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ANALYSIS OF PERFORMANCE AND EMISSIONS OF A V.C.R C. I. ENGINE USING METHYL ESTERS OF RICE BRAN OIL AS BIODIESEL

*** Mr. V. Nageswara Reddy, Dr. G. Sreenivasa Rao**
*R.G.M. College of Engg. & Tech, Nandyal, A.P., India,
R.V.R. & J.C. Engg. College, Guntur, A.P., India.

KEYWORDS: Bio-diesel; Rice Bran Oil; Variable Compression Ratio; Injection Pressure; Performance; Emissions.

ABSTRACT
Biodiesel is one of the most promising alternative fuels for diesel engines. Biodiesel is renewable, non-toxic biodegradable, clean burning, high lubricity, biodegradable, low environmental impact, derived from vegetable oils and potential as a green alternative fuel to diesel engines and could be used directly in diesel engines without requiring extensive engine modifications. In this research work the performance and emissions of a single cylinder,4-stroke, variable compression ratio direct injection diesel engine with diesel , different blends of rice bran oil were measured by varying the load at different variable compression ratio (VCR-18, VCR-16 & VCR-14) and at different injection pressures (220 bar, 200 bar & 180 bar). The results proved that the use of biodiesel (produced from rice bran oil) in compression ignition engine is a viable alternative to diesel.

INTRODUCTION
Biodiesel fuel is used in diesel engines and is made from domestically available, renewable organic resources, such as vegetable oils and animal fats. Biodiesel burns cleaner than traditional petroleum diesel fuel. Biodiesel fuel combustion products have reduced levels of particulates, carbon monoxide, and, under some conditions, nitrogen oxides. It is well established that biodiesel affords a substantial reduction in Sox emissions and considerable reductions in CO, hydrocarbons, soot, and particulate matter (PM). There is a slight increase in NOx emissions, which can be positively influenced by delaying the injection timing in engines. In Europe the biodiesel is being produced using methanol. In the United States, the second largest producer and user of biodiesel, the fuel is usually made from soybean oil or recycled restaurant grease [1]. A lot of research work has been carried out to use vegetable oil both in its neat form and modified form. Studies have shown that the usage of vegetable oils in neat form is possible but not preferable [2]. The reaction is catalysed by a reaction with either an acid or base and involves a reaction with an alcohol, typically methanol if a biodiesel fuel is the desired product. Methyl/ ethyl esters of Rapseed oil [3], Sunflower [4], Mahua[5], and Palm Oil [6] have been successfully tested on C.I. engines and their performance has been studied Gholamhassan NAJAFI [7] conducted the combustion analysis on commercial DI engine. Venkateswara Rao et al.[8] has been successfully tested biodiesel on C.I. engine and performance of Pongamia, Jatropha and Neem has been studied and reported that B20 have closer performance to diesel and B100 had lower brake thermal efficiency mainly due to its high viscosity compared to diesel. Roberto G. Pereira1 [9] reported that the emissions decrease in the case of the mixtures diesel-soybean biodiesel. Ramesh and Sampathrajan [10] has been conducted performance and emission characteristics test of diesel engine with Jatropha biodiesel and its blends and reported that the brake thermal efficiency for biodiesel and its blends was found to be slightly higher than that of diesel fuel.

MATERIALS & METHODS
In this research work the fuels used were conventional diesel fuel, rice bran oil biodiesel and methanol. Fuel properties of rice bran oil biodiesel and methanol are determined in the laboratory as shown in the table 1.

Property parameters	Diesel Fuel	Rice Bran Oil Biodiesel	Methanol
Density at 20^0 C (g/cm^3)	0.82	0.96	0.78
Viscosity at 40^0C (mm^2/s)	3.4	4.56	1.35
Flash Point ^{0}C	57	160	21
Fire Point ^{0}C	60	175	25
Cetane Number	45	54	10

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Calorific value (KJ/kg)	43,500	39,800	28,700

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Table 1: properties of diesel, rice bran oil biodiesel and bio methanol.

