"PERFORMANCE AND EMISSION ANALYSIS OF DIESEL-ETHANOL-BIODIESEL BLEND ON CI ENGINE"

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ABSTRACT

Today use of fossil fuel is continuously increasing due to growth in industrialization and transportation section, for economic development of country and living standards. Hence there is need to find and alternative fuels to decrease the consumption of fossil fuel and reduce the emission emitted from fossil fuel which produces hazards effect on human health and environment. Ethanol and biodiesel are most suitable alternative for petroleum fuels since they are produced from renewable feedstock. A number of research works has being done on biodiesel and ethanol blends with diesel fuel at constant compression ratio to determine performance and emission characteristics. In this paper the research work is carried to study performance and emission analysis of diesel-ethanol-biodiesel blends (D90E5B5,D80E10B10 and D80E15B5) on Variable compression ratio engine at 0%,10%,25%,50%,75%,100% of maximum load and CR 16,17,18 respectively and result obtained are validated with pure diesel (D100)at same load and compression ratio. It is observed that BTE (brake thermal efficiency) increases with increase in load for blend D80E15B5 at compression ratio 16 at higher load. Also it is observed that CO_2 emission decreases with increase in load by 3.44%, 9.19% and 5.74% for blends D90E5B5, D80E10B10 and D80E15B5 at CR-16 respectively.

Keyword: - *Diesel, Biodiesel, Ethanol, VCR Engine, Brake thermal efficiency , HC, CO_2.*

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1. INTRODUCTION

The rapid growth in industrialization has increased the consumption of fossil fuel, due to this the fossil fuels are depleting at a fast rate. Also they are dominant to global sources of CO_2 emission, greenhouse gases and global warming. Hence there is need to find and alternative fuels which could reduce the consumption of fossil fuels as well as reduces the pollution problem. Lot of research work is done to find alternative fuels among the proposed alternative fuels biodiesel and ethanol are suitable fuels for diesel engines. In country like India which is known as land of agriculture, fuels like biodiesel and ethanol can be best alternative fuels. Since biodiesel can be produced from non-edible oilseeds which can be grown on non cropped marginal lands and waste lands so it will not affect the production of other edible sources. The production of biodiesel from non-edible oilseeds will lead additional income to farmers. Also the ethanol is produced from sugarcane. It is a low cost oxygenate with high oxygen content. The direct used of ethanol blend reduce the particulate matter due to increase in oxygen content also cold flow properties can be improved, but direct use of ethanol fuel lead to many technical barriers due to its low cetane number, low flash point and poor solubility. Also the direct use of biodiesel with diesel fuel lead to many technical barriers due to is high flash point, high viscosity and low calorific value. Thus to improve the solubility of ethanol in diesel fuel biodiesel can be added. This ternary blend can remains miscible for wide range of temperature [1].

2. EXPERIMENTAL SETUP

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for Pθ−PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand-alone panel box consisting of air box, two fuel tanks for duel fuel test, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement.

Fig- 1.1: Experimental Setup

The setup enables study of VCR engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption. Lab view based Engine Performance Analysis software package “Enginesoft_9.0” is provided for on line performance evaluation.

2.2 SETUP SPECIFICATIONS

Table-1: Specifications one engine setup

Product	Research Engine test setup 1 cylinder, 4 stroke, Multifuel VCR with open ECU for petrol mode (Computerized)
Product code	240PE
Engine Type	1 cylinder, 4 stroke, water cooled, stroke 110 mm, bore 87.5 mm. Capacity 661 cc.
	Diesel mode: Power 3.5 KW, Speed 1500 rpm, CR range 12-18 Injection variation:0-25^0 BTDC
	ECU Petrol mode: Power 3.5 KW @ 1500 rpm, Speed range 1200-1800 rpm, CR range 6-10
Dynamometer	Type eddy current, water cooled, with loading unit
Air box	M S fabricated with orifice meter and manometer
Fuel tank	Capacity 15 lit, Type: Duel compartment, with fuel metering pipe of glass
Piezo sensor	Combustion: Range 5000 PSI, with low noise cable
	Diesel line: Range 5000 PSI, with low noise cable
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Sensors for ECU	Air temp, coolant temp, Throttle position and trigger.
Engine Control hardware	Fuel injector, Fuel pump, ignition coil, idle air
Digital voltmeter	Range 0-20V, panel mounted
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	Type two wire, Input RTD PT100, Range 0–100 Deg C,
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Fuel flow transmitter	DP transmitter, Range 0-500 mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250 mm WC
Software	"Enginesoft" Engine performance analysis software
Rotameter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH

3. RESULTS AND DISCUSSION

3.1Performance Characteristics

3.1.1 Volumetric Efficiency

It is defined as the ratio of actual volume of air fuel mixture drawn into the cylinder at atmospheric pressure to the volume of cylinder. It indicates the breathing capacity of engine.Chart 1.1, 1.2, 1.3 shows the variation of volumetric efficiency with load for CR 16,17and 18 respectively. It is observed that initially at low load volumetric efficiency is higher but as load increases the volumetric efficiency goes on decreasing for all blended fuel at CR 16, 17 and 18 respectively. It is observed that volumetric efficiency of blend D80E15B5 is closer to pure diesel at all compression ratio.

