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PERFORMANCE AND EMISSIONS ANALYSIS OF DIESEL BLENDED WITH NAHAR BIODIESEL BY VARYING COMPRESSION RATIO OF CI ENGINE

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Abstract:*The present experimental investigation evaluates the effects of using blends of diesel fuel with 18% concentrations of Ethyl Ester of Nahar biodiesel blended with various compression ratios. The experiment was carried out with three different compression ratios. Experimental Biodiesel was extracted from Nahar oil, 18% (B18) concentrations of oil in diesel was found to be best blend ratios from the earlier experimental study. The engine was maintained at various compression ratios i.e., 16, 17 and 18 respectively. It is found that, at compression ratios of 18:1 for B18 blended fuel (Pure Diesel 82% + Nahar Biodiesel 18%) shows better performance and lower emission level which is very close to neat diesel fuel. It is also found that the increase of compression ratios increases the Brake Thermal Efficiency and reduces Brake Specific Fuel Consumption and having lower emission without any engine in design modifications.*

Key words: *Compression Ratio, Nahar Biodiesel, Engine Performance, Emissions.*

1. INTRODUCTION

The aim of the study was to investigate the effect of Nahar oil biodiesel fuels on engine performance. To investigate the effect of varying compression ratio in Nahar oil on engine performance and emissions characteristics. A single cylinder, 4 stroke, compression ignition direct injection diesel engine has been used to measure the emissions performance characteristics of blends of biodiesel and Diesel.

The world is confronted with the twin crises of fossil fuel depletion and environmental degradation. The rapid extraction and consumption of fossil fuels have led to a reduction in petroleum reserves [1]. Biodiesel is an alternative fuel for diesel engines that is produced by chemically combining vegetable oils and animal fats with an alcohol to form alkyl esters. Extensive research and demonstration projects have shown that it can be used pure or in blends with conventional diesel fuel in unmodified diesel engines [3]. Interest in biodiesel has been expanding recently due to government incentives and high petroleum prices. While the current availability of vegetable oil limits the extent to which biodiesel can replace petroleum to a few precent, new oil crops could allow biodiesel to make a major contribution in the future.[2][5]

2. LITERATURE REVIEW

Pillai et al. [1] studied performance of DI compression ignition engine with blends of 5-carbon alcohol, rubber seed biodiesel and diesel at various compression ratio viz.16: 1, 17: 1, 18: 1. It proves that CR 17.5 is the best compression ratio for all the blends. The result shows that the emission is reduced except for NOx when compared with the diesel fuel. Finally concluded that emission was reduced in R10P10 blend at CR 17.5 and it is an eco friendly alternative fuel.

Venkateswara et al. [2] performed experiment on tested in uneven firmness ratio engine (VCR) with methyl ester of jatropha oil (MEOJ) and diesel. The compression ratio was varied for 14, 16, 18 and 20. The BTE and BSFC were measured for performance parameter and CO, CO_2, HC, NOx and smoke for emission parameter. It was noticed that higher CR, performance of engine increased apparently with less BSFC for biodiesel blends fuel. The emission was higher for CO and CO2, HC, NOx and smoke density emission is lower when CR is higher. The higher compression ratio of the combustion parameter is improved in biodiesel blends.

Sejaj et al. [3] reveals the natural aspirated, various compression ratio engine with different biodiesel blends (B10, B20, B30, B40, B60, B80 and B100). The test was conduct in no load to full load in all blends. All emission parameter such as HC, CO, and NOx were measured. The compression ratio was varied from 14 to 18 with equal interval of two. In higher compression ratio 18 the BTE was increased and lower in SFC. The results shown B20 biodiesel was superior in both performance and emission parameter in higher compression ratio of 18 compare to other compression ratio and other biodiesel blends.