2.1 Research Engine Test Set Up

Experimental set up used for this research work consists of a single cylinder, four strokes, variable compression ratio (computerized) diesel engine connected to eddy current type dynamometer for loading. The detailed specifications of the engine used as shown in Table 2. Figure: 1 shows the schematic diagram of engine test rig. The tests were conducted at different loads (3 kg, 6 kg, 9 kg, 12 kg, and 15 kg) at different compression ratios (VCR-18, VCR-16, & VCR-14) and also at different injection pressures (IP 220 bar, IP 200 bar & IP180 bar).

Make	Kirloskar Model AVL
No of strokes per cycle	04
No of Cylinders	01
Combustion chamber position	Vertical
Cooling Method	Water cooled
Starting Method	Cold Start
Ignition Technique	Compression Ignition
Stroke Length (L)	110 mm
Bore Diameter (D)	87.5 mm
Rated Speed	1500 r.p.m.
Rated Power	3.5 KW
Compression ratio	12:1 To18:1

Table 2: Specifications of the diesel engine

Figure: 1 Schematic diagram of engine test rig.

Experimental results were obtained at different loads (20%, 40%, 60%, 80% and 100%) on the engine. In the same manner the test was conducted with the blend of 90% diesel and B10 %,B20% and B30 %. The experiment tests were conducted with these three blends and measured brake power (B.P), brake specific fuel consumption (BSFC) and brake Mechanical efficiency (ME). Exhaust emissions such as Carbon Monoxide (CO), Nitrogen Oxides (NOx) and Hydrocarbons (HC) were measured by AVL exhaust analyzer and by smoke meter for diesel fuel and blends separately under all load conditions. The results from the engine with a blend of rice bran oil biodiesel methanol were compared with the baseline parameters obtained during engine fuelled with diesel fuel.

RESULTS AND DISCUSSIONS

Experimental results obtained from the research work pertaining to the performance of the engine are demonstrated with the help of graphs. The vary of BTE with load for diesel and blends at 220 bar IP and VCR 18:1 is shown in Fig. 2

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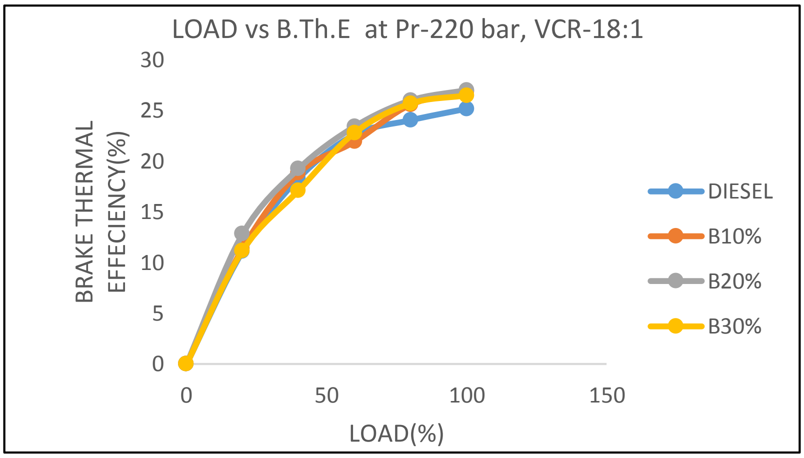
Fig: 2 Vary of BTE with load at 220 bar IP and at VCR-18:1



The vary of BTE with load for diesel & biodiesel blends at 220 bar IP and VCR 16:1 is shown in the Fig. 3