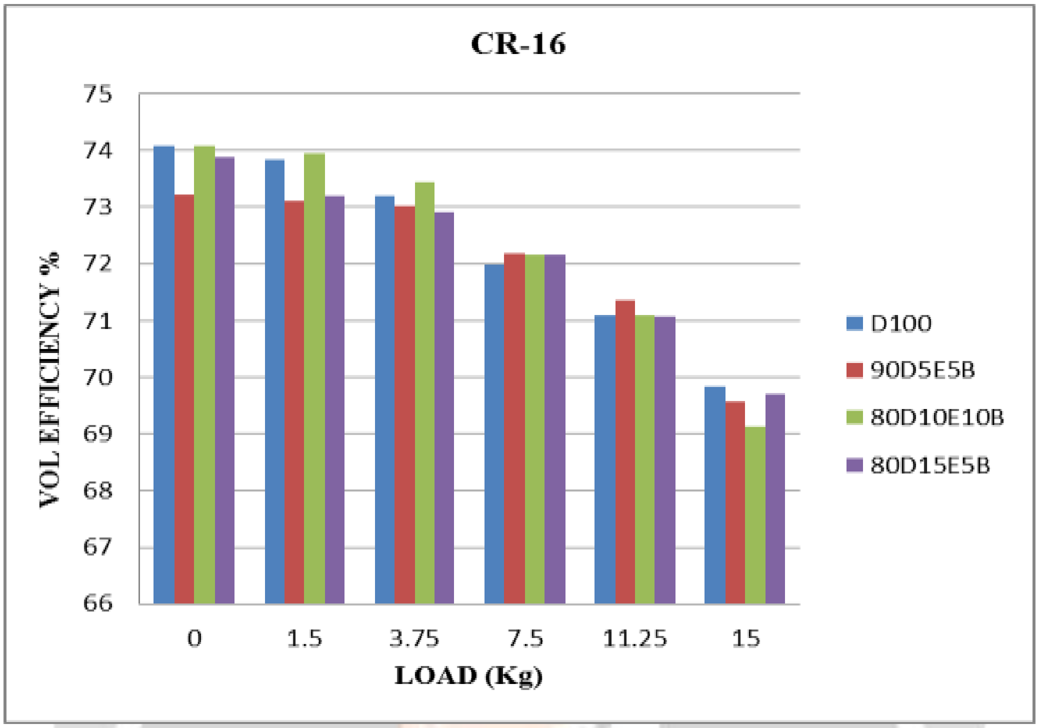

Chart 1.1: Variation of volumetric efficiency with load at 16

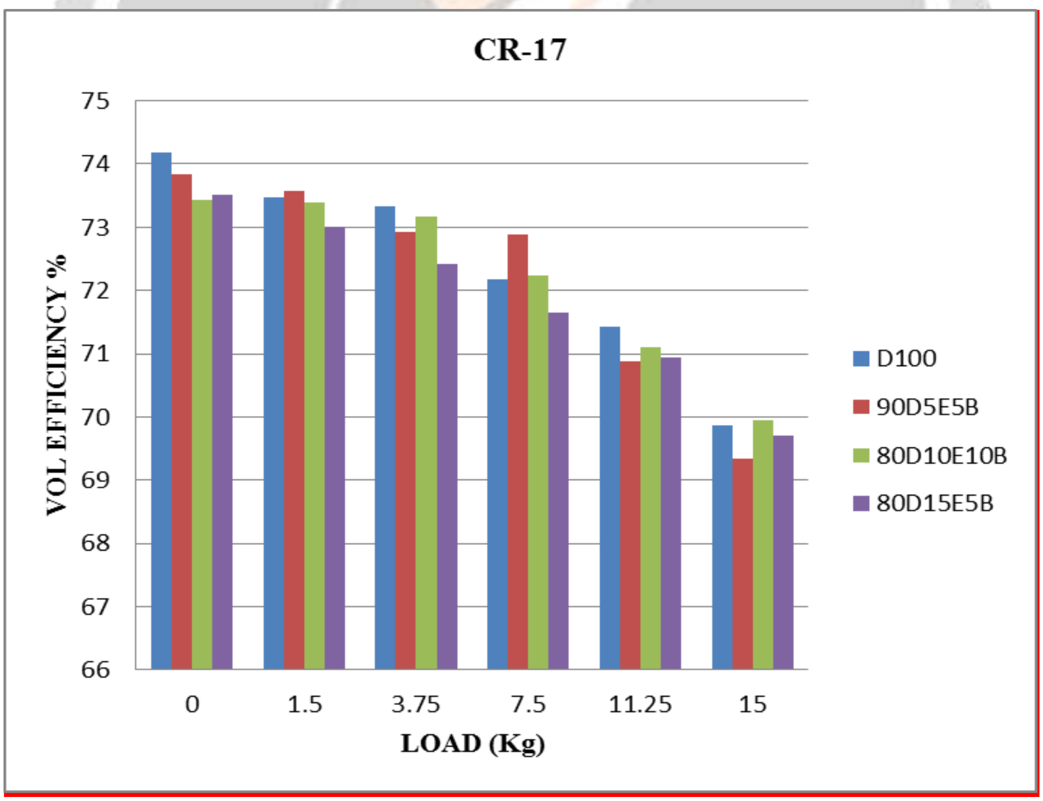

Chart 1.2: Variation of volumetric efficiency with load at CR 17

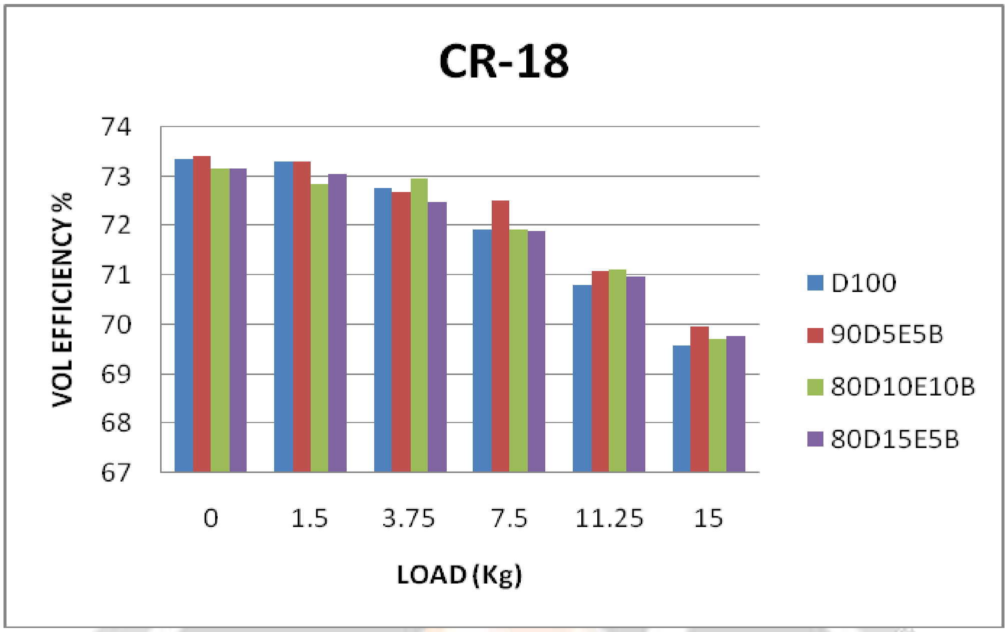

Chart 1.3: Variation of volumetric efficiency with load at CR 18

3.1.2 Brake Thermal Efficiency

It is the ratio of output i.e. BP to that of the chemical energy of fuel supplied. Chart 1.4, 1.5, 1.6 shows variation of BTE with load for CR, 16, 17 and 18. From the chart, it is observed that in comparison with DF, the BTE of all blended fuels get increased with load.

