Combined Effect of EGR and VCR of Rapeseed Oil Methyl Ester – Butanol blend on Performance Characteristics of Diesel Engine

Pratik V. Swami
PG Student
Department of Mechanical Engineering
Dr. J. J. Magdum College of Engineering Jaysingpur

S. M. Shaikh
Assistant Professor
Department of Mechanical Engineering
Dr. J. J. Magdum College of Engineering Jaysingpur

A. M. Vibhute
Assistant Professor
Department of Mechanical Engineering
Women's Polytechnic Tasgaon

Abstract

The purpose of this work is to find out the combined effect of exhaust gas recirculation (EGR), variable compression ratio (VCR) and blending of butanol on the performance characteristics of diesel engine and comparing the results with diesel and biodiesel fuel. The rapeseed oil methyl ester (ROME) blended with butanol with 10% and 20% by volume basis at EGR 0%, 5%, 10%, 15% and variable compression ratio 14,16,18 respectively. Density and viscosity of ROME is decreased with increase in blending of butanol. As compare to diesel the butanol blended fuel shows less brake power, brake thermal efficiency and mechanical efficiency on the other hand more specific fuel consumption.

Keywords: VCR, EGR, Biodiesel, Butanol

I. INTRODUCTION

As we know reserves of fossil fuel is decreasing day by day which is caused by rapid increase in consumption of energy has increasing the use of alternative fuels as replacement of non-renewable fossil fuels such as diesel and gasoline. For the energy saving diesel engine has high thermal efficiency than gasoline engine therefore for transportation and industrial purposes diesel engine is used. Because of less reserves of fossil fuel many researchers are beginning to investigate the performance of biofuels on diesel engine[1]. There are many researchers have investigated the engine performance in diesel engine fueled with diesel-butanol blend at various EGR rate, but there are very few researches are done on the performance parameter with biodiesel-butanol blend in combination with EGR and VCR[2-6]. EGR is effective technology which is mainly used for reducing NOx emission, now a day's many vehicles are adopted these technology.

The main objective of these work is to check the feasibility of rapeseed oil methyl ester and butanol blend in diesel engine and compare different engine performance parameters such as brake power, brake thermal efficiency, mechanical efficiency and specific fuel consumption at various EGR and VCR rate.

ABBREVIATIONS

CR	Compression ratio	Bu	Butanol	ME	Mechanical efficiency
VCR	Variable compression ratio	BP	Brake power		
EGR	Exhaust gas recirculation	BTE	Brake thermal efficiency		
ROME	Rapeseed oil methyl ester	SFC	Specific fuel consumption.		

A. *Properties of Fuels*

Table - 1
Properties of Fuels

Test Description	*B100 [8]*	*B90Bu10*	*B80Bu20*
Density	*0.876*	*0.868*	*0.861*
calorific value	*38.50*	*38.01*	*36.50*
cetane no	*51.10*	*50.50*	*50.20*
Viscosity	*5.40*	*4.70*	*4.80*
moisture	*NA*	*NA*	*NA*
Flash point	*163*	*13*	*138*

Fire point	*171*	*139*	*145*
Cloud point	*3*	*5*	*6*
Pour point	*1*	*1*	*1*
Ash	*0.050*	*0.050*	*0.050*

II. EXPERIMENTAL SETUP AND PROCEDURE

The Experiment is performed on four stroke, single cylinder variable compression ratio diesel engine.

1) Ensure that all the nut bolts of engine, dynamometer, propeller shaft and base frame are properly tightened.
2) Ensure the sufficient lubrication oil is present in the engine sump tank this can be checked by marking on the level stick
3) Ensure sufficient fuel in fuel tank. Remove air in fuel line, if any
4) Switch on electric supply and ensure that DLU (Dynamometer loading unit), Load indicator and Voltmeter are switched on.
5) Start water pump. Adjust the flow rate of "Rotameter (Engine)" to 250-350LPH and "Rotameter (Calorimeter)" to 75-100 LPH by manipulating respective globe valves provided at the rotameter inlet. Ensure that water is flowing through dynamometer at a pressure of @ 0.5 to 1 Kg/cm^2.
6) Adjust the required compression ratio.
7) Start the set up and run the engine at no load for 4-5 minutes.
8) Note down the observations for no load condition.
9) Note down the fuel consumption per 50cc of fuel.
10) Gradually increase the load to 12 kg on the engine by rotating dynamometer loading unit.
11) Wait for steady state (for @ 3 minutes) and collect the reading at full loads.
12) According to flow rate calculate the required air flow for 5 and 10% of EGR and adjust the valve by manual operation.
13) Gradually decrease the load to zero.
Repeat the procedure for all readings.

