find the best biodiesel blend to prepare the emulsified fuel and to proceed with the future experimental work. The findings of this phase revealed that nerium biodiesel 20% by volume with diesel (N20) was best blend among all other biodiesel blends with other compositions. It has been chosen based on the results of performance, combustion and emission parameters. The N20 biodiesel produced a brake thermal efficiency almost close to diesel and more than other biodiesel blends. The emission parameters were also found to be lesser than other biodiesel blends, except the oxides of nitrogen (NO_x) emission. Since the aim of this investigation is to overcome the limitations in using the biodiesel as an alternative fuel, N20 has been chosen for further testing.

1. INTRODUCTION

Dr. Rudolf Diesel invented the first diesel engine in 1892 and it was designed to run on a number of fuels along with vegetable oil. He advanced the diesel engine to run on vegetable oil and commented that it might assist substantially in the improvement of agriculture of the nations that use it. He validated his engine at the sector Exhibition in Paris in 1900 and described an experiment the usage of peanut oil as fuel in his engine. Biodiesel has actually been around for round 100 years but the cheap availability of petroleum gasoline has made it the choice for diesel fuel. However now that petro diesel prices have risen to this type of high level it's turning into less costly to use biodiesel.

And it's becoming very popular in many countries throughout the globe. Many of the numerous varieties of combustion engines to be have today, compression ignition engines have been identified as the most ideal engines within the fields of transportation, enterprise and agriculture. A significant percentage of the total number of engines belongs to the compression ignition group; this is in particular because of their long existence, reliability and fuel economic system. Rapid economic boom has supposed more human beings touring than ever earlier than and larger quantities of goods being transported.

2. LITERATURE SURVEY

Biodiesel is produced from vegetable oil or animal fats through a chemical process referred to as transesterification. Biodiesel is a smooth and renewable fuel which is taken into consideration to be the fine substitution for diesel fuel [1]. Biodiesel refers to a diesel-equal, processed fuel which is derived from biological resources. it's far described by way of the arena World Customs Organization (WCO) as combination of mono-alkyl esters of lengthy-chain (C16-18) fatty acids derived from vegetable oil or animal fat, which is a domestic renewable fuel for diesel engines and which meets the specs of ASTM D6751" [2]. Transesterification procedure is generally used for extracting biodiesel from vegetable oil. NaOH (Sodium hydroxide) or KOH (Potassium hydroxide) is used as the catalyst for the response at the side of methanol or ethanol Transesterification entails stripping the glycerine from the fatty acids with a catalyst together with sodium or potassium hydroxide and changing it with an anhydrous alcohol, this is, typically methanol [3].

3. PROPERTIES OF VARIOUS BIODIESEL FUELS AND DIESEL-WATER EMULSION

Table 3.1 Comparison of properties of diesel and other biodiesel fuels

Property	Diesel	Nerium oil	Tung oil	Polanga oil	Soap Nut oil
Kinematic viscosity at 40° C (cSt)	3.09	3.57	4.68	4.91	6.4
Calorific value (kJ/kg)	43198	42823	35692	40800	38698
Density at 15°C (kg/mm^3)	830	850	910	862	896
Flash point (° C)	56	70	86	87	91
Fire point (° C)	64	83	93	95	104

4. ENGINE SETUP AND EXPERIMENTAL PROCEDURE

The most popular engine used for agricultural pump units, farm machinery and medium scale testing is Kirloskar brand engine, that's one of the oldest brands. It has the features including sturdiness at higher pressure with rugged shape. Water cooled, naturally aspirated, single cylinder, 4 stroke direct injection compression ignition engine were used for this investigation. It had a displacement volume of 661 cc and compression ratio of 17.5:1. The engine developed 5.9 kW at 1800 rpm. Now load the engine in steps of quarter, half, three fourth and complete loads and allow the engine to stabilize at each load. The fuel injection pressure was 200bar and the manufacturer had set injection timing at 27° before TDC. The engine had a combustion chamber with overhead valves operated by means of push rods.