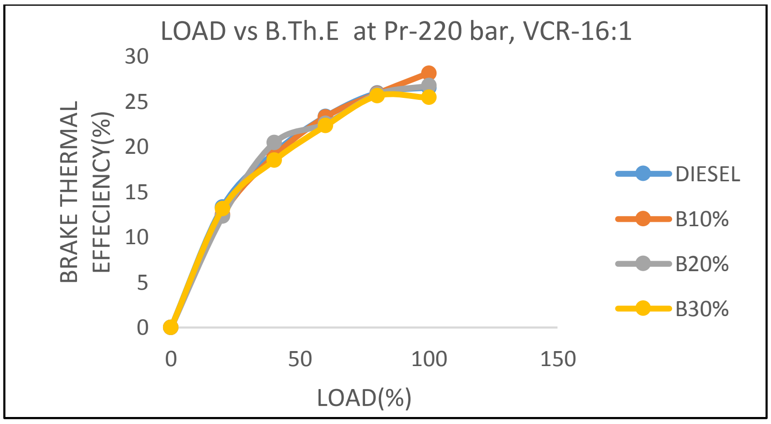


Fig: 3Vary of BTE with load at 220 bar IP and at VCR-16:1

The vary of BTE with load for diesel and blends at 220 bar IP and VCR 14:1 is shown in the Fig. 4.

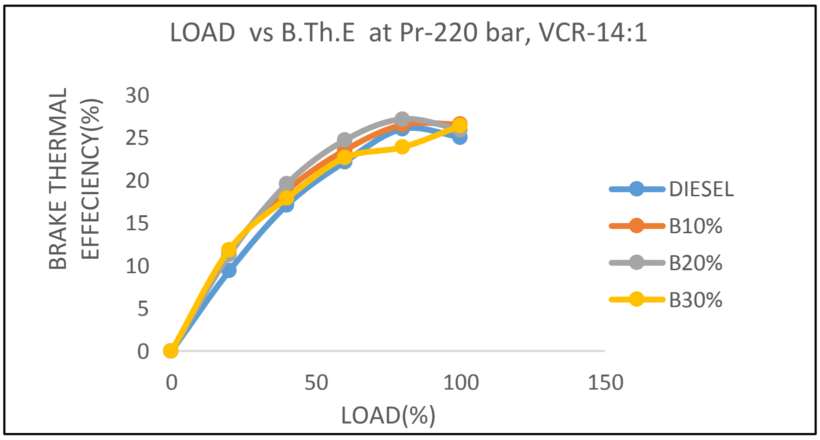


Fig: 4Vary of BTE with load at 220 bar IP and at VCR-14:1

The vary of BTE with load for diesel and blends at 200 bar IP and VCR 18:1 is shown in the Fig. 5.

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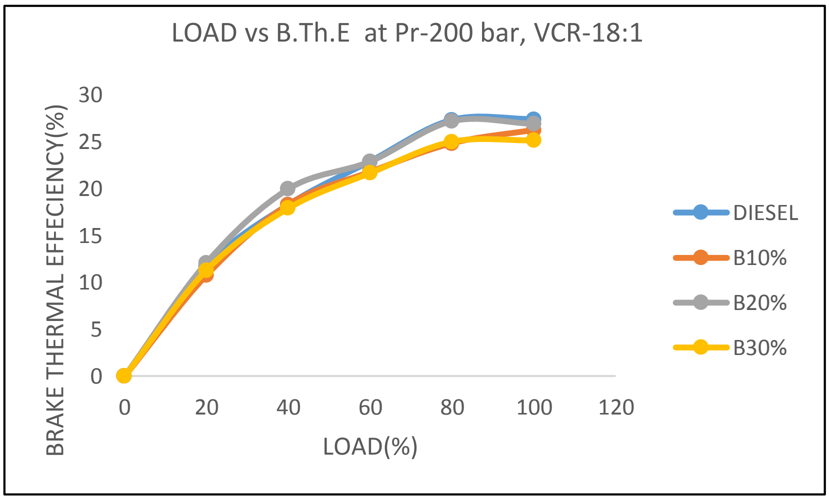

Fig: 5Vary of BTE with load at 200 bar IP and at VCR-18:1

The vary of BTE with load for diesel and blends at 200 bar IP and VCR 16:1 is shown in the Fig. 6.

