PERFORMANCE AND EMISSION ANALYSIS OF SINGLE CYLINDER DIESEL ENGINE OPERATING WITH TRANSESTRIFICATION PROCESSED PONGAMIA OIL BLENDS

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ABSTRACT: Transport vehicles greatly pollute the environment through emissions such as CO, CO_2, NOx, unburnt or partially burnt HC and Particulate emissions. Fossil fuels are the chief contributors to urban air pollution and major source of green house gases (GHGs) and Considered to be the prime cause behind the global climate change. Bio fuels are renewable, can supplement fossil fuels, and reduce GHGs and mitigate their adverse effects on the climate resulting from global warming.

This project presents the results of performance and emission analyses carried out in a un modified diesel engine fuelled with Pongamia oil and its blends with diesel. Engine tests have been conducted to get the comparative measures of Specific Fuel Consumption (SFC), Total Fuel Consumption (TFC), Mechanical Efficiency (ME), and Brake Thermal Efficiency (BTE), Indicate Thermal Efficiency (ITE), Heat Supply (QS) and emissions such as CO, CO_2, HC, and NOx to evaluate the behavior of Pongamia oil and diesel in varying proportions like that (5%, 10% &20%) of its volume.

***KEYWORDS*: Transesterification Process, Methanol Recovery, Bio Diesel Refining.**

I.INTRODUCTION

Fossil fuels are one of the major sources of energy in the world today. Their popularity can be accounted to easy usability, availability and cost effectiveness. But the limited reserves of fossil fuels are a great concern owing to fast depletion of the reserves due to increase in worldwide demand. Fossil fuels are the major source of atmospheric pollution in today’s world. So efforts are on to find alternative sources for this depleting energy source. Even though new technologies have come up which have made solar, wind or tidal energy sources easily usable but still they are not so popular due to problems in integration with existing technology and processes. So, efforts are being directed towards finding energy sources which are similar to the present day fuels so that they can be used as direct substitutes. Diesel fuel serves as a major source of energy, mainly in the transport sector. During the World Exhibition in Paris in 1900, Rudolf Diesel was running his engine on 100% peanut oil. In 1911 he stated ‘‘the diesel engine can be fed with vegetable oils and would help considerably in the development of agriculture of the countries, which use it’’ . Studies have shown that vegetable oils can be used in diesel engines as they are found to have properties close to diesel fuel . It is being considered a breakthrough because of availability of various types of oil seeds in huge quantities .

Vegetable oils are renewable in nature and may generate opportunities for rural employment when used on large scale. Vegetable oils from crops such as soya bean, peanut, sunflower, rape, coconut, karanja, neem, cotton, mustard, jatropha, linseed and castor have been evaluated in many parts of the world. Non edible oils have been preferred because they don't compete with food reserves.

Karanja (pongamia) is an oil seed-bearing tree, which is non-edible and does not find any other suitable application due to its dark colour and odour [5]. The oils have high viscosity and other problems make their use difficult, so it was used after conversion to its methyl ester which modified all the characteristics to suit our demand. In this work, different proportions of karanja methyl ester, viz, 5%, 10%, 15%, 20%, 30%, 40% and 50% are mixed with 95%, 90%, 85%, 80%, 70%, 60% and 50% respectively with diesel fuel on mass basis.

II.TRANSESTERIFICATION PROCESS

Transesterification is a most suitable process to convert oils and fats into biodiesel. It is the most popular reaction used for the conversion of vegetable oils into biodiesel in order to reduce its viscosity. It is the reaction of an alcohol, in most cases methanol, with the triglycerides present in oils, fats or recycled grease, forming biodiesel (fatty acid alkyl esters) and glycerol. The reaction requires heat and a strong base catalyst, such as sodium hydroxide or potassium hydroxide. It has been reported that the methyl and ethyl esters of vegetable oil can result in superior performance than neat vegetable oils.

Oil feedstocks containing small amounts of free fatty acids are fed directly to the transesterification process. The catalyst, potassium hydroxide, is dissolved in methanol and then mixed with the pretreated oil. The co-products of this reaction are biodiesel and glycerin.

METHANOL RECOVERY:

Methanol is usually removed after the biodiesel and glycerin have been separated into two layers, preventing reaction reversal. The methanol is then cleaned and recycled back to the beginning of the process.