Anand et al. [4] investigated about the methyl ester of cotton seed oil production by transesterification process and blends with four different blends B5 to B20 in equally raised by 5%. An experiment is studied at constant speed in 1500 rpm with variable compression ratio (CR). The compression ratio of 15 and 17 were found better in performance characteristics with 5% blends. The oxides of nitrogen emission are higher in compression ratio 17 with B20 blend. Also reduction in carbon monoxide and smoke in all loads in higher compression ratio of 17 with B20 blend. They concluded B20 with higher compression ratio is suitable for diesel engine.

Metin et al. [5] stated that the Hydro Carbon emission for B20 blends of MEOJ and diesel at variable compression ratio (CR). The HC emission increase or decrease is based on the CR value. Normally if the CR value is increased, the HC emission reduced. At full load with the CR of 17.5, the HC for B20 is 33ppm while compared to other compression ratio. During the end of the compression stoke the air temperature gets higher, this enhance the complete burning and reduction HC emission.

The review gives a thorough attitude toward the investigation of biodiesel creation, engine examination utilizing biodiesel with mixes of diesel, impact of engine parameters on engine examination and engine examination utilizing Nahar Oil mixes. The survey plainly demonstrates that investigation of Variable Compression Ratio engine utilizing cottonseed oil methyl ester as fuel is exceptionally restricted. In addition, the Nahar Oil mixes as fuel in Variable Compression Ratio isn't finished by any scientist. Thus, in this work, an endeavor is made to examine the execution, ignition and discharge qualities of Variable Compression Ratio engine utilizing biodiesel and its mixes.

3. TRANSESTERIFICATION REACTION

The main components of animal fats and vegetable oils are Triglycerides. The vegetable oil or animal fat is subjected to a chemical reaction called Transesterification to produce biodiesel. The fatty acid triglycerides are esters of fatty acids and the chemical divides up of the heavy molecules and forming simpler esters is termed as Transesterification. These triglycerides are reacted with alcohol (Methyl, Ethyl, or others) in the presence of a catalyst under a restricted temperature for a given length of time. The final products are Alkyl esters and Glycerin. The Alkyl esters are having positive properties as fuels for use in CI engines, are the main product and the Glycerin, is a by-product

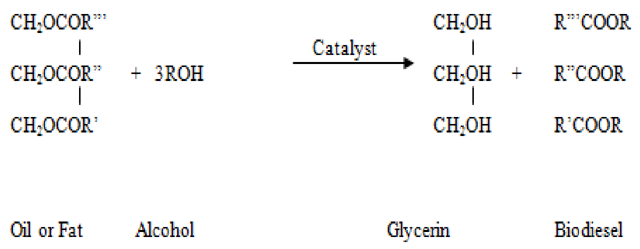

Fig. 1 Transesterification reaction.

1. Filtering: The vegetable oil is first filtered to remove solid particles from it. It is to be warmed up a bit first to get it to run freely; 35°C should be enough. A Cartridge filter is used for the same.
2. Removing the Water: First the oil is heated to remove the water content. Vegetable oil may contain water, which can slow down the reaction and causes saponification (soap formation). Then the temperature is raised to 100°C, holding it and allows water contents to boil off. Run the agitator to avoid steam pockets forming below the oil and exploding, splashing hot oil puddles out from the bottom. When boiling slows, the temperature is raised to 130°C for 10 minutes and allow cool to it.

The physico-chemical properties of Hybrid biodiesel i.e. equal mixture of cotton-seed and Eucalyptus oil biodiesel is given in the Table 1. The specific gravity, Kinematic Viscosity, Flash Point, Cloud Point, Pour point, Cetane index and color are comparable with that of diesel fuel.

Properties	Diesel	Nahar oil
Specific gravity	0.860	0.952
Kinematic viscosity, cst$^{40°C}$	2.2894	20.589
Flash point, ºC	83	--
Cloud point, ºC	-1	8
Pour point, ºC	-6	--
Cetane index	52.4	--
Color	Light	Brown

Table 1 Tested Properties of Hybrid Biodiesel

4. EXPERIMENTAL SET UP

The engine was started and allowed to run for 15-20 minutes to get stabilized using pure diesel fuel and baseline data for B00 was generated. Compression ratio was set at 18:1 and performance parameters were noted using I.C. engine software. The exhaust gas emission parameters like HC, NOx, CO_2, CO were recorded by pelting the probe of AVL gas analyser in the exhaust pipe. For noting the value of smoke (opacity) the exhaust gas was directed to AVL smoke meter and the opacity was recorded.

