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Influence of Deccan Hemp Biodiesel over the Performance and Emissions of a CI Engine

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ABSTRACT

Pollution levels for two decades have risen to alarming levels due to rapid growth in transportation sector all over the world. In this regard many researchers worked on finding an alternate fuel either to replace or to blend partially with diesel. In this work, Deccan hemp oil's influence over the performance of internal combustion engine is studied experimentally. This paper presents the trials conducted by blending the diesel and the Deccan hemp oil at five different ratios. The performance and emission characteristics are elaborated. It was evident from the results that emissions improved briefly but the performance was less than the diesel engines.

Keywords: Alternate fuels, Biodiesel, Deccan Hemp oil, Emissions, Diesel.

I. INTRODUCTION

Two main outcomes of industrialization had severe impacts on the environmental aspects of the earth. These were rapidly driven by the transportation and the power generation sectors that actively employed fossil fuels. This led to the increase in pollutants and the global temperature levels. With the recent estimations in energy scarcity of fossil fuels in near future many organisations and researchers turned towards the renewable and novel energy generation and consumption approach.

Most of them are mainly focused in creating bio diesel as an alternate fuel to support or completely replace the diesel fuel. Oils that were massively accredited for their energy potential are palm oil, rice bran oil, cotton seed oil, jatropha oil, mahua oil. These were the biproducts of agricultural waste which were commonly available in many developed nations (Ravichandra, Puli, Chandramohan and Geo, 2018) [1].

India is known for its agricultural production capacity due to the vast availability of cultivable land. This agricultural advantage paves way for the abundant availability of options for bio diesel generation. Factors that influence in choosing a particular oil source is dependent on its accessibility, availability, associated costs and majorly the oil yield per kilogram (Sonar et al. 2014) [2].

Most of many lands which are not suitable for agricultural purpose can be used for processing the non-edible oil which would help in fighting the food vs fuel crises. Bio diesel production from non-edible sources will also help in tackling the socio-economic problem in backward or rural regions (Shehata2013) [3].

Utilisation of bio diesel has its own setbacks, the main problem is associated in using them is viscosity. The viscosity of most biodiesels is higher than diesel, thus making it difficult for them to flow through small places and even atomisation is affected. These are mainly responsible for reduction in thermal efficiency of the engines (Nwafor 2004) [4].

Thus, bringing down the viscosity has been the main objective when exploring alternate energy sources for the internal combustion Engine (Senthil kumar 2015) [5].

Many clogging problems like injector clogging were encountered when the raw oils were used. Thus, oils were blended with diesel and they achieved similar performance results without substantial modifications to the engine. This was even experimented with altering the inlet temperature of fuel (FIT) (Chauhan et al. 2010) [6].

II. METHODOLOGY

The oil was extracted from Deccan hemp seeds from a local dealer. The thermo-physical properties of the extracted oil were examined for its density, viscosity, flash and fire points. A bomb calorimeter was used for estimating the calorific value of the oil. The same procedure was followed for examining the properties of the oil extracted from the transesterification process.

A. Transesterification Process :

The general procedure of transesterification was followed where Ethanol and Potassium Hydroxide were used as catalysts. Dilution of these catalysts was done by mixing 200 ml and ten grams of ethanol and Potassium hydroxide, respectively. One litre of extracted oil was then mixed with the diluted catalyst solution and this entire mix was heated to 60° C for thirty minutes. After the entire solution is left undisturbed for one complete day, two layers were formed and with the influence of gravity the heaviest glycerol layer settles down. The upper layer was of ester that was washed away by water and dried later at temperatures above boiling point of water. The extracted biodiesel was blended with diesel in a volumetric fashion to obtain these compositions Dh05D95, Dh10D90, Dh15D85, Dh20D80, and Dh25D75.

TABLE I FUEL COMPOSITION TABLE

composition	Diesel (%)	Deccan hemp oil (%)
Dh05D95	95	5
Dh10D90	90	10
Dh15D85	85	15
Dh20D80	80	20
Dh25D75	75	25

The properties of the fuel samples blended are mentioned in the following table.