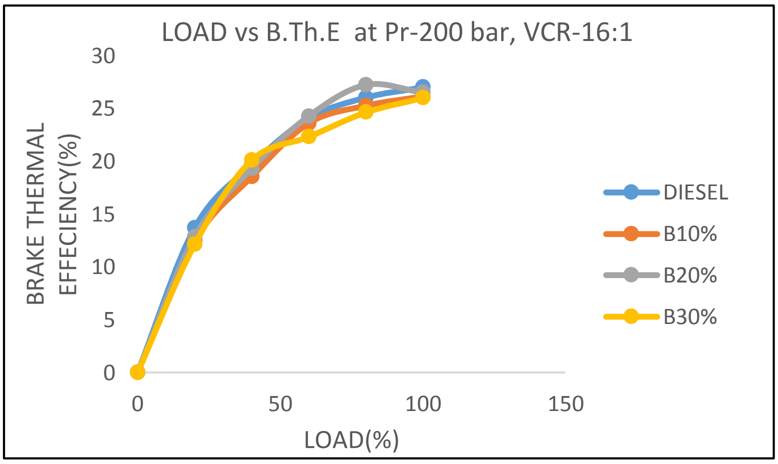

Fig: 6Vary of BTE with load at 200 bar IP and at VCR-16:1

The vary of BTE with load for diesel and blends at 200 bar IP and VCR 14:1 is shown in the Fig. 7.

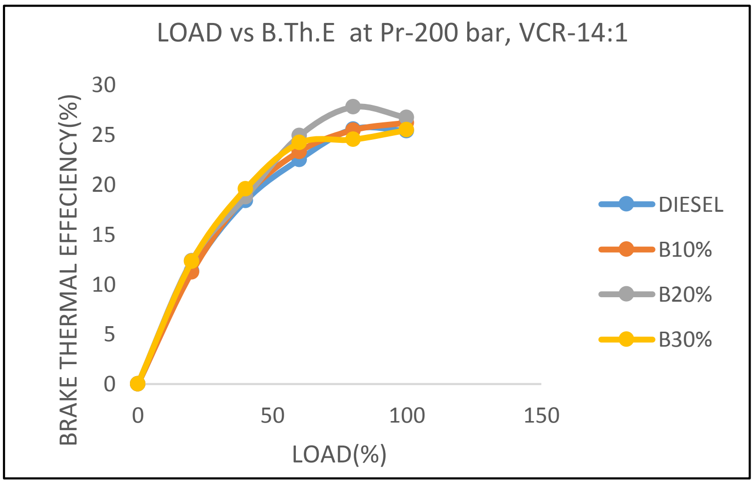

Fig: 7Vary of BTE with load at 200 bar IP and at VCR-14:1

The vary of BTE with load for diesel and blends at 180 bar IP and VCR 18:1 is shown in the Fig. 8.

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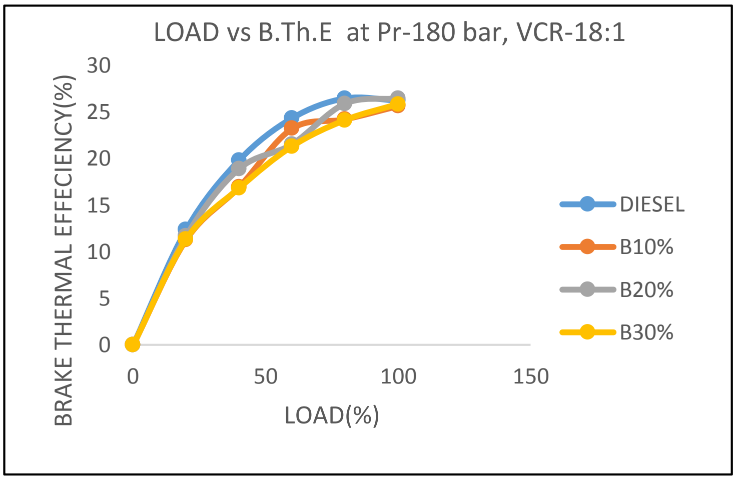

Fig: 8 Vary of BTE with load at 180 bar IP and at VCR-18:1

The vary of BTE with load for diesel and blends at 180 bar IP and VCR 16:1 is shown in the Fig. 9.