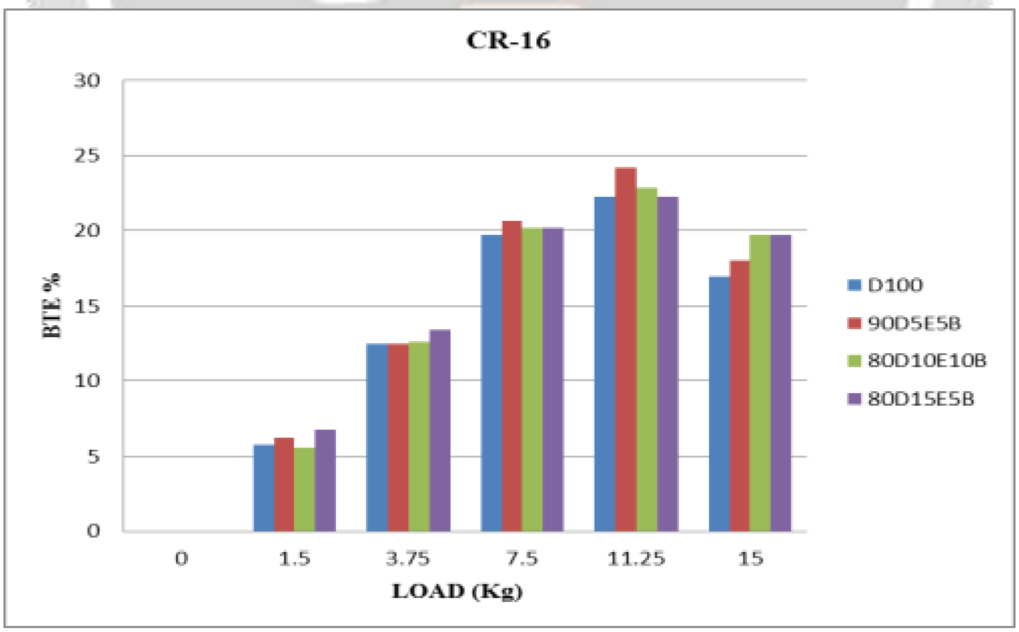

Chart 1.4: Variation of BTE with load at CR 16

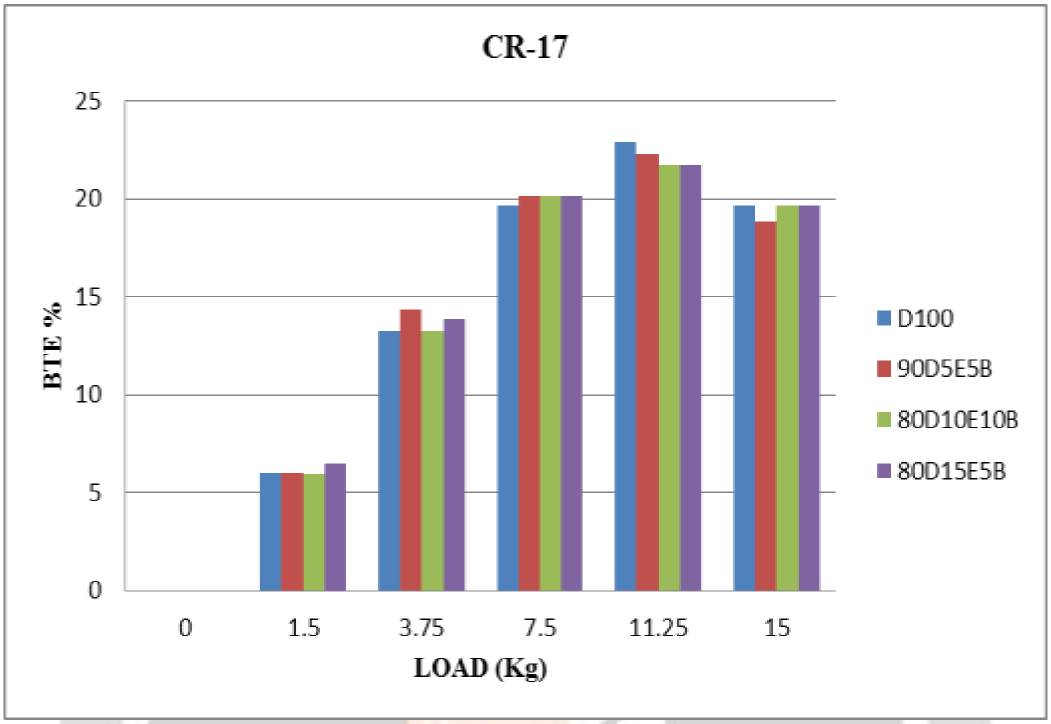

Chart 1.5: Variation of BTE with load at CR 17

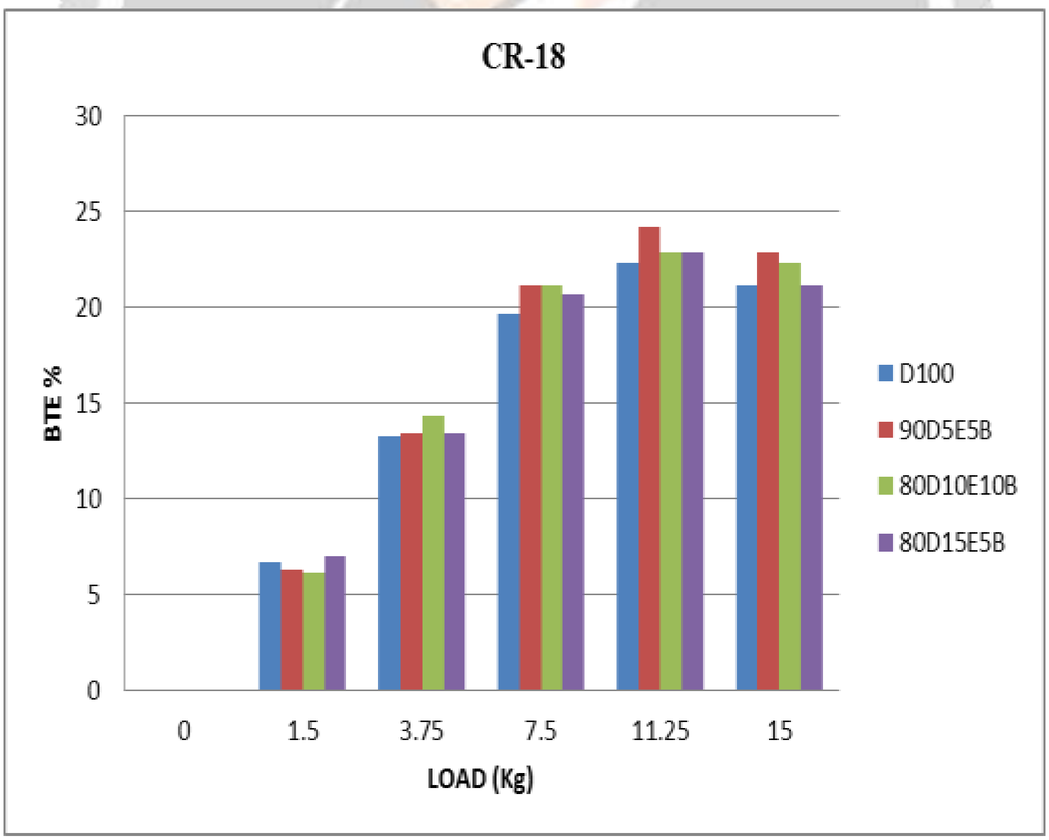

Chart 1.6: Variation of BTE with load at CR 18

3.2 EMISSION CHARACTERISTICS

3.2.1 Smoke Emissions

The particulate matter (PM) is essentially composed of soot, though some hydrocarbons, generally referred to as a soluble organic fraction (SOF) of the particulate emissions, are also adsorbed on the particle surface or simply emitted as liquid droplets. Chart 1.7,1.8, 1.9 shows variation of smoke emissions with load for CR-16, CR-17 and CR-18. It is observed that for CR-16 at load 15kg the smoke emission are decreased by 22.44%, 54.57% and 51.52% for blends D90E5B5, D80E10B10 and D80E15B5 respectively compared to pure diesel. Also smoke emission are decreased with load for blends D90E5B5, D80E10B10 and D80E15B5 for CR-17 and 18 respectively compared to pure diesel.