TABLE 2 FUEL COMPOSITION PROPERTIES

composition	**Viscosity (Cst at 40°C)**	**Density (kg/m^3)**	**Calorific Value (MJ/Kg)**	**Fire point (°C)**	**Flash point (°C)**
Diesel	3.04	840	45.5	62	51
Dh05D95	3.17	843.7	44.46	63	58
Dh10D90	3.24	850.5	43.26	65	61
Dh15D85	3.31	856	41.46	69	63
Dh20D80	3.34	861	39.28	72	66
Dh25D75	3.41	868	36.72	75	69

III. TESTING

The predefined compositions were tested for their pollutant formation and performance of the engine. It is to be noticed that the experiment runs were conducted with no load condition as the focus of this work is to observe the performance of fuel but as the loading is introduced into the experiment then this would hinder the performance to an extent. The motto of this work is to first of all identify the discrepancies associated in using biofuels as an alternate fuel source. The experimental setup that is employed in this scenario was of Kirloskar make single cylinder Cmbustion Ignition Engine.

A. Emissions Analyser:

QROTECH 401 was used as the gas analyser which has the capability to measure five pollutants. They are CO, HC, CO2, NOX, and O2. The method employed to detect these pollutants is NDIR for CO, HC,CO2 and the other two are captured using electro-chemical method.

TABLE 3 TEST RIG SPECIFICATIONS

parameter	**Value**
Manufacturer	Kirloskar Oil Engines Ltd
Power Output (rated)	7.5Kw@1500rpm
Bore(mm)	116
Stroke(mm)	102
Engine Volume (cc)	948
Starting type	Hand cranking
Fuel type	Diesel

Figure No.1 Test engine setup

Figure No.2 Exhaust gas analyser

Figure No.3 Hot Plate Magnetic stirrer

Hot plate magnetic stirrer was used for mixing the diesel and bio diesel into the proportionate ratios. The stirrer was run for 12 minutes at 45°C. This leads to a uniform distribution of biodiesel.

IV. RESULTS

A. Cylinder pressure:

The cylinder pressure reading of the experiments shows the results in reference with diesel run (black line). The maximum pressure of 87 bar was observed for the 100 percent diesel runs while the maximum pressure achieved by biodiesel was 80 bar for Dh5D95 fuel sample.

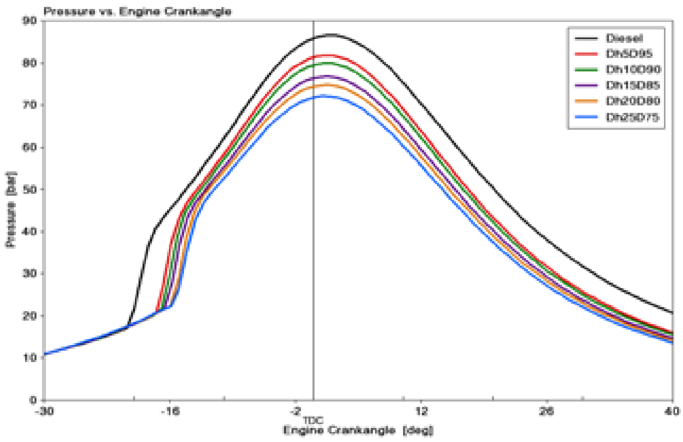

Figure No.4 Cylinder Pressure

It can be seen that there is an ignition delay of at least 4° CA for the diesel and biodiesel samples.

B. Heat release rate :

The instantaneous heat release of the diesel was maximum with 300 J/deg, while the samples with 5 and 10 percent biodiesel blends were more than 273 Joules

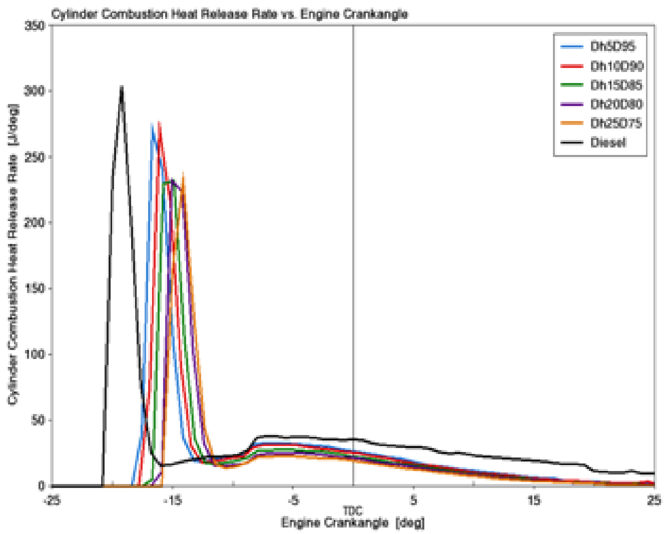

Figure No.5 Heat release rate

The fuels with further dilution of biodiesel dropped gradually in heat release with the lowest being 236 J/deg. The location of maximum heat release has a direct effect on the BTE of the engine.