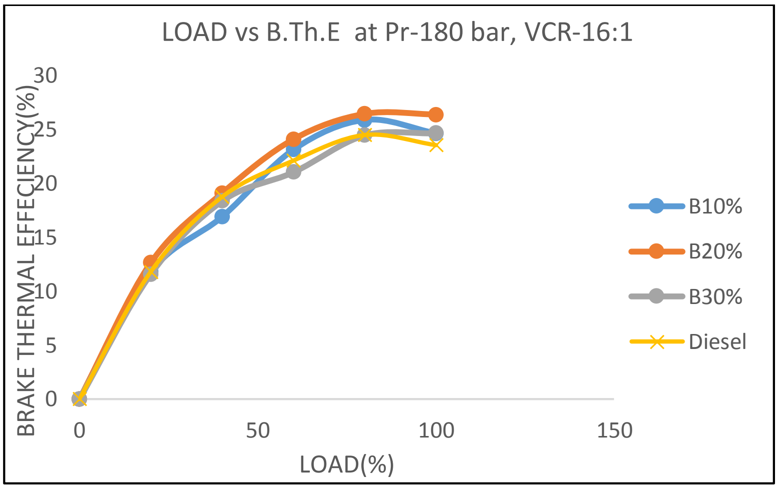

Fig: 9Vary of BTE with load at 180 bar IP and at VCR-16:1

The vary of BTE with load for diesel and blends at 180 bar IP and VCR 14:1 is shown in the Fig. 10.

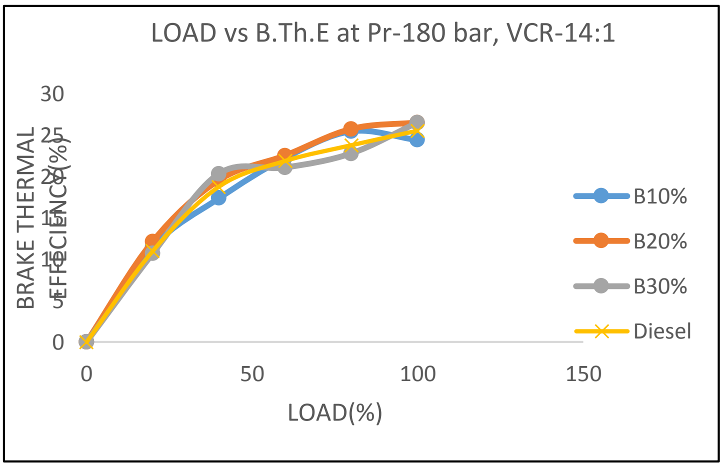

Fig: 10Vary of BTE with load at 180 bar IP and at VCR-14:1

The vary of HC with load for diesel and blends at 220 bar IP and VCR- 16:1 is shown in figure 11.

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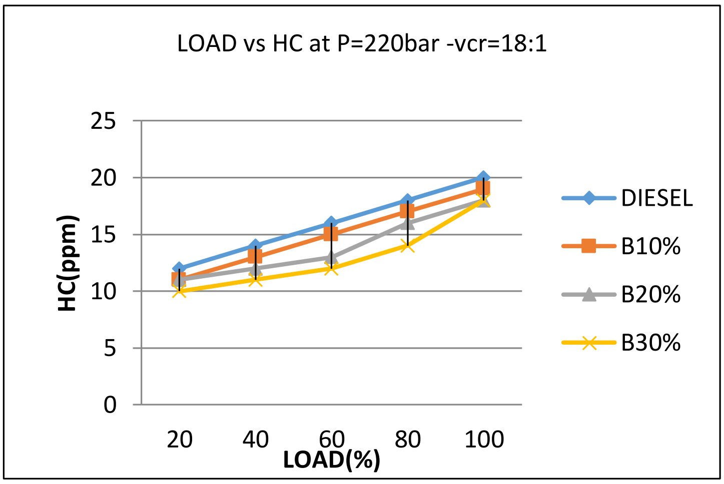

Figure: 11 Vary of HC with load at 220 bar IP and VCR-18:1

The vary of HC with load for diesel and blends at 220 bar IP and VCR-16:1 is shown in the Figure 12.