Then the load on the engine was further increased from 0 kg, 3 kg, 6 kg, 9 kg, 12 kg and 15kg while keeping the fuel injector triggering pressure and fuel injection advance angle unchanged. The engine was run for sufficient time duration to ensure that the diesel fuel phase is over and the engine has started running with biodiesel as fuel. The entire process was repeated while engine running with different blends of hybrid biodiesel i.e. B06, B12, B18, B24, B30 and B36 as a fuel and various performance and emission parameters were noted.

Sr. No.	Description	Specification
1	Make	Rocket Engineering Model VRC-1
2	Bore	80 mm
3	Stroke	110 mm
4	Swept Volume	553 mm
5	RPM	1500
6	Brake Horse Power	5 HP
7	Compression Ratio	17.5 : 1
8	Fuel Oil	High Speed Diesel
9	Coefficient of Discharge	0.65
10	Water Flow Transmitter	0 to 10 lit./min.
11	Air Flow Transmitter	0 to 250 wc
12	Piezo Sensor	0 to 5000 psi with low noise cable
13	Software	Lab view

Table 2 Test Engine specifications

Sr. No.	Description	Specification
1	Make	AVL
2	Type	AVL Digas 444
3	Power supply	110V-220V 25 W
4	Warm up time	7 min.
5	Connector gas in	180 l/h, max. overpressure 450 hPa
6	Response time	T95 15s

7	Operating temperature	5 …45 C
8	Storage temperature	0…50 C
9	Dimension (w x d x h)	270 x 320 x 85 mm3
10	Weight	4.5 kg net weight without accessories
11	Interfaces	RS 232 C, Pick up, Oil temperature probe

Table 3 Specifications of AVL Gas Analyser.

Fig.2 Engine Test Rig

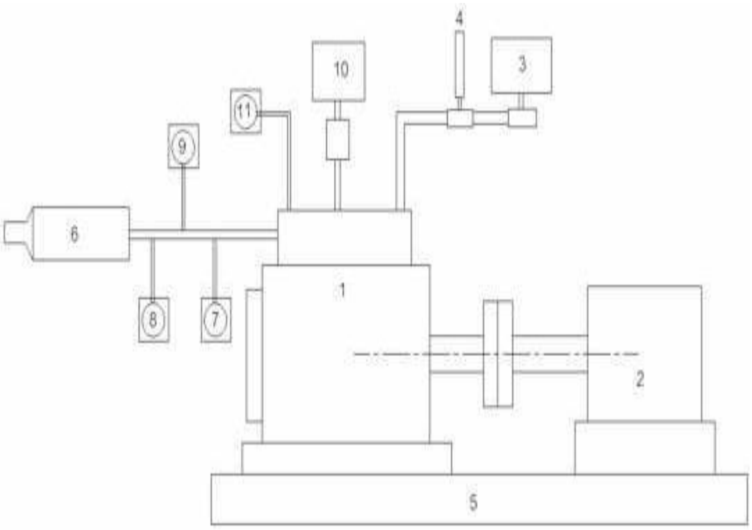

Fig. 3 Experimental Engine Setup Arrangements

1. Test Engine
2. Hydraulic Dynamometer
5. Fuel Tank
4. Fuel Burette
6. Test Bed
6. Silencer
7. Smoke Meter
8. HC/CO/NOx/CO_2/O_2 Analyzer

8. Exhaust Temp Indicator 09. Air Flow Meter
1. Stop Watch

5. RESULTS AND DISCUSSION

5.1 Engine performance Analysis- The engine performance parameters such as Brake Power, Specific Fuel Consumption, Brake Thermal Efficiency, and Brake Mean Effective Pressure obtained with B18 at compression ratios of 16, 17 and 18 are discussed in the following sections.