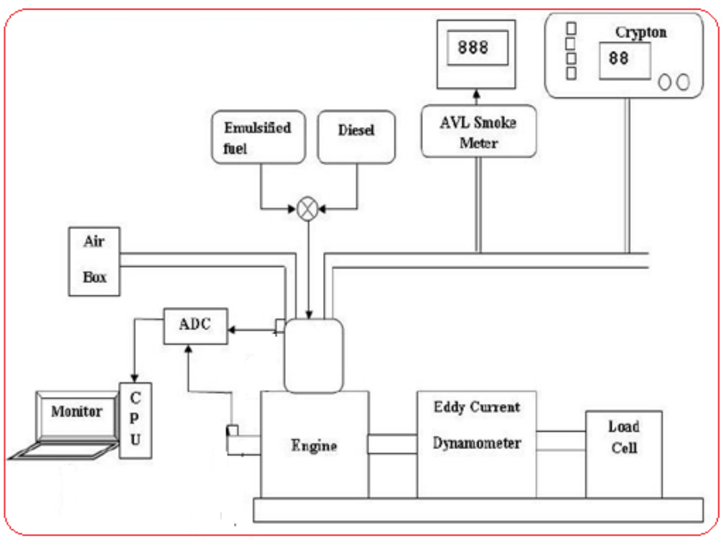


Figure 4.1 Schematic diagram of experimental layout

Figure 4.1 indicates the schematic diagram of the experimental layout used for this experimental investigation. A kirloskar SV1 engine have been coupled to an eddy current loading. Two separate fuel tanks have been maintained for reference fuel (diesel) and test fuels (biodiesel and emulsified gasoline). An AVL smoke meter and crypton fuel analyzer has been probed into the exhaust pipe.

5. RESULT AND DISCUSSION

5.1 Brake thermal efficiency (BTE)

Figure 5.1 shows the comparison of brake thermal efficiency for diesel, P10 (Polanga oil), S10 (Soap Nut oil), T10 (Tung oil), and N10 (Nerium oil) without changing manufacturer's settings. Brake thermal efficiency was found to increase with an increase in load and the maximum efficiency became found at three fourths of load condition for reference and test fuels. The brake thermal performance of diesel at three fourths of load was found to be 28.47%. There has been decrease in brake thermal efficiency by using 2.7 %, 3.5 %, 4.1%, and 1.9 % for P10, S10, T10, and N10 respectively while as compared with diesel. There has been decrease in brake thermal efficiency by using 4.5%, 5.4 %, 6.1%, and 2.5% for P20, S20, T20, and N20 respectively when compared with diesel. The reason for the reduction may be attributed to lower calorific value and greater viscosity of biodiesel fuels, than diesel fuel. It could be that higher viscosity of biodiesel fuel led to poor atomization due to its heavier molecular size and for this reason decreased flow rate whereas it was higher with diesel fuel because of its much less viscosity, better calorific value and higher combustion than biodiesel fuels. Among all the biodiesel blends, N20 caused a marginal decrease in brake thermal efficiency in comparison with diesel, because of its viscosity among other biodiesel fuels being slightly decrease which caused better atomization. Also their calorific values were found to be higher than that of different biodiesel fuels. From the figures 5.3, 5.4 and 5.6 it was observed that brake thermal efficiency decreased with the increasing content material of biodiesel.

5.2 Specific energy consumption (SEC)

Figures 5.7 to 5.12 show the specific energy consumption of diesel (reference fuel) and numerous biodiesel blends (test fuels). The increase in specific consumption energy consumption was found to be 11.58%, 9.66%, 12.5%, and 4.75% for P10, S10, T10, and N10 respectively and B10 is a much closed to diesel fuel in case of fuel energy and fuel Consumptions. The specific fuel consumption was determined to be lowering at part load and again it increase for both reference fuel and test fuel. It changed into found from figure 6.9 that specific energy consumption was much less with diesel when as compared other biodiesel blends. It might be due to the much less heating value of biodiesel fuel than diesel. The maximum specific fuel consumption was located to be 14878.6 kJ/kWh for diesel at full load situation. The increase in specific energy consumption was determined to be 17.85%, 20.81%, 22.6%, and 8.86% for P20, S20, T20, and N20 respectively. Because of the much less calorific value of biodiesel fuel, the engine consumed more than diesel to get the same power output. The specific energy consumption of nerium biodiesel fuel was lowest a few of the other biodiesel blends.

5.3 Carbon monoxide (CO) emission

From graph 5.13 it was observed that carbon monoxide emission reduced with the increase in brake power. For the reference fuel (diesel) the CO emission at maximum load was found to be