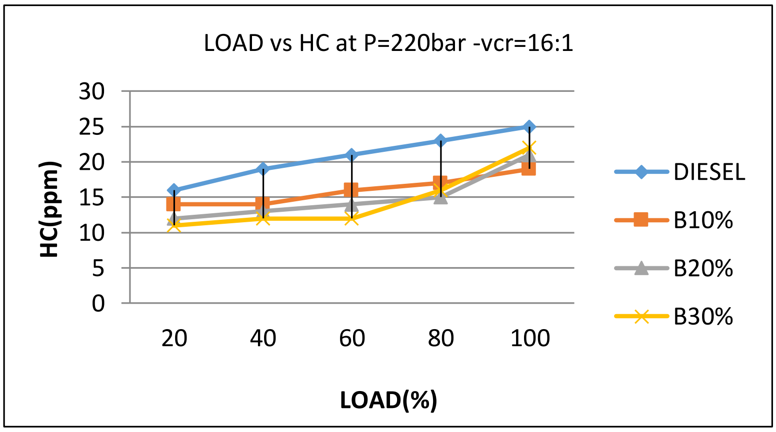

Figure:12VaryofHCwithloadat220barIPandVCR-16:1

The vary HC with load for diesel and blends at 220 bar IP and VCR-14:1 is shown in the Figure 13.

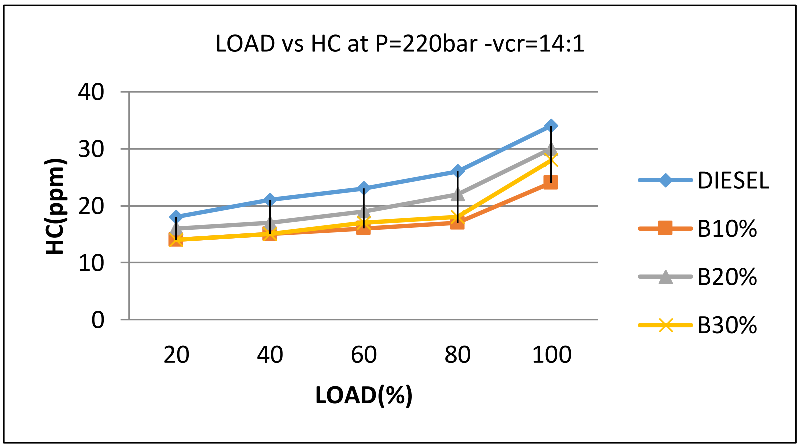

Figure: 13 Vary of HC with load at 220 bar IP and VCR-14:1

The vary of HC with load for diesel and blends at 200 bar IP and ratio VCR-18:1 is shown in the Figure 14.

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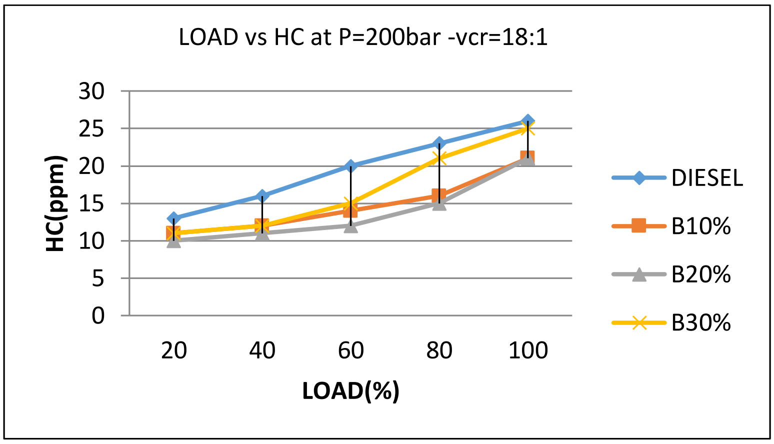

Figure: 14 Vary HC with load at 200 bar IP and VCR-18:1

The vary of HC with load for diesel and blends at 200 bar IP and VCR-16:1 is shown in the Figure 15.