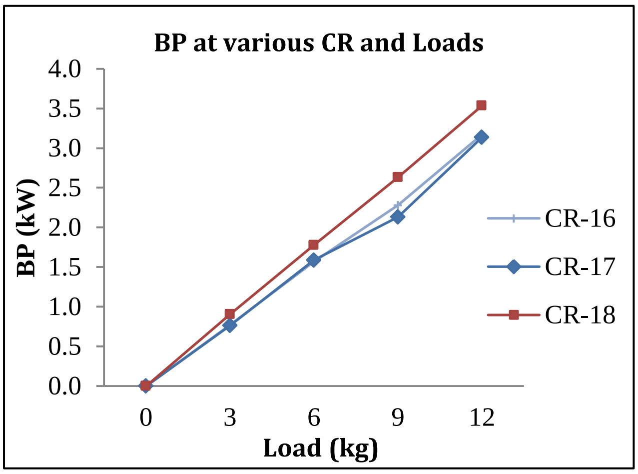

Fig.4: Load vs Brake Power

Fig. 4 depicts the variation of the Brake power for diesel at various conditions of load. The BP increases with the increase in the compression ratio. Percentage increment in BP of B18 obtained at compression ratio, 16, 17 and 18 are 1.56, 1.52 and 1.77.

Fig.5 depicts the variation of the Brake mean effective pressure for diesel at various conditions of load. The BMEP increases with the increase in the compression ratio. Percentage decrement in BMEP of B00 obtained at compression ratio, 16, 17 and 18 are 1.94, 1.91 and 2.06.

Fig. 6 depicts the variation of the Brake thermal efficiency for diesel at various conditions of load. The BTHE increases with the increase in the compression ratio. Percentage decrement in BTHE of B18 obtained at compression ratio, 16, 17 and 18 are 12.59, 13.42.