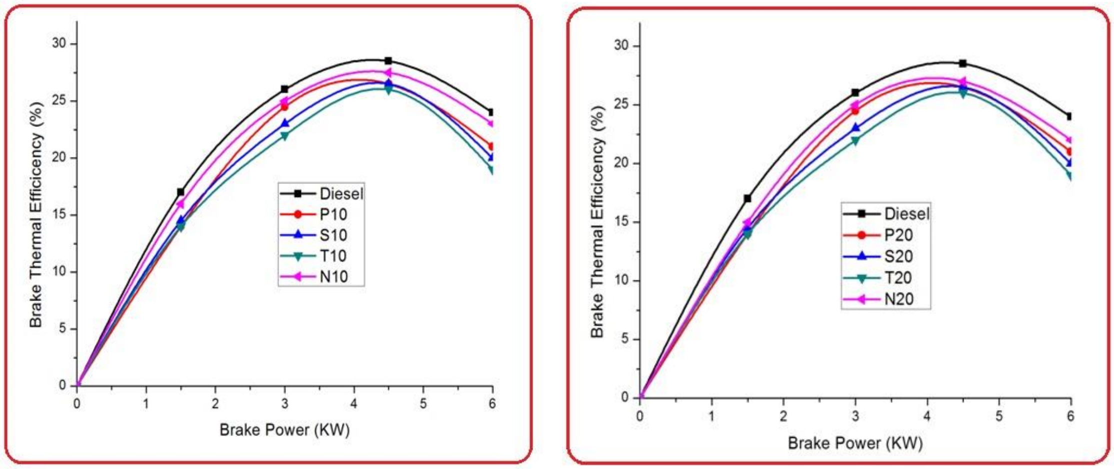
0.092%, whereas it become reduced by way of 0.011%, 0.004%, 0.001%, and 0.012% for P10, S10, T10, and N10. Lower carbon to hydrogen ratio is probably the purpose for the decrease on CO emission with all biodiesel blends. Availability of oxygen enabled entire combustion which decreased CO emission better than diesel. From graphs 5.14 to 5.18 it become located that the CO emission was similarly reduced with increase content of biodiesel. Availability of oxygen content enabled the whole combustion and subsequently reduction in CO emission.

5.4 Smoke opacity emission

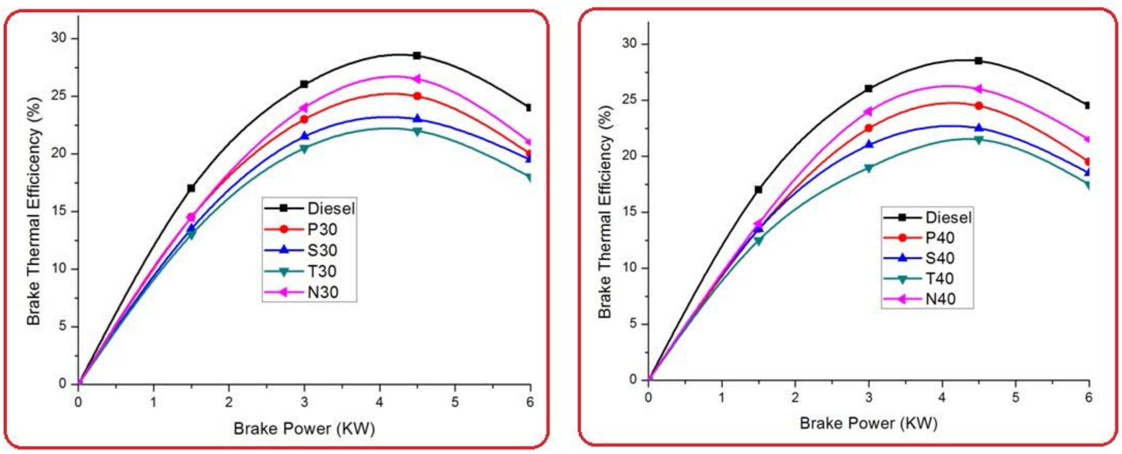
It was observed from figure 5.19 to 5.24 that the smoke opacity emission increase for both reference (diesel) and test fuels (biodiesel blends) with the increasing load. The smoke opacity emission for diesel fuel was found to be 53.4 HSU at maximum load. The increase in smoke opacity was found to be 3.7 HSU, 4.7 HSU, 6.7 HSU, and 2.9 HSU for P10, S10, T10, and N10 respectively. Poor atomization of biodiesel at higher load due to its heavier molecules might be the reason which in addition precipitated incomplete combustion. Better viscosity of biodiesel fuels might be the reason for the slow combustion reaction. But, the smoke opacity emission was least with N20 biodiesel while in comparison to different blending ratios of nerium and other biodiesel blends. Lesser viscosity of N20 biodiesel than other biodiesel blends might be the reason for less smoke emission.