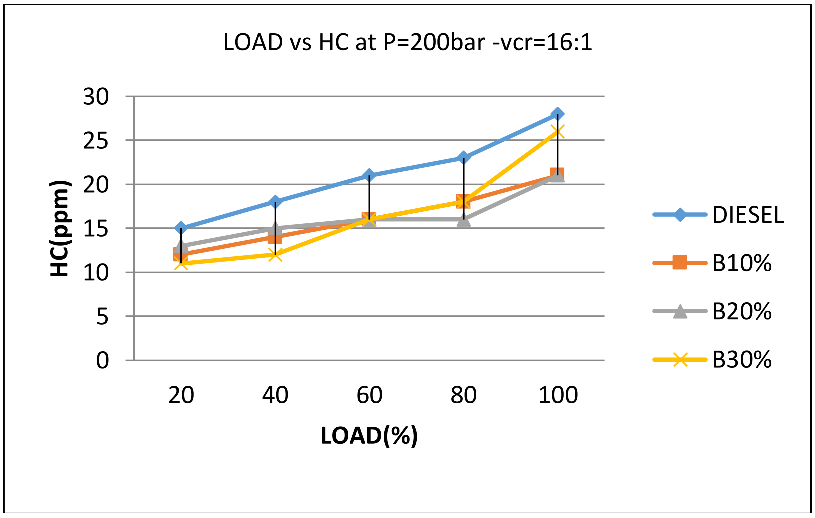

Figure: 15 Vary of HC with load at 200 bar IP and VCR-16:1

The vary of HC with load for diesel and blends at 200 bar IP and VCR-14:1 is shown in the Figure 16.

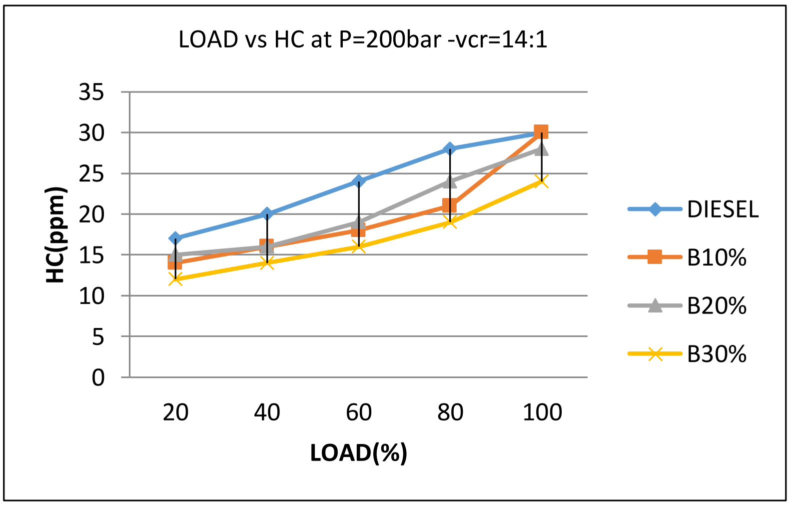

Figure: 16 Vary HC with load at 200 bar IP and VCR-14:1

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The vary HC with load for diesel and blends at 180 bar IP and VCR-18:1 is shown in the Figure 17.

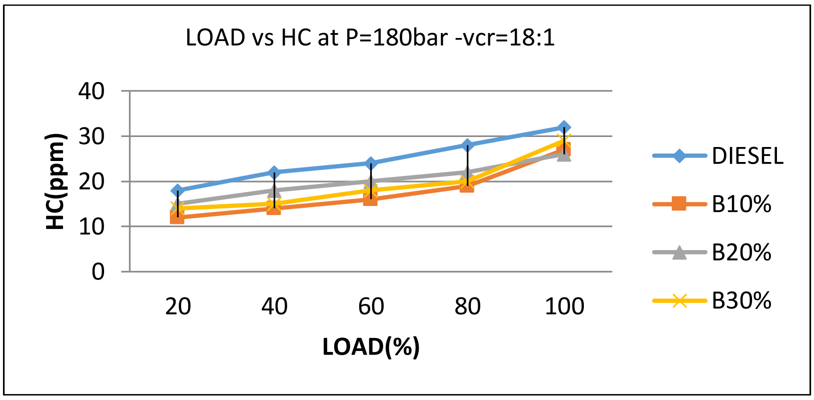

Figure: 17 Vary of HC with load at 180 bar IP and VCR-18:1.