C. Hydro-carbon emissions:

The hydro-carbon fuel emissions of diesel fuel were 0.158 g/kW/hr which was the lowest while the Dh5D95 fuel sample emitted the lowest of the biodiesel fuel sample which was 0.186 g/kW/hr. However, the emissions rose rapidly for the samples with more than 10 percent biodiesel fuel content. The highest emissions of 0.218 g/kW/hr were recorded when the Dh25D75 sample was run. Thus, it is evident that as the dilution increased the emissions also increased.

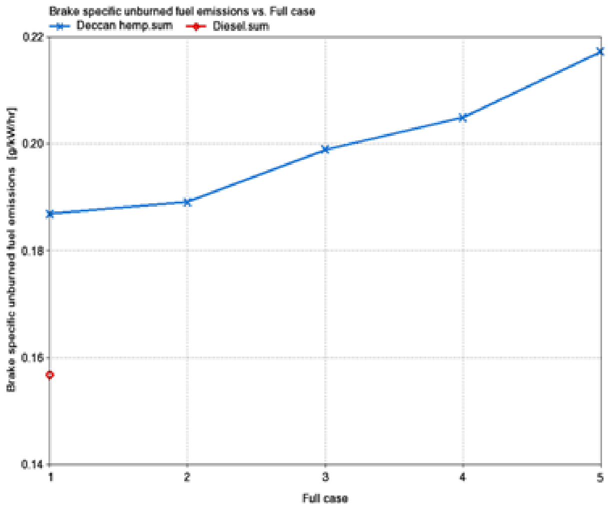

Figure No.6 Hydro-carbon (HC) emissions

D. Carbon monoxide :

The carbon monoxide depicts an inverse behaviour to the HC emissions where the diesel fuel emission was 0.16 g/kW/hr while the Dh05d95 emitted just over 0.35 g/kW/hr. The CO emissions decreased rapidly for the first three fuel samples with the least dilutions.

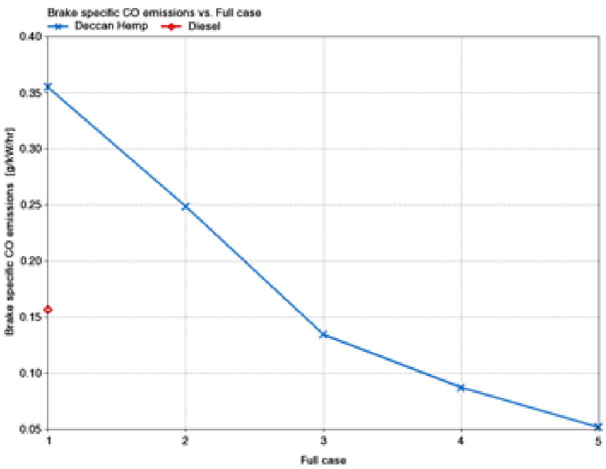

Figure No.7 Carbon monoxide (CO) emission

The Dh25D75 sample produced less CO emissions of 0.05 g/kW/hr. the emission for the samples Dh15D85, Dh20D80 and Dh25D75 were less than the diesel fuel emissions.

E. NOx emissions :

The trend of the NOx emissions was similar to that of the CO emissions. The fuel samples with less dilution generated more emissions as higher temperatures are observed. The Dh05D95 sample produced 5650 ppm which was the highest while the Dh25D75 produced the least of 4500 ppm. However, the 100 percent diesel fuel produced much lesser emissions than Dh25D75 fuel sample. The emissions of diesel run were 4400 ppm.