5.5 Oxides of nitrogen (NO_x) emission

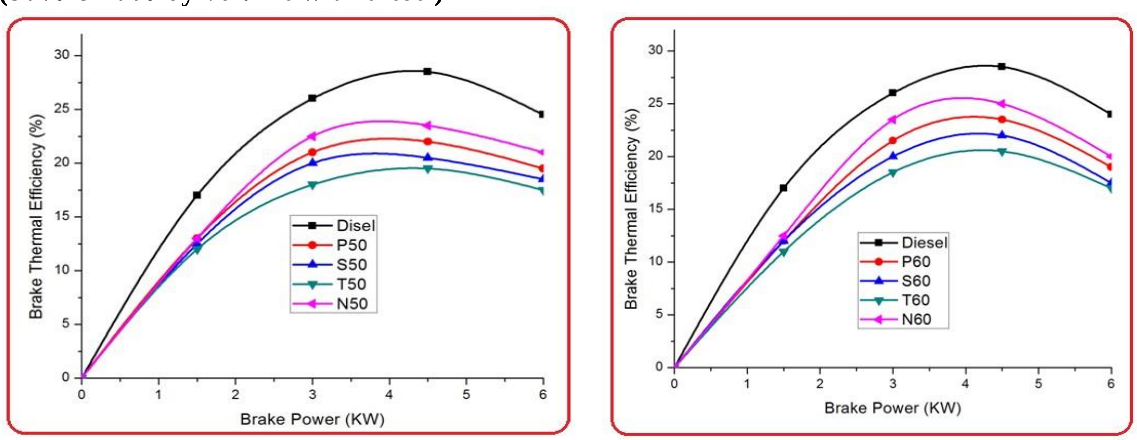
Figure 5.25 shows the assessment of oxides of nitrogen (NOx), for diesel and various biodiesel blends. The NOx emission is found to be low at initial load condition and increased with increasing load. Increased intake of fuel and rich combustion has been the motives for the increased NOx emission at better load. The NOx emission is found to be less for diesel fuel with a value of 484 ppm, when in comparison to other biodiesel blends. It is also observed that there has been an increase in NOx emission with all other biodiesel blends. The increase in NOx emission also observed to be 11.96 %, 5.87 %, 2.52 and 16.86 % for P10, S10, T10, and N10, while in comparison to diesel. The reason is probably because of the presence of oxygen which reacted with nitrogen at peak flame temperature in during combustion. Amongst all biodiesel fuels the oxides of nitrogen emission of N20 biodiesel blend were found to be the high. The increase in NOx emission is observed to be 13.87%, 7.86%, 3.51%, and 21.94% for P20, S20, T20, and N20, when compared to diesel. Figures 5.26 to 5.30 show the graph among brake power and biodiesel blends starting from B30 to B60.



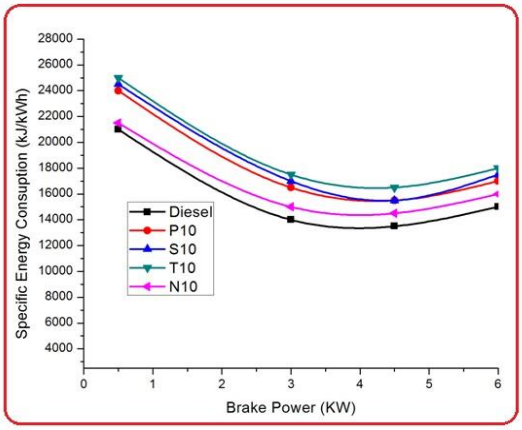
Figures 5.1 &5.2 Brake power Vs brake thermal efficiency of diesel and various biodiesel blends (10% &20% by volume with diesel)

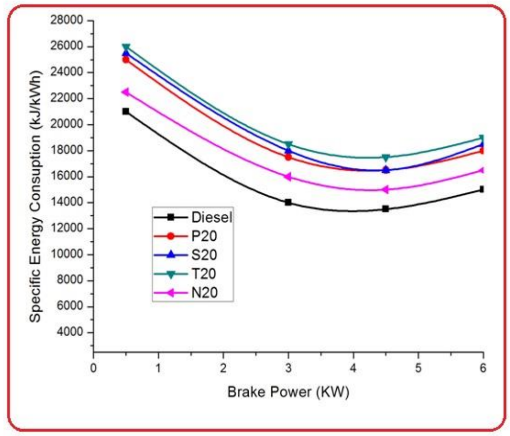


Figures 5.3 &5.4 Brake power Vs brake thermal efficiency of diesel and various biodiesel blends (30% &40% by volume with diesel)