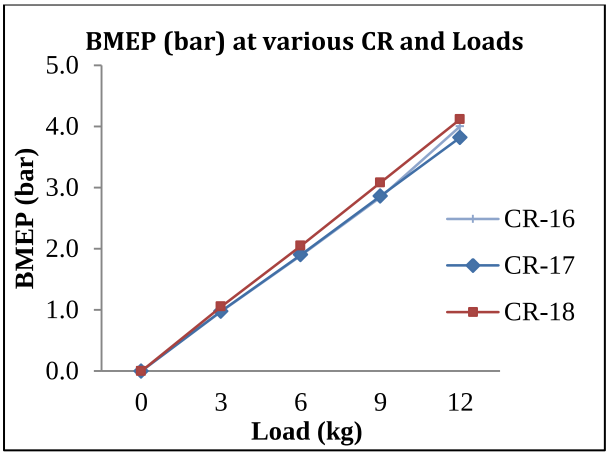

Fig 5: BMEP at various Compression Ratio and Loads

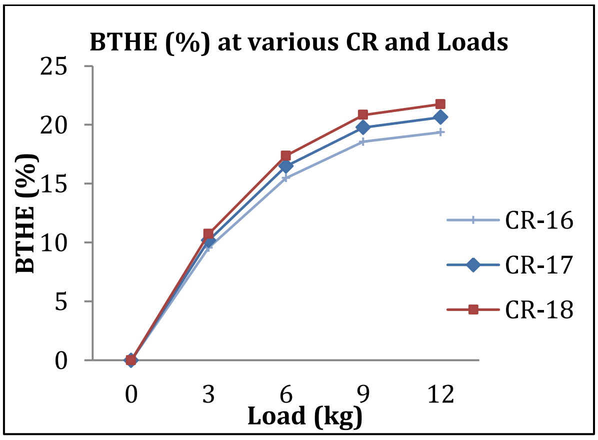

Fig.6: BTHE at various Compression Ratio and Loads

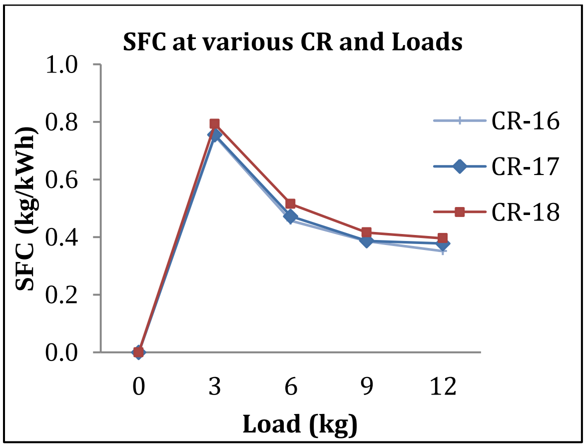

Fig.7: SFC at various Compression Ratio and Loads

Fig.7 depicts the variation of the Specific fuel consumption for diesel at various conditions of load. The SFC decreases with the increase in the compression ratio. Percentage decrement in SFC of B18 obtained at compression ratio, 16, 17 and 18 are 0.39, 0.40 and 0.42.

5.1 Engine Exhaust Emission Analysis- The engine performance parameters such as BP, SFC, Brake Thermal Efficiency, and Brake Mean Effective Pressure obtained with B18 at compression ratios of 16, 17 and 18 are discussed in the following sections.

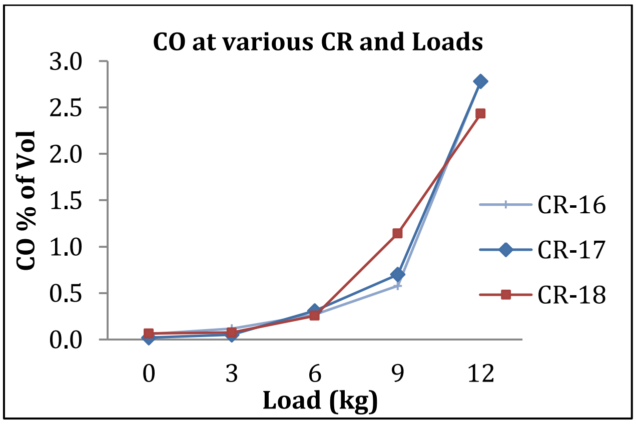

Fig.8: CO at various Compression Ratio and Loads

Fig.8 depicts the variation of the Carbon monoxides for diesel at various conditions of load. The CO decreases with the increase in the compression ratio. Percentage decrement in CO of B18 obtained at compression ratio, 16, 17 and 18 are 0.79, 0.77 and 0.76.

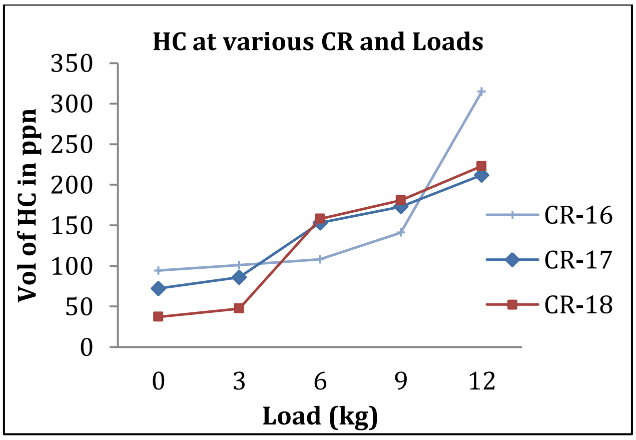

Fig.9: HC at various Compression Ratio and Loads

Fig.9 depicts the variation of the Hydrocarbons for diesel at various conditions of load. The HC reduces with the increase in the compression ratio. Percentage decrement in HC of B00 obtained at compression ratio, 16, 17 and 18 are 152, 139 and 129.