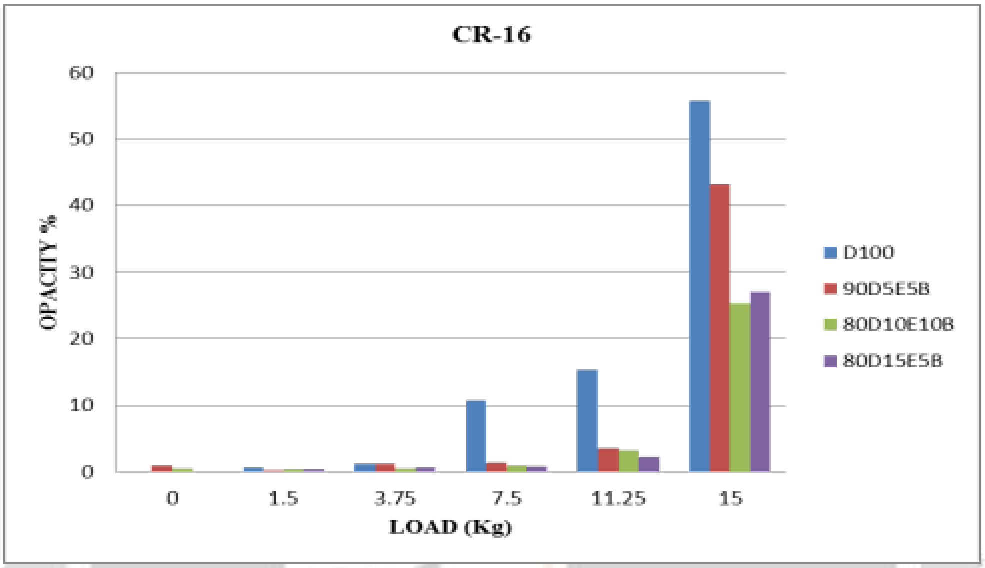

Chart 1.7: Variation of Smoke Emissions with load at CR 16

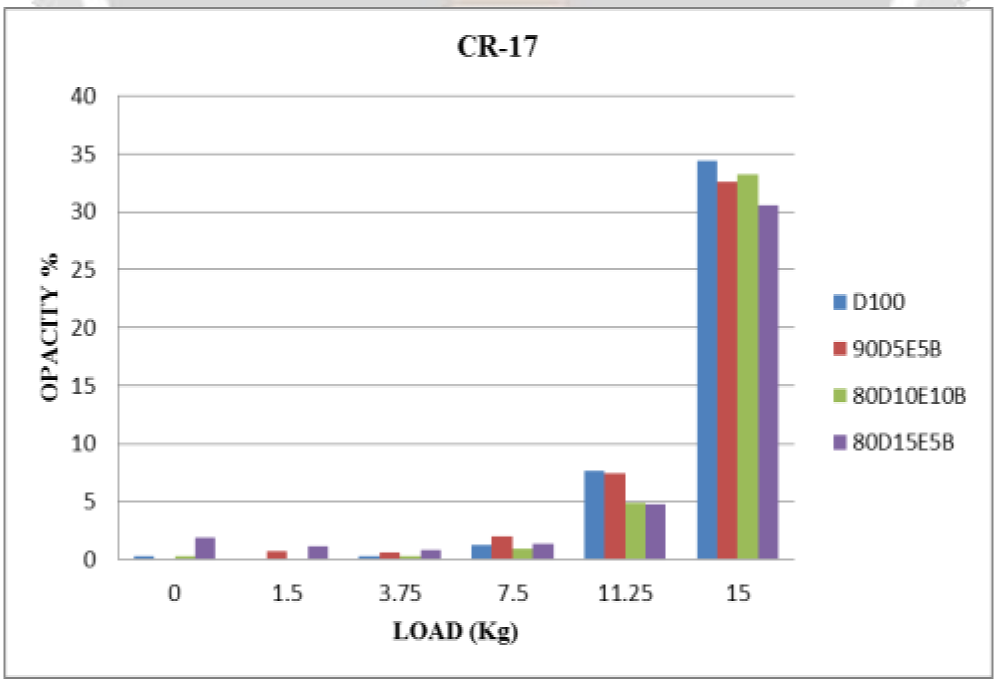

Chart 1.8 : Variation of Smoke Emissions with load at CR 17

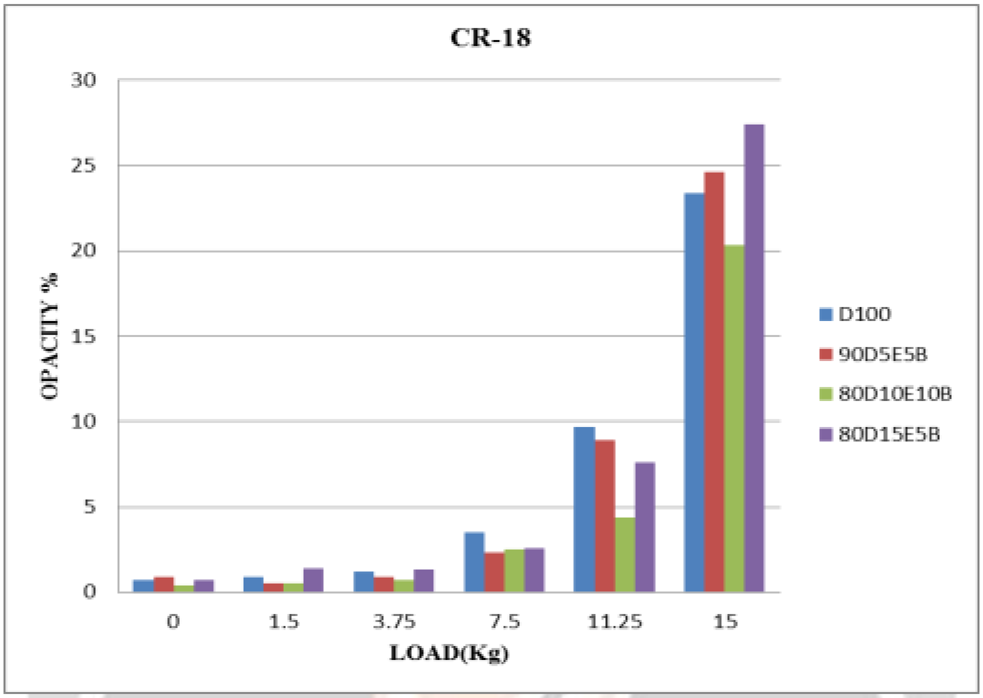

Chart 1.9 : Variation of Smoke Emissions with load at CR 18

3.2.2 Emissions of Carbon dioxide (CO_2)

Chart 1.10, 1.11, 1.12 shows variation of emissions of CO_2 with load for all fuels and CR. It is observed that CO_2 emission decreases with increase in load by 3.44%, 9.19% and 5.74% for blends D90E5B5, D80E10B10 and D80E15B5 respectively. Also for CR-17 and CR-18 there is decrease in CO2 emission with increase in load.