BIODIESEL REFINING:

Once separated from the glycerin, the biodiesel goes through a purification process, removing all remaining alcohol and catalyst. It is then dried and stored. To guarantee the biodiesel is without color, odor and sulfur, an additional distillation process may be implemented.

Figure 2.1 Transesterification Process flow chart

III.RESULTS AND DISCUSSIONS

3.1 RESULTS

SPECIFIC FUEL CONSUMPTION (SFC)

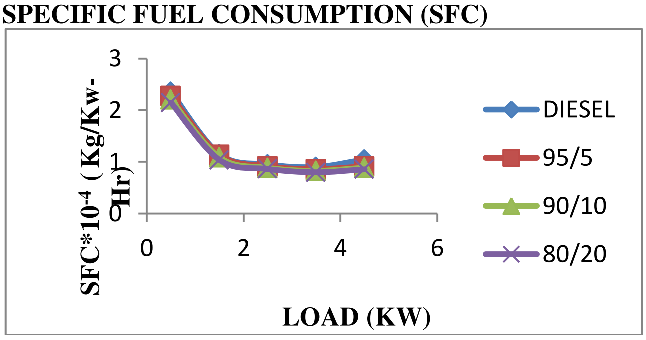

Figure 3.1 LOAD VS SFC at varying loading conditions

TOTAL FUEL CONSUMPTION (TFC)

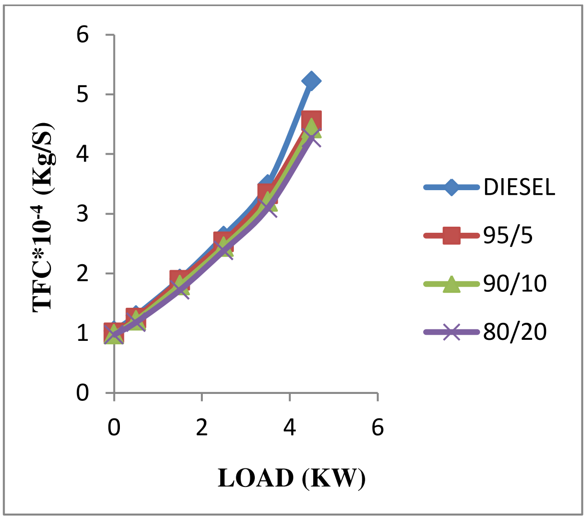

Figure 3.2 LOAD Vs TFC at varying loading conditions

BRAKE THERMAL EFFICIENCY (BTE)

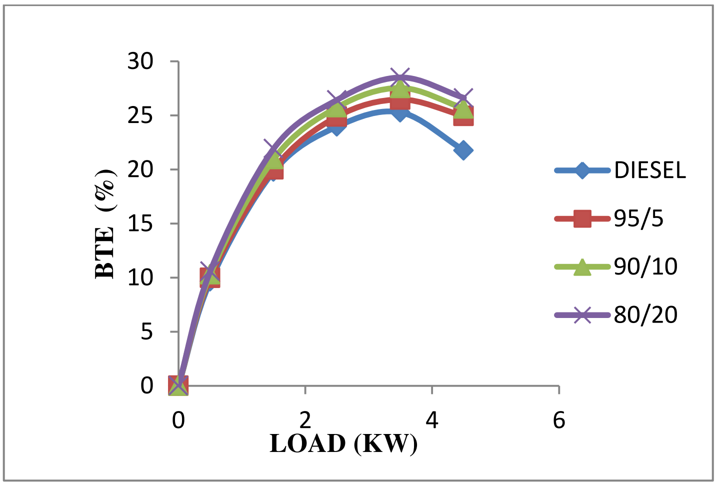

Figure 3.4 LOAD Vs BTE at varying loading conditions

HEAT SUPPLY (QS)