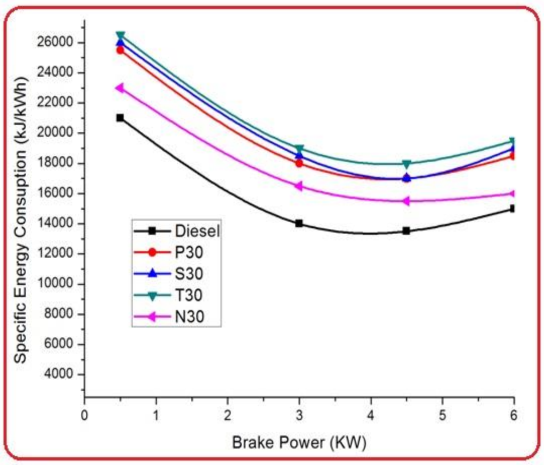


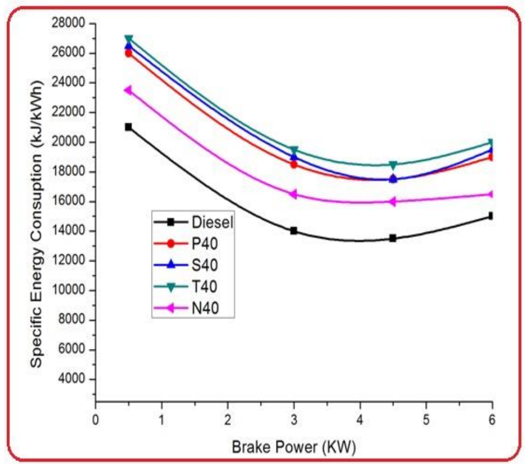
Figures 5.5 &5.6 Brake power Vs brake thermal efficiency of diesel and various biodiesel blends (50% &60% by volume with diesel)



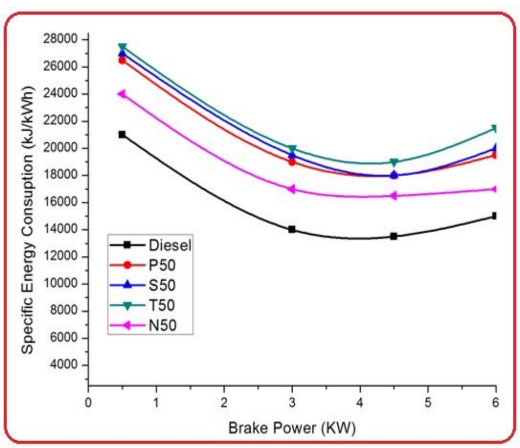


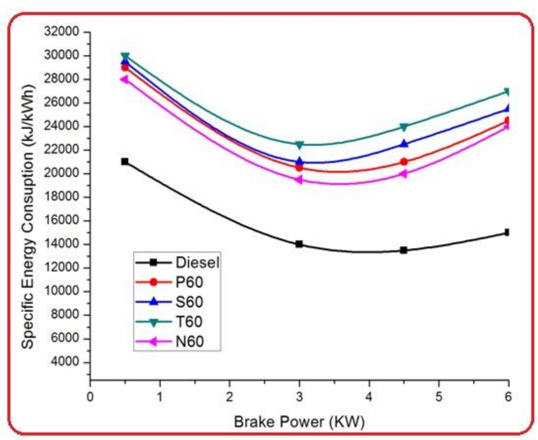
Figures 5.7 & 5.8 Brake power Vs specific energy consumption of diesel and various biodiesel blends (10% &20% by volume with diesel)



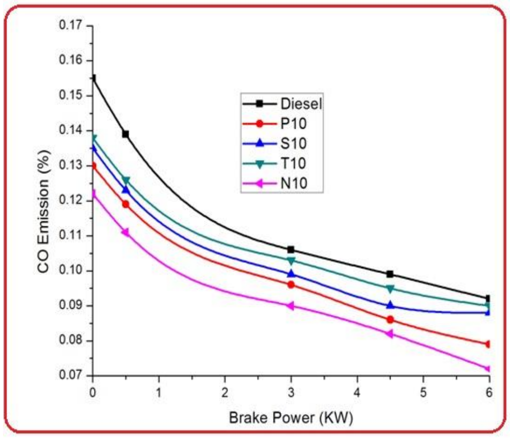


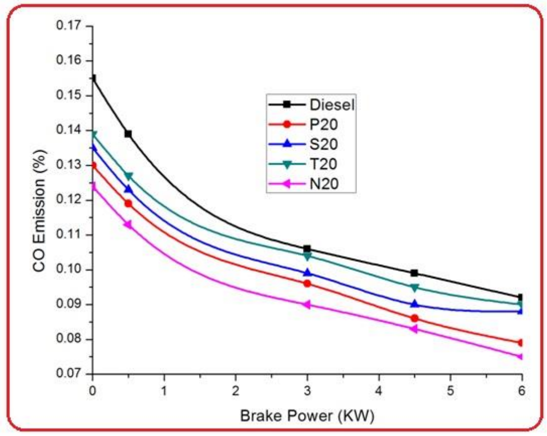
Figures 5.9 &5.10 Brake power Vs specific energy consumption of diesel and various biodiesel blends (30% &40% by volume with diesel)