III. RESULT AND DISCUSSION

Effect of EGR and VCR using different fuels on performance characteristics

A. Brake Power

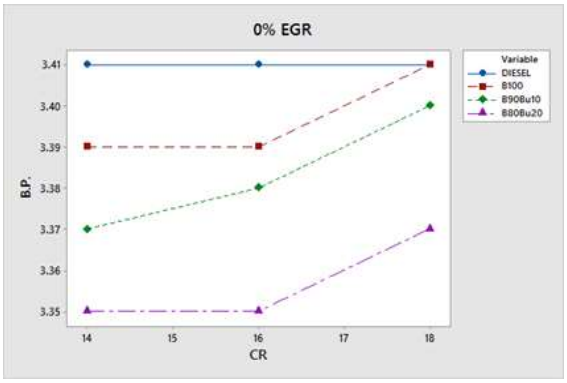

Fig. 3.1: BP at 0% EGR

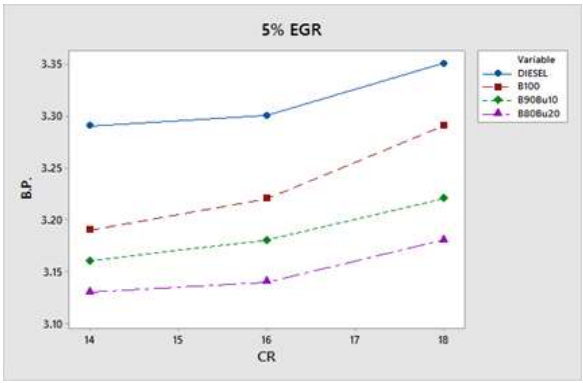

Fig. 3.2: BP at 5% EGR

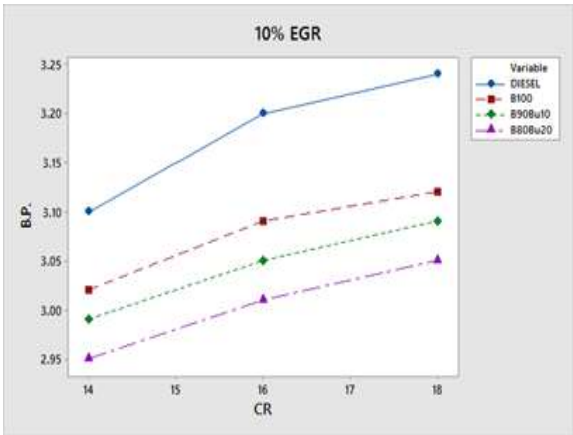

Fig. 3.3: BP at 10% EGR

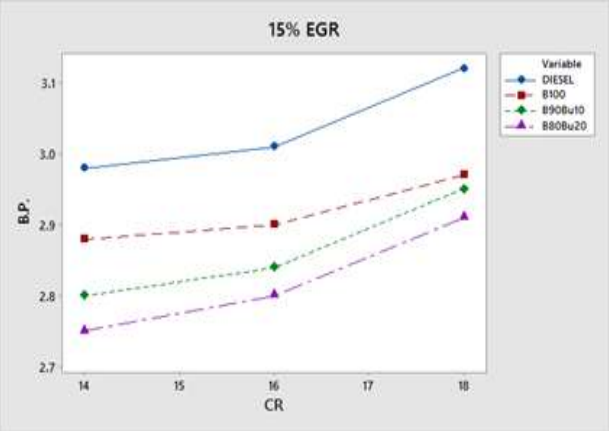

Fig. 3.4: BP at 15% EGR

From the results it is shown that rapeseed oil methyl ester shows maximum brake power than the other blended fuels as the n-butanol is added in ROME the BP is reduced as compared to the ROME. As EGR increases the brake power decreases, on the other hand as CR increases the brake power is increases for all fuels