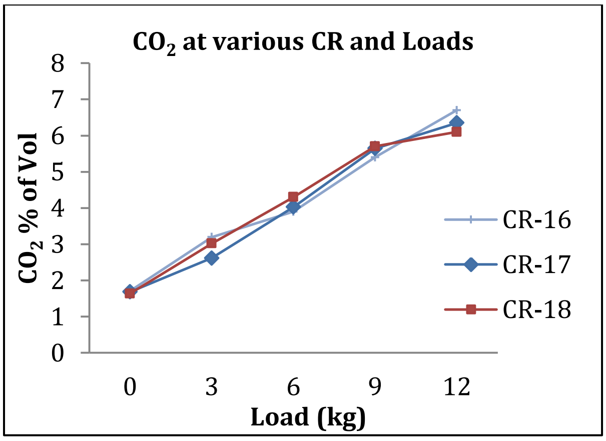

Fig.10: CO2 at various Compression Ratio and Loads

Fig.10 depicts the variation of the Carbon dioxides for diesel at various conditions of load. The CO_2 reduces with the increase in the compression ratio. Percentage decrement in CO_2 of B18 obtained at compression ratio, 16, 17 and 18 are 4.18, 4.15 and 4.07.

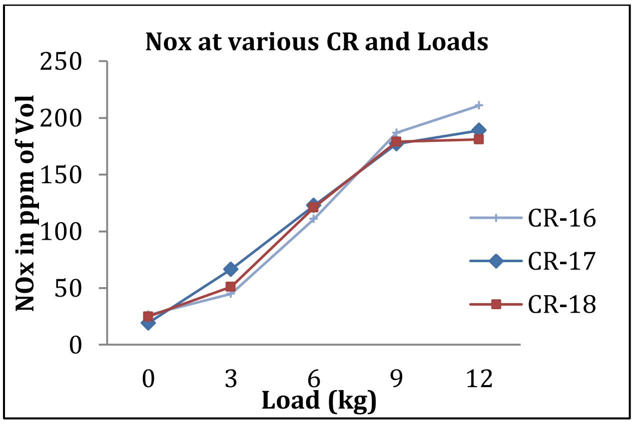

Fig.11: NOx at various Compression Ratio and Loads

Fig.11 depicts the variation of the Carbon dioxides for diesel at various conditions of load. The CO_2 reduces with the increase in the compression ratio. Percentage decrement in CO_2 of B18 obtained at compression ratio, 16, 17 and 18 are 116, 114.9 and 111.4.

6. CONCLUSION

The Experimental work carried out in this study, and the conclusions made from above discussions are as follow

1 The BP increases with the increase in the compression ratio. Percentage increment in BP of B18 obtained at compression ratio, 16, 17 and 18 are 1.56, 1.52 and 1.77.

2 The BMEP increases with the increase in the compression ratio. Percentage decrement in BMEP of B00 obtained at compression ratio, 16, 17 and 18 are 1.94, 1.91 and 2.06.

3 The BTHE increases with the increase in the compression ratio. Percentage decrement in BTHE of B18 obtained at compression ratio, 16, 17 and 18 are 12.59, 13.42.
4 The SFC decreases with the increase in the compression ratio. Percentage decrement in SFC of B18 obtained at compression ratio, 16, 17 and 18 are 0.39, 0.40 and 0.42.
5 The CO decreases with the increase in the compression ratio. Percentage decrement in CO of B18 obtained at compression ratio, 16, 17 and 18 are 0.79, 0.77 and 0.76.
6 The HC reduces with the increase in the compression ratio. Percentage decrement in HC of B00 obtained at compression ratio, 16, 17 and 18 are 152, 139 and 129.
7 The CO_2 reduces with the increase in the compression ratio. Percentage decrement in CO2 of B18 obtained at compression ratio, 16, 17 and 18 are 4.18, 4.15 and 4.07.
8 The CO_2 reduces with the increase in the compression ratio. Percentage decrement in CO_2 of B18 obtained at compression ratio, 16, 17 and 18 are 116, 114.9 and 111.4.

The results concluded that the compression ratio 18 with B18 biodiesel blend is the best compression ratio in terms of performance, emission characteristics of variable compression diesel engine.

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