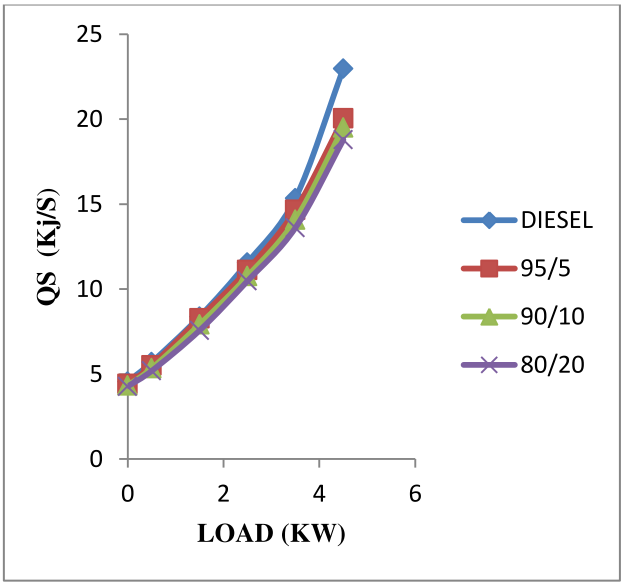

Figure 3.C

INDICATE THERMAL EFFICIENCY (ITE)