B. Specific Fuel Consumption

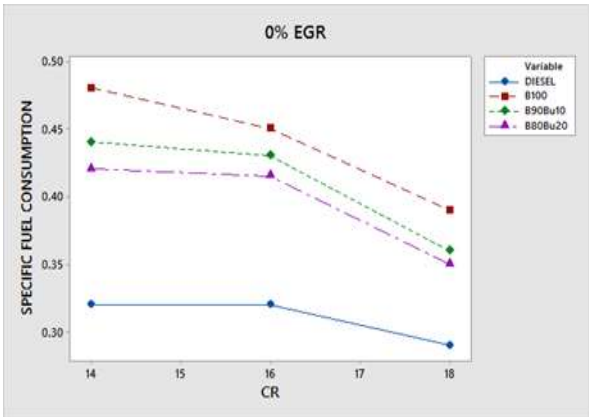

Fig. 3.5: SFC at 0% EGR

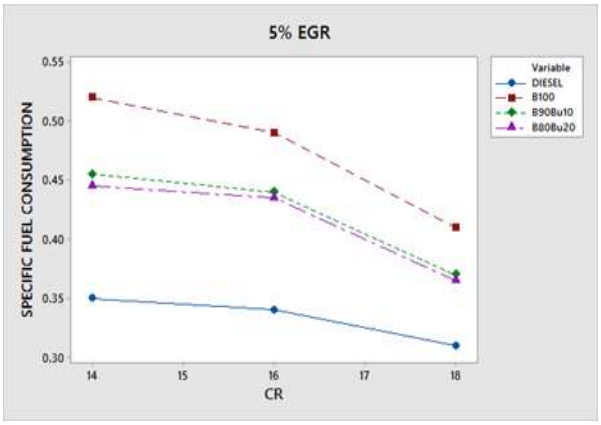

Fig. 3.6: SFC at 5% EGR

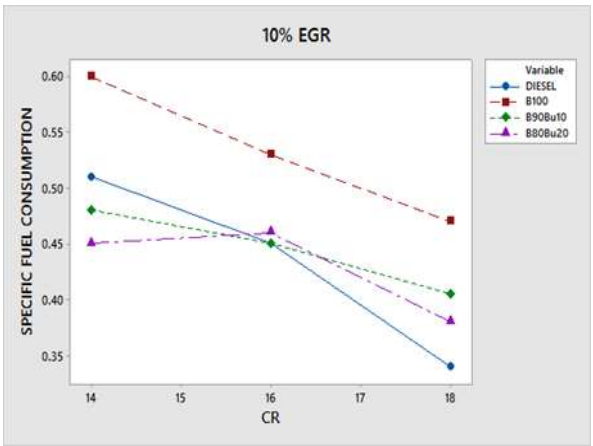

Fig. 3.7: SFC at 10% EGR

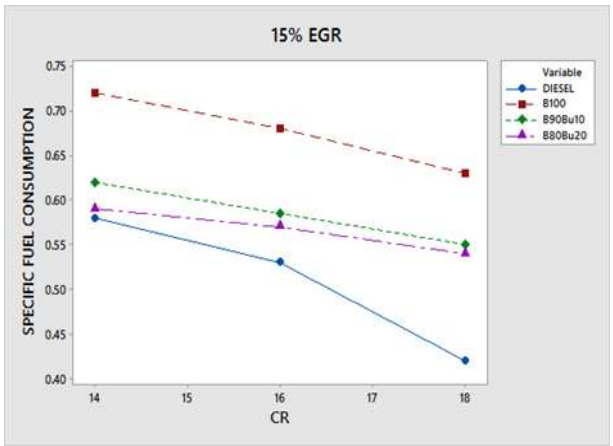

Fig. 3.8: SFC at 15% EGR

It is observed that specific fuel consumption are higher at low compression ratio and lesser at high compression ratio for various fuels, as EGR is increased the specific fuel consumption is also increased while the SFC is decreases as the compression ratio is increases.B100 shows the maximum fuel consumption for various EGR and VCR rate, as the butanol is added in ROME the SFC is decreased.