The vary of HC with load for diesel and at 180 bar IP and VCR-16:1 is shown in the Figure 18.

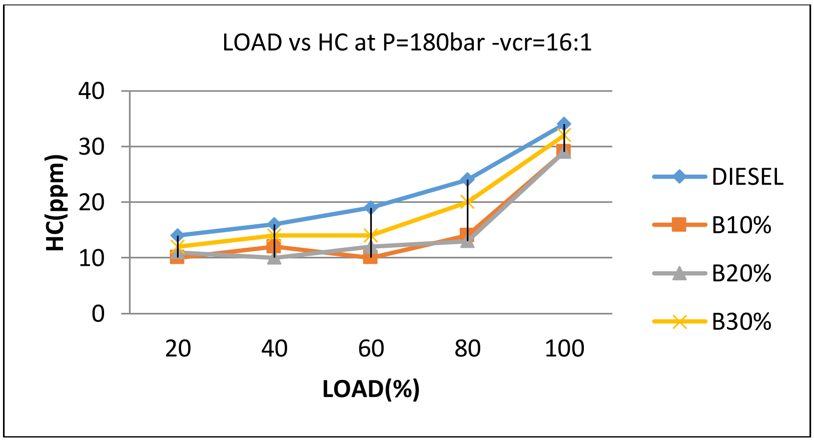

Figure: 18 Vary HC with load at 180 bar IP and VCR-16:1

The vary of HC with load for diesel and at 180 bar IP and VCR-14:1 is shown in the Figure 19.

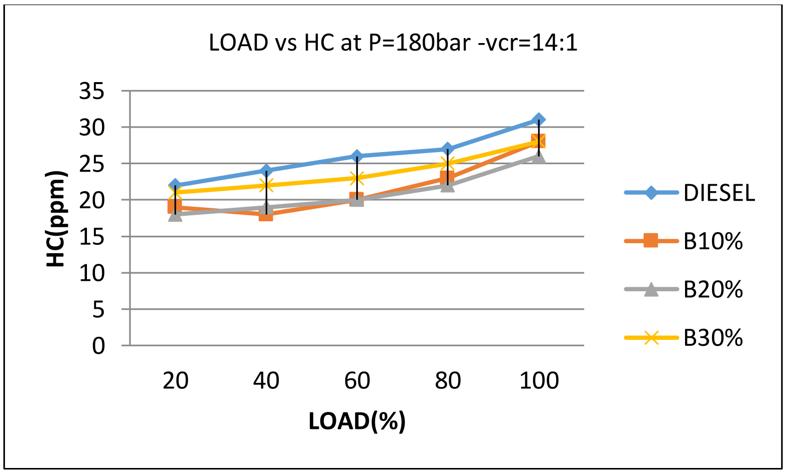

Figure: 19 Vary HC with load at 180 bar IP and VCR-14:1

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CONCLUSIONS

The emission characteristics of diesel, rice bran oil biodiesel-methanol blends were investigated at different injection pressures on a single cylinder computerized variable compression ratio diesel engine. The conclusions of this research work are as follows:

- The brake thermal efficiency of blend 10% was higher at 200 bar IP and at VCR 16:1 with load for all the fuel modes. The minimum brake thermal efficiency of diesel fuel was observed at 180 bar IP and at VCR 16:1 with load for all the fuel modes.
- The Hydro Carbon emissions were increased with increased of rice bran oil percentage in diesel-biodiesel-methanol blends and lower than those of the conventional diesel at all loads on the engine at all injection pressures and all compression ratios. The minimum CO emissions were observed with the blend B20% (5%methanol,15% rice bran oil) at 220 bar injection pressure and at VCR-14.

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