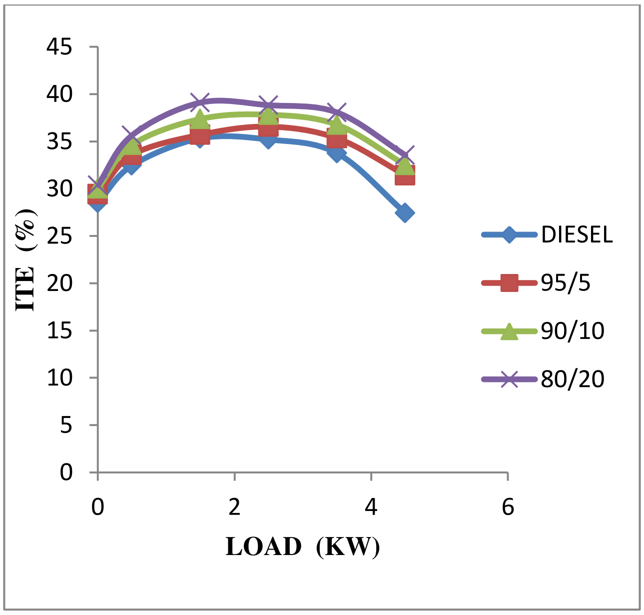

Figure 3.5 LOAD Vs ITE at varying loading conditions

NOx EMISSION

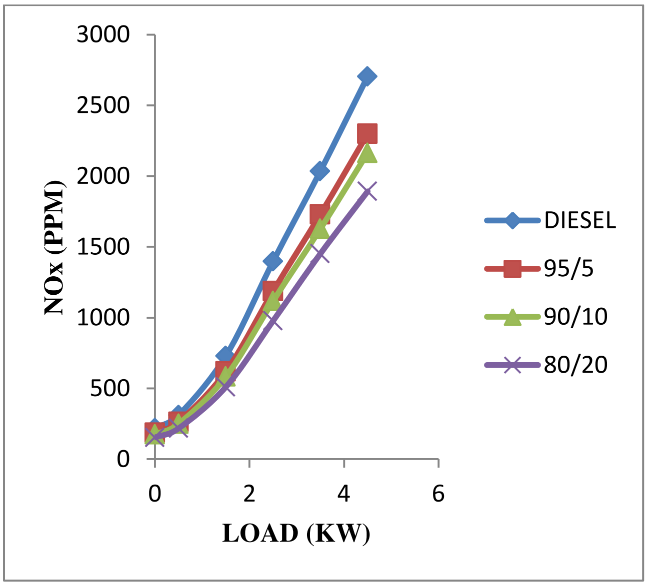

Figure 3.6 LOAD Vs NOx at varying loading conditions

CO EMISSION

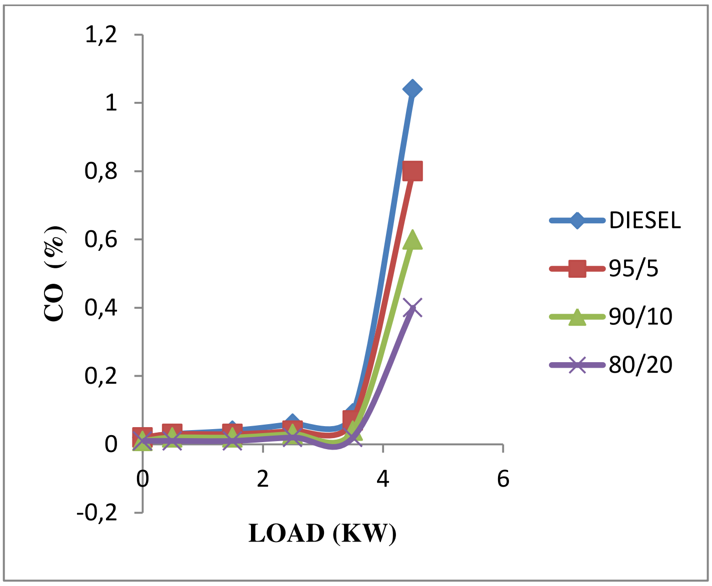

Figure 3.8 LOAD Vs CO at varying loading conditions

HC EMISSION

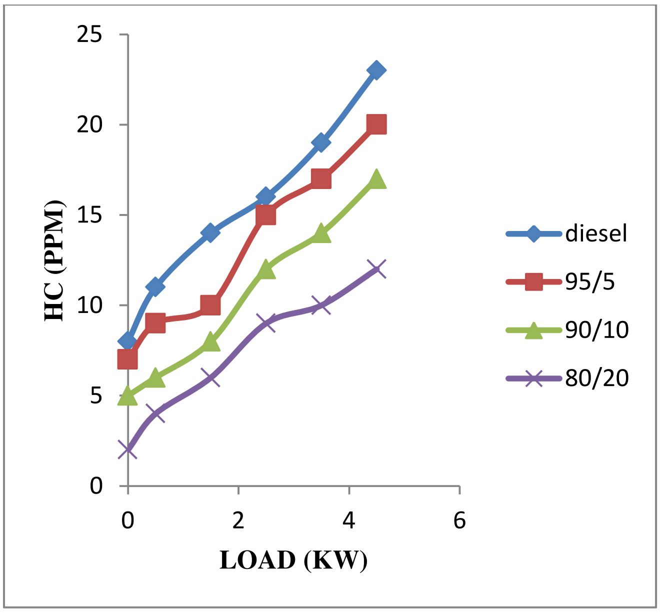

Figure 3.7 LOAD Vs HC at varying loading conditions

CO_2 EMISSION

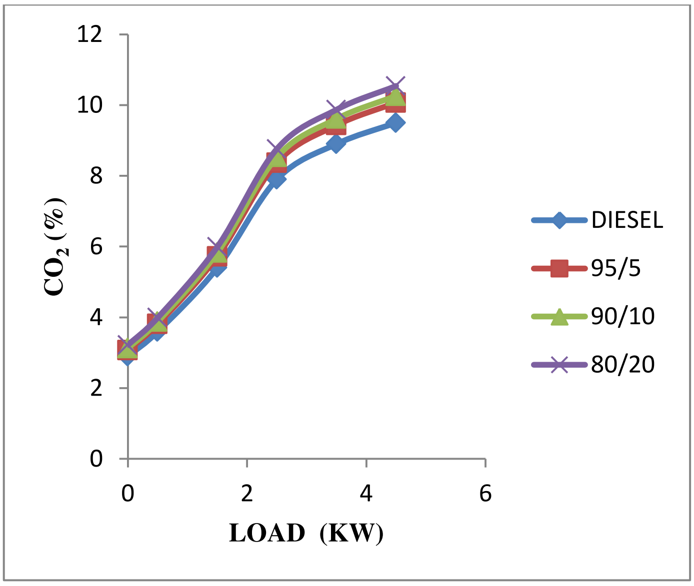

Figure 3.9 LOAD Vs CO_2 at varying loading conditions

3.2 DISCUSSIONS

3.2.1 SPECIFIC FUEL CONSUMPTION (SFC)

Fig 10.1 shows the specific fuel consumption (SFC) value of the engine is decreasing with the increased load on the engine. Then the SFC value decreased with compare diesel value at the same time increasing Honge oil blend resulting the decreased SFC value.B20 gives the better SFC value compare than other blend value and diesel.

3.2.2 TOTAL FUEL CONSUMPTION (TFC)

Fig 10.2 shows the total fuel consumption (TFC) value of the engine is increasing with the increased load on the engine. Then the TFC value decreased with compare diesel value at the same time increasing Honge oil blend resulting the decreased TFC value. B20 gives the better TFC value compare than other blend value and diesel.