C. *Brake Thermal Efficiency*

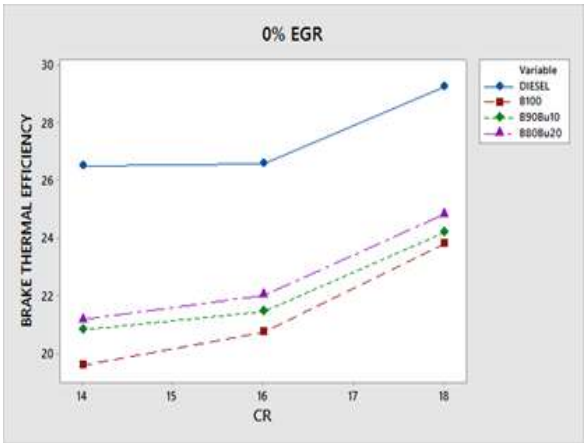

Fig. 3.9: BTE at 0% EGR

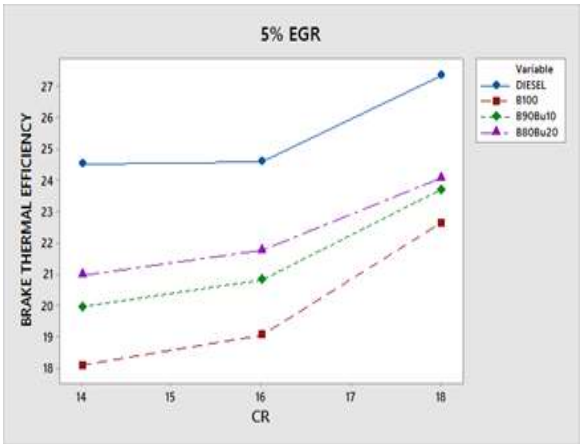

Fig. 3.10: BTE at 5% EGR

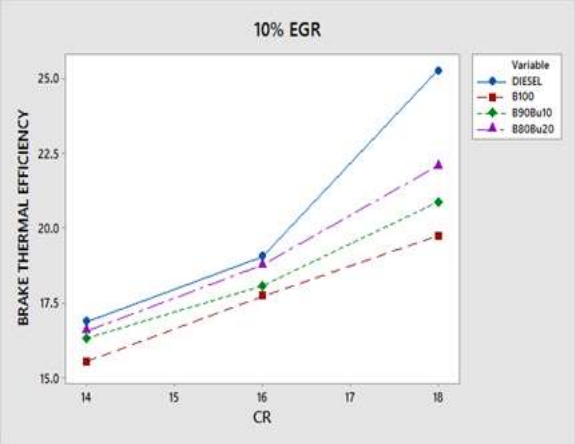

Fig. 3.11: BTE at 10% EGR

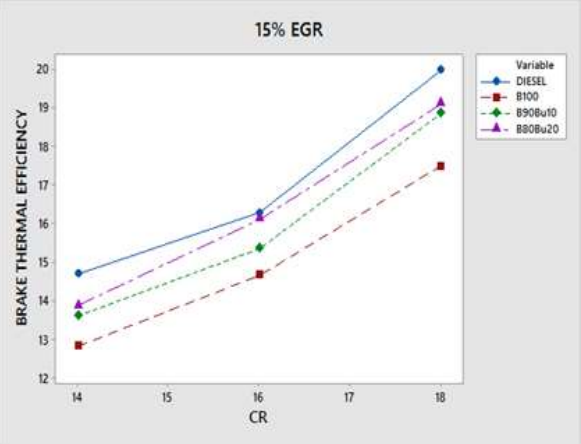

Fig. 3.12: BTE at 15% EGR

It can be observed from the fig. 9-12 that brake thermal efficiency increases as the CR is increases for all tested fuels it is because of the complete combustion of fuel at higher CR. It is also observed that the butanol blend is increases in ROME then the brake power is decreases, also the BTE decreases as the percentage of EGR increases.