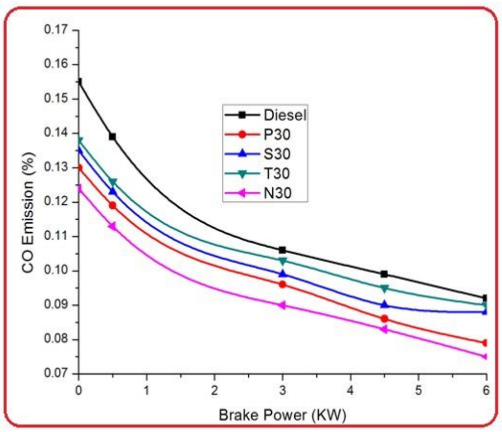


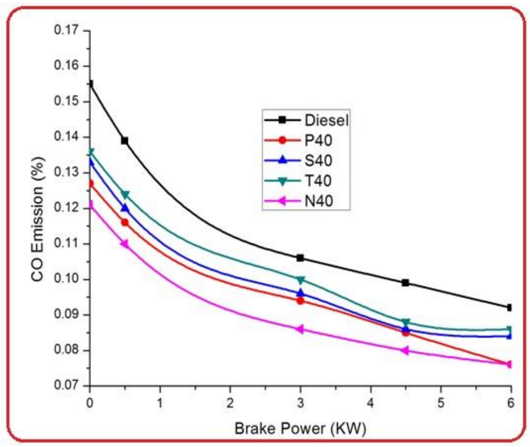
Figures 5.11 &5.12 Brake power Vs specific energy consumption of diesel and various biodiesel blends (50% &60% by volume with diesel)



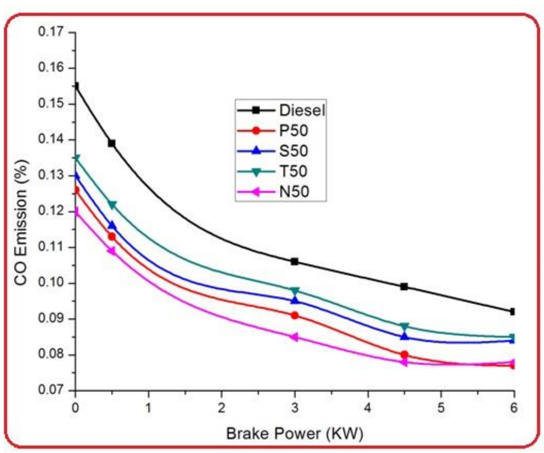


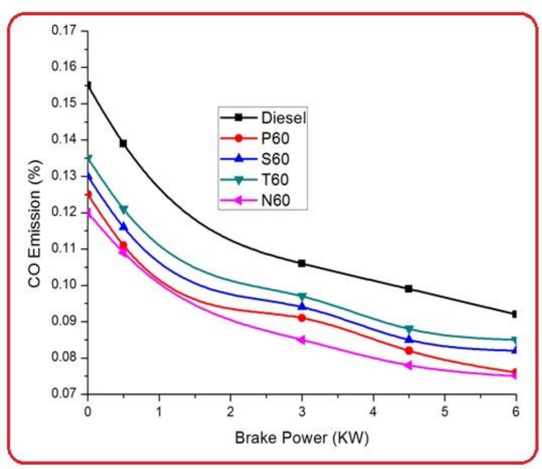
Figures 5.13 & 5.14 Brake power Vs CO emission of diesel and various biodiesel blends (10% &20% by volume with diesel)



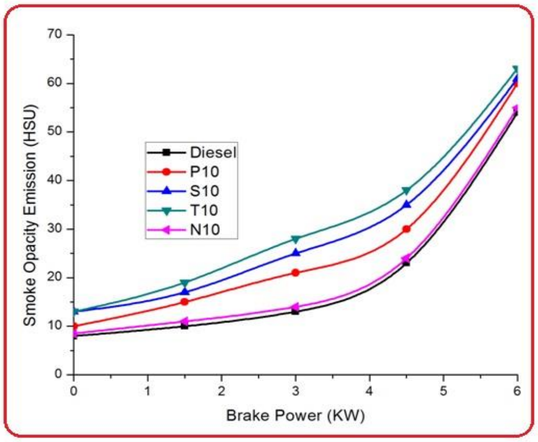


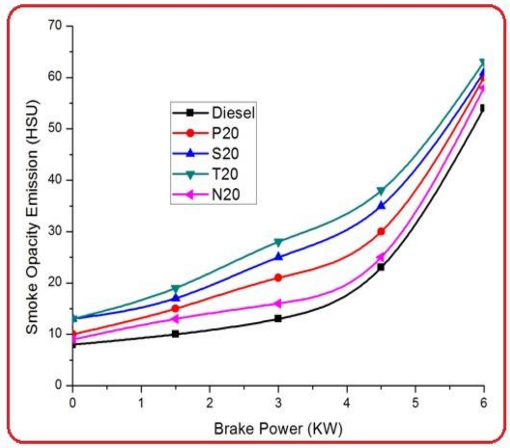
Figures 5.15 & 5.16 Brake power Vs CO emission of diesel and various biodiesel blends (30% &40% by volume with diesel)