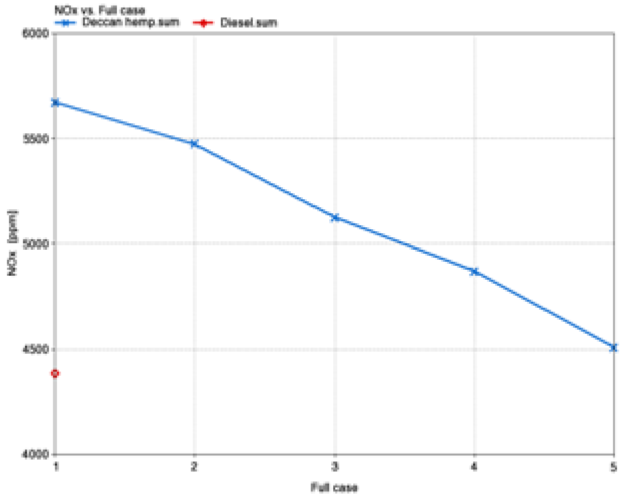

Figure No.8 Oxides of Nitrogen (NOx)

V. CONCLUSION

The main factor that influences the overall performance and emissions of the engine are the developed cylinder pressure. The cylinder pressure is in turn dependant on the ignition delay property of the fuel. As this ignition delay is more for the biodiesel blended fuel samples compared to the diesel fuel this resulted in the generation of less pressure at TDC which led to the decrease in BTE of engine with increase in biodiesel composition

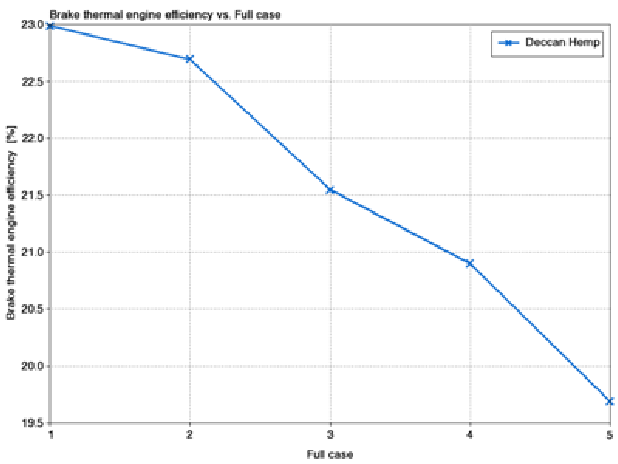

Figure No.9 Brake thermal efficiency

Since the cylinder pressure is again the ability to of the fuel to burn quickly, the heat release of the diesel is quicker than the biodiesel blends. This is primarily due to the density and the viscosity of the fuel. As the blend percentage of the biodiesel increased, the average density and viscosity of the entire fuel sample increased, resulting in faster settling of fuel droplets, much coarse atomisation of fuel. These factors led to the decrease in combustion efficiency. This in turn led to more emissions depending upon the scenario of poor and better combustion which led to formation of CO, HC and NOx formation.

VI.REFERENCES

[1]. Ravichandra, D., Puli, R., Chandramohan, V. and Geo, V., 2018. Experimental analysis of Deccan hemp oil as a new energy feedstock for compression ignition engine. International Journal of Ambient Energy, 40(6), pp.634-644.

[2]. Sonar, D., S. L. Soni, D. Sharma, A. Srivastava, and R. Goyal. 2015. "Performance and emission characteristics of a diesel engine with varying injection pressure and fuelled with raw mahuaoil(preheated and blends) and mahua oil methyl ester." Clean Technologies and Environmental Policy17 (6):1499–1511.

[3]. Shehata, M. S. 2013. "Emissions, performance and cylinder pressure of diesel engine Fuelled by biodiesel fuel." Fuel 112: 513–522.

[4]. Nwafor, O. M. I. 2004. "Effect of advanced injection timing on emission characteristics of a diesel engine running on biofuel."International Journal of Ambient Energy25 (3): 115-122.

[5]. Senthilkumar, P., and G. Sankaranarayanan. 2015. "Effect of Jatropha methyl ester on waste plastic oil fueled DI diesel engine." Journal of the Energy Institute, article in press: 1 – 9.

[6]. Chauhan, B. S., N. Kumar, Y. D. Jun and K. B. Lee. "Performance and emission study of preheated Jatropha oil on medium capacitydieselengine ."Energy 35: 2484-2492.