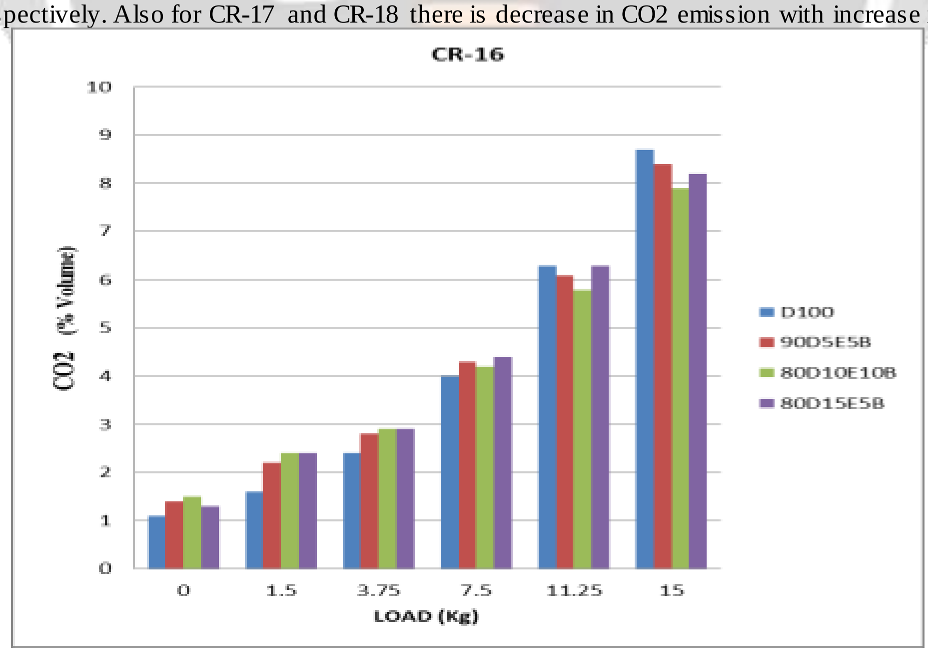

Chart 1.10 : Variation of CO_2 emissions with load at CR 16

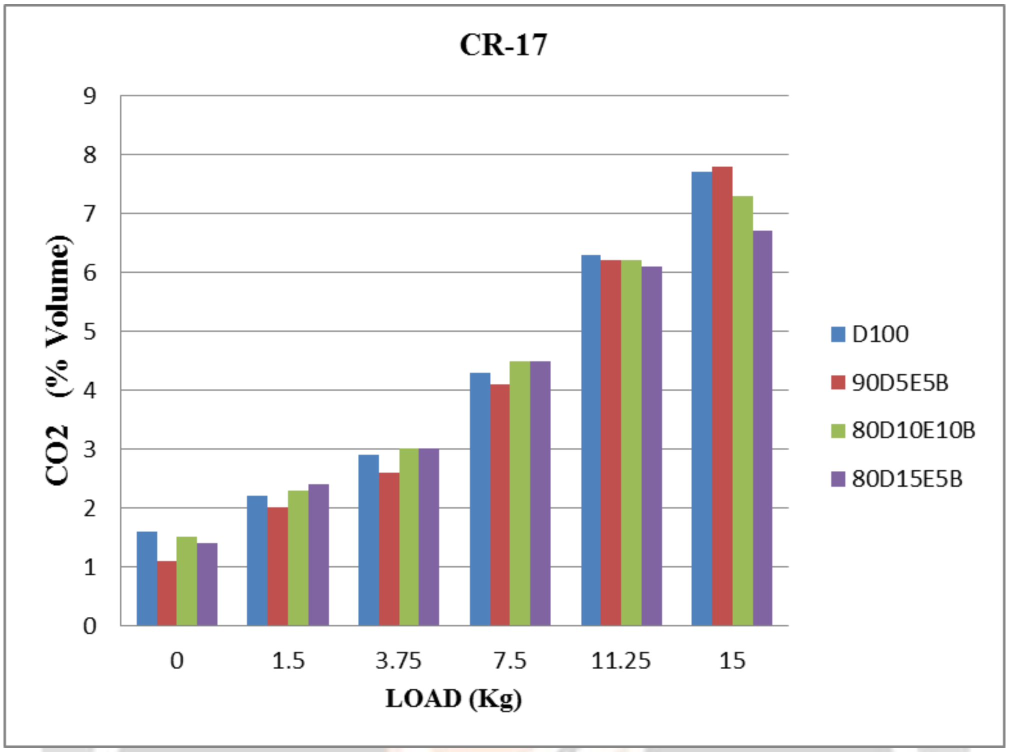

Chart 1.11: Variation of CO_2 emissions with load at CR 17

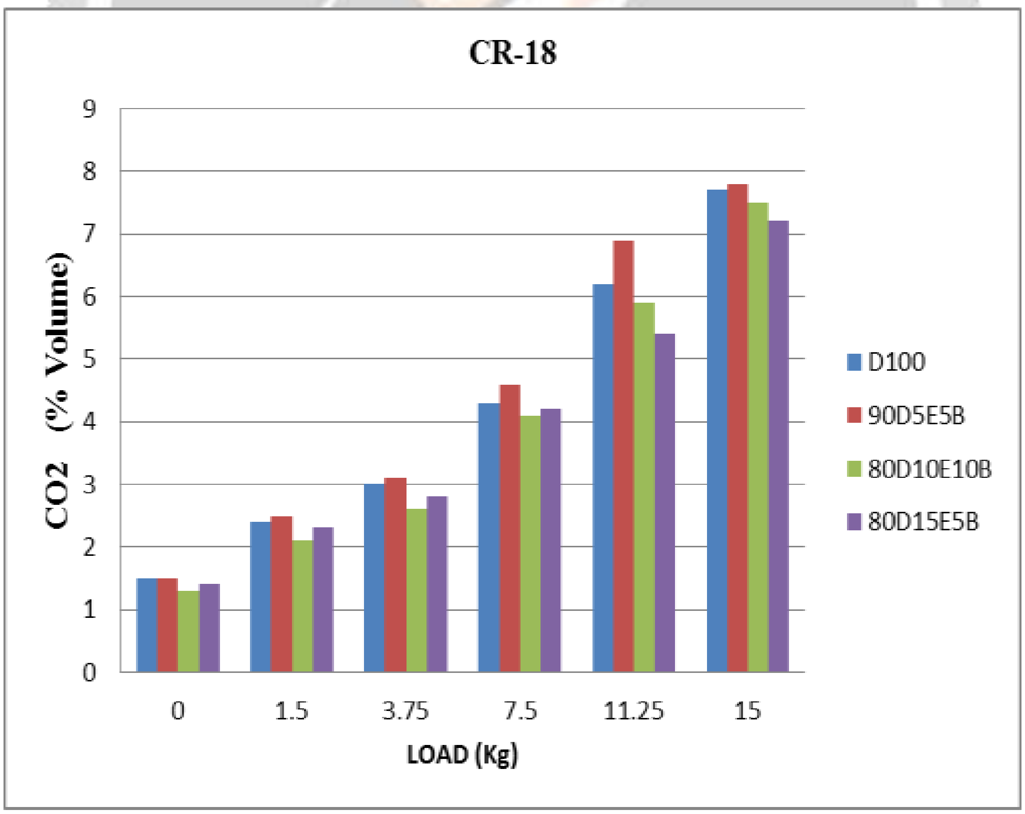

Chart 1.12 : Variation of CO_2 emissions with load at CR 18

4. CONCLUSIONS

Following conclusion is obtained by taking trial on variable compression ratio engine for blends D90E5B5, D80E10B10 , D80E15B5 and D100.

1. Volumetric Efficiency is at high at low load but as load increases the volumetric efficiency goes on decreasing for all blended fuel at CR 16, 17 and 18 respectively.
2. Brake thermal efficiency of all blended fuels goes on increasing with increase in load compared to pure diesel.
3. Smoke emission are decreased by 22.44%,54.57% and 51.52% for blends D90E5B5, D80E10B10 and D80E15B5 respectively compared to pure diesel at CR-16.
4. CO_2 emission decreased with increase in load by 3.44%, 9.19% and 5.74% for blends D90E5B5, D80E10B10 and D80E15B5 respectively at CR-16. Also for CR-17 and CR-18 there is decrease in CO_2 emission with increase in load.

5. REFERENCES

[1]. Dattatray Bapu Hulwan , Satishchandra V. Joshi., Performance, emission and combustion characteristic of a multicylinder DI diesel engine running on diesel–ethanol–biodiesel blends of high ethanol content , Applied Energy , 2011, 88, pp. 5042–5055.

[2]. D. H. Qi , H. Chen, L. M. Geng, Y. ZH. Bian, X. CH. Ren ., Performance and combustion characteristics of biodiesel–diesel–methanol blend fuelled engine, Applied Energy , 2010, 87, pp. 1679–1686.