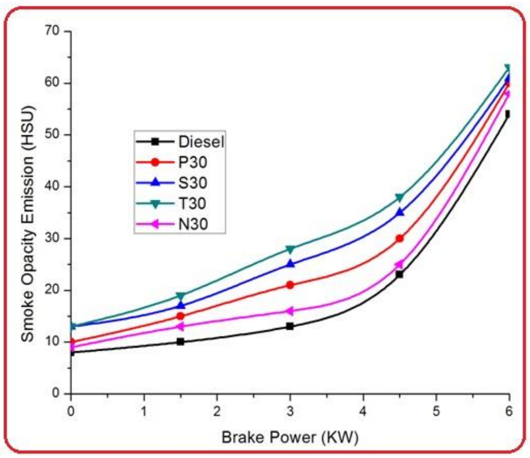


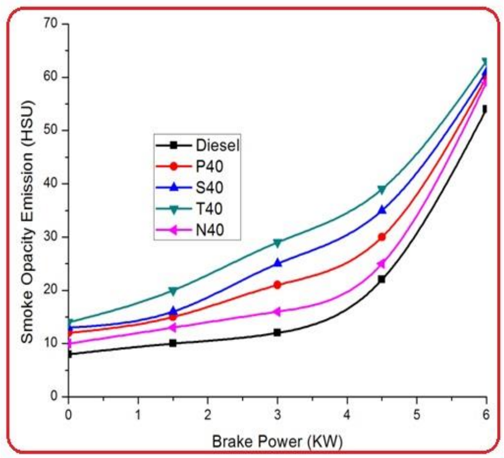
Figures 5.17 & 5.18 Brake power Vs CO emission of diesel and various biodiesel blends (50% &60% by volume with diesel)



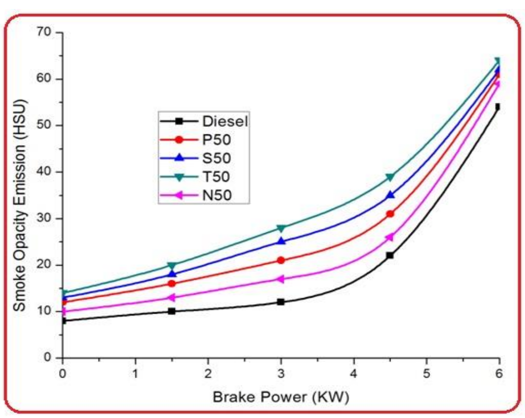


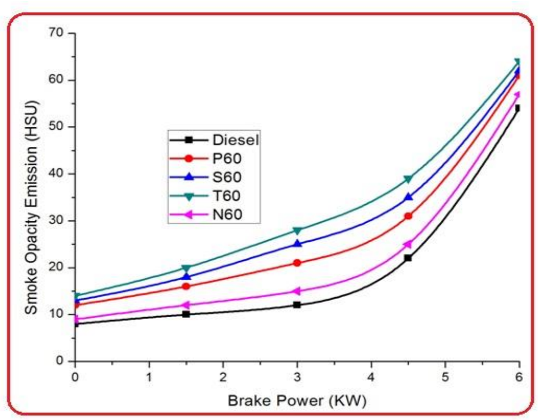
Figures 5.19 &5.20 Brake power Vs smoke opacity emission of diesel and various biodiesel blends (10% &20% by volume with diesel)



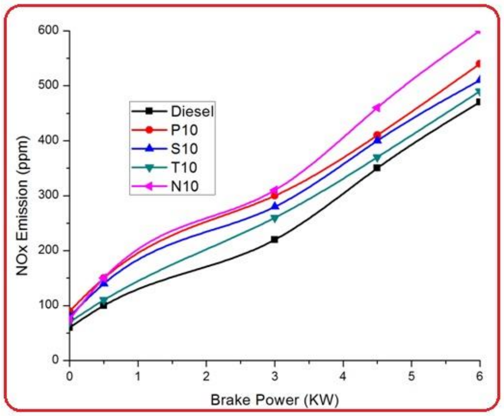


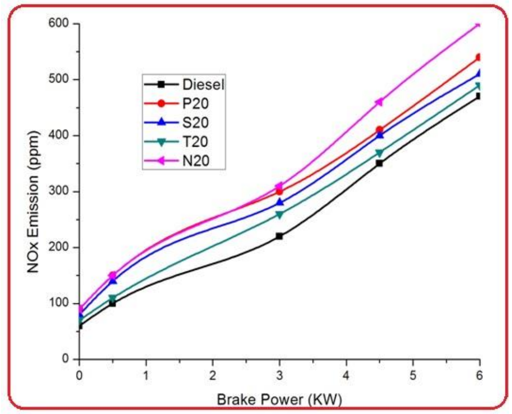
Figures 5.21 &5.22 Brake power Vs smoke opacity emission of diesel and various biodiesel blends (30% &40% by volume with diesel)