3.2.3 HEAT SUPPLY (QS)

Fig 10.3 shows the heat supply (QS) value of the engine is increasing with the increased load on the engine. Then the QS value decreased with compare diesel value at the same time increasing Honge oil blend resulting the decreased TFC value. B20 gives the better QS value compare than other blend value and diesel.

3.2.4 BRAKE THERMAL EFFICIENCY (BTE)

Fig 10.4 shows that the Brake thermal efficiency of the Engine gradually increased with increasing load (up to 3.5 KW) then slightly decreases with increased load Honge oil blend B20 gives the highest Brake Thermal Efficiency(28.50 %) compared with diesel (25.27%) and other Honge oil blend value. Diesel value gives low Brake thermal efficiency compared with all Honge oil blends.

3.2.5 INDICATE THERMAL EFFICIENCY (ITE)

Fig 10.5 shows that the Indicate Thermal Efficiency of the Engine gradually increased with increasing load (upto1.5 KW) then slightly decreases with increased load. At load (1.5KW) the Honge oil blend B20 gives the highest Indicate Thermal Efficiency (39.10 %) compare than diesel (35.32%).

3.2.6 NOx EMISSION

Fig 10.6 shows that the variation of NOx emission for different blends. The NOx emission for all the fuels tested followed an increasing trend with respect to load.

A reduction in the emission for all the blends as compared to diesel was noted. As the Honge oil content of the fuel increases, a corresponding reduction in emission was noted and the reduction was remarkable for B5, B10. Maximum and minimum amount of NOx produced were 187 and 2299 ppm corresponding B5, for B10 is 176 and 2164 ppm and corresponding to B20 is which is 154 and 1892 low with compare Diesel value (220 and 2704 ppm). According to the graph Honge oil blend B20 gives the Less NO_X value compared with diesel value.

3.2.7 HC EMISSION

Fig 10.7 shows that the variation of HC emission for different blends. It is seen from the figure that the HC emission increases with increase in load for diesel. The graph shows that the Honge oil blends B5, B10 and B20 gives lower HC value compared with diesel. And also it shows the HC value for the all blends are gradually increased with increasing load. The maximum and minimum amounts of HC produced were 7 and 20 ppm corresponding B5, for B10 is 5 and 17 ppm for B20 is 2 and 12. This is low with compare Diesel value (8 and 23 ppm).

3.2.8 CO EMISSION

Fig 10.8 shows that the variation of CO emission for different blends. At lower Honge oil concentration, the oxygen present in the Honge oil aids for complete combustion. However, as the Honge oil concentration increases, the negative effect due to high viscosity and small increase in specific gravity suppresses the complete combustion process which produces small amount of CO. The graph shows that the CO value for Honge oil blends gradually decreases when compared with diesel.

It also shows B5, B10 and B20 gives low CO value compared with diesel. B20 gives the minimum amount of CO value (0.01%, 0.4%) at full and no load conditions compared with diesel (0.02%, 1.04%).

3.2.9 CO_2 EMISSION

Fig 10.9 shows that the variation of CO_2 emission for different blends. The graph shows that the CO_2 value for Honge oil blends slightly increases when compared with diesel. It also shows B5, B10 and B20 gives slightly high CO_2 value compared with diesel. B20 gives the maximum amount of CO_2 value (3.52%, 10.54%) at full and no load conditions compared with diesel (2.9%, 9.5%).

CONCLUSIONS

Following are the conclusions based on the experimental results obtained while operating single cylinder diesel engine fuelled with biodiesel from Honge oil.

- Honge oil blended with diesel (biodiesel) can be directly used in diesel engines without any engine modifications.
- The specific fuel consumption is reduced by increase of blend of Honge oil. At starting condition SFC is high for various blends, and then it is reduced for increase of load. B20 gives the less SFC value compared with diesel.
- The total fuel consumption is reduced by increase of blend of Honge oil compared with diesel. At starting condition TEC is low for various blends, and then it is increase of load.
- Brake thermal efficiency of B5, B10 and B20 blends are better than diesel.
- Indicate thermal efficiency of B5, B10 and B20 blends are better than diesel.
- NOx, HC, CO, CO2 emissions at different loads were found to be higher for diesel, compared to B5, B10, B20 blends.
- Resulting error were calculated between the Experimental value and ANN value.

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