[3]. K. Cheenkachorn and B. Fungtammasan., An Investigation of Diesel-Ethanol-Biodiesel Blends for Diesel Engine: Part 2—Emission and Engine Performance of a Light-Duty Truck, Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 2010, 32, pp.894–900.

[4]. Istvan Barabas , Adrian Todorut , Doru Ba ldean., Performance and emission characteristics of an CI engine fueled with diesel–biodiesel–bioethanol blends, Fuel ,2010, 89, pp. 3827–3832.

[5].R.E. Tate, K.C. Watts , C.A.W. Allen, K.I. Wilkie., The viscosities of three biodiesel fuels at temperatures up to 300 C, Fuel , 2006, 85, pp. 1010–1015.

[6]. A. E. Atabani , A. S. Silitonga , Irfan Anjum Badruddin , T. M . I. Mahlia , H. H. Masjuki , S. Mekhilef., A comprehensive review on biodiesel as an alternative energy resource and its characteristics , Renewable and Sustainable Energy Reviews , 2012, 16, pp. 2070– 2093.

[7]. Nadir Yilmaz., Comparative analysis of biodiesel-ethanol-diesel and biodiesel-methanol-diesel blends in a diesel engine, Energy , 2012, 40, pp. 210-213.

[8].Mario L. Randazzo , Jose R. Sodre ., Exhaust emissions from a diesel powered vehicle fuelled by soybean biodiesel blends (B3–B20) with ethanol as an additive (B20E2–B20E5), Fuel , 2011, 90, pp. 98–103.

[9]. Lei Zhu , C. S. Cheung , W. G. Zhang , Zhen Huang ., Combustion, performance and emission characteristics of a DI diesel engine fueled with ethanol–biodiesel blends , Fuel , 2011, 90, pp. 1743–1750.