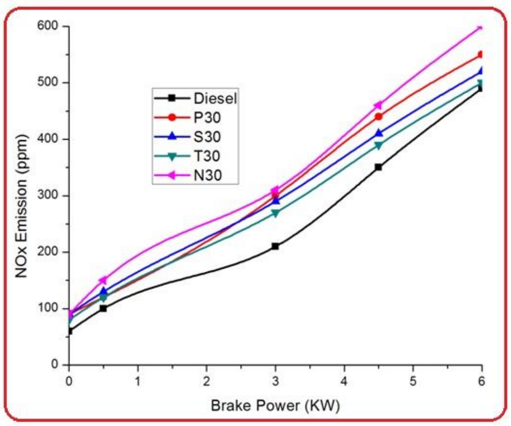


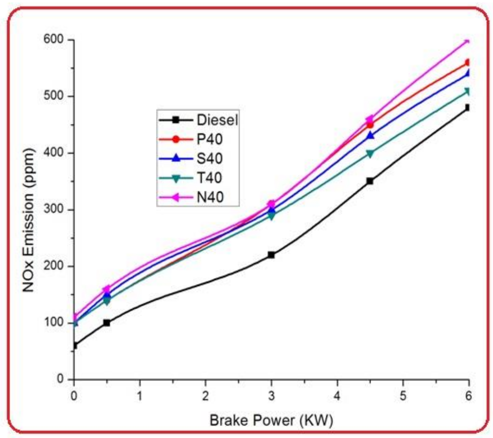
Figures 5.23 &5.24 Brake power Vs smoke opacity emission of diesel and various biodiesel blends (50% &60% by volume with diesel)



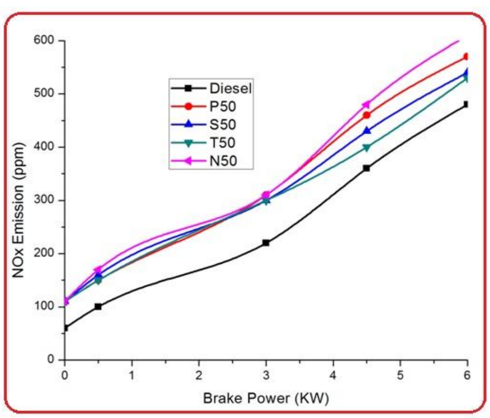


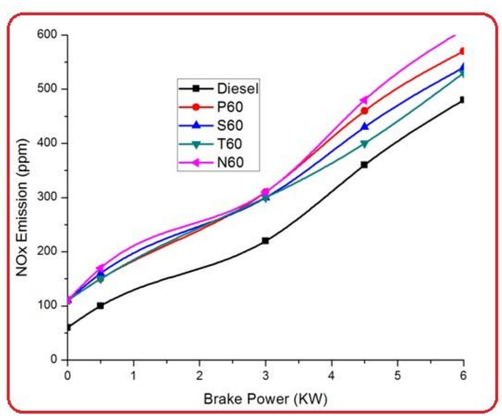
Figures 5.25 &5.26 Brake power Vs NO_X emission of diesel and various biodiesel blends (10% &20% by volume with diesel)





Figures 5.27 &5.28 Brake power Vs NO_X emission of diesel and various biodiesel blends (30% &40% by volume with diesel)





Figures 5.29 &5.30 Brake power Vs NO_X emission of diesel and various biodiesel blends (50% &60% by volume with diesel)

6. CONCLUSION

- The brake thermal efficiency of N20 biodiesel was was to be maximum compared with different blends of biodiesel fuel.
- The specific energy consumption found to be the lowest for N20 biodiesel whilst as compared to different biodiesel fuels.
- The smoke opacity emission of N20 biodiesel become decrease whilst in comparison to different biodiesel blends. But it was better than diesel.
- The emission of oxides of nitrogen (NOx) becomes better for N20 biodiesel while as compared to diesel and other biodiesel blends.

Final analysis readings showed considerable result in a few parameters which include brake thermal efficiency unburnt hydrocarbon emission, and CO emission for N20 biodiesel. But, it gave out higher NOx emission. The aim of this experimental investigation was to increase the efficiency with simultaneous reduction of smoke and NOx. Hence even though N20 biodiesel produced better NOx emission it was chosen for further testing.

7. ACKNOWLEDGEMENT

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