D. *Mechanical Efficiency*

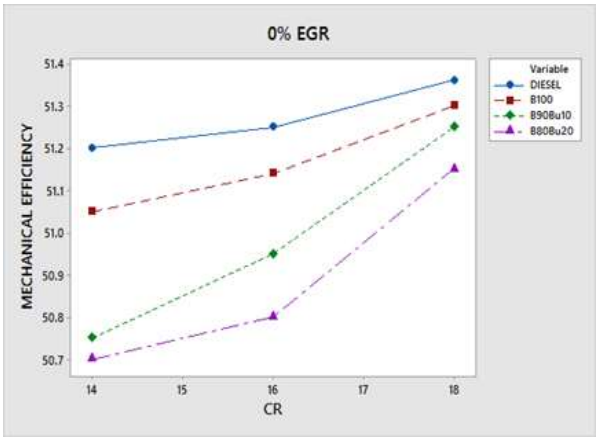

Fig. 3.13: ME at 0% EGR

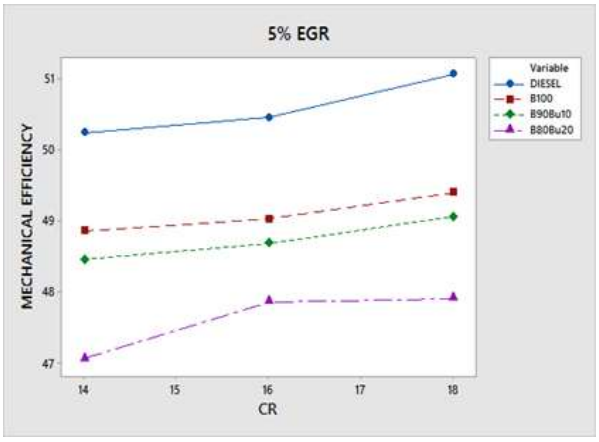

Fig. 3.14: ME at 5% EGR

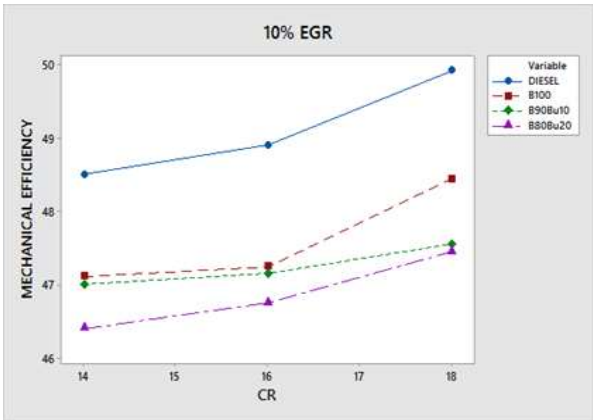

Fig. 3.15: ME at 10% EGR

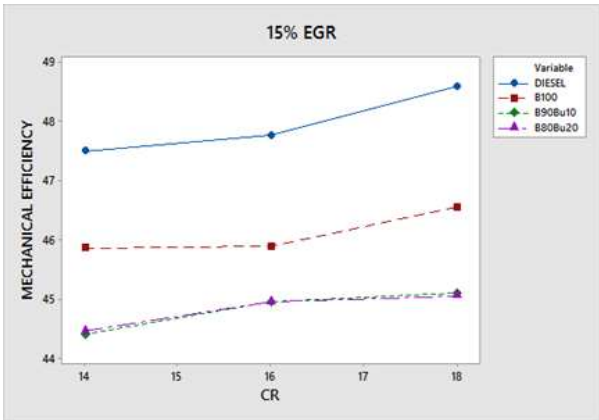

Fig. 3.16: ME at 15% EGR

It is observed from fig. 13-16 that the mechanical efficiency is increases for all fuel as the CR is increases while it decreases for all tested fuels as EGR is increases, also for increase in EGR the CO_2 emission is increased.

IV. CONCLUSION

This study shows that rapeseed oil methyl ester – butanol blend can be used as an alternative for a diesel fuel successfully with variable compression ratio diesel engine and various EGR without any modification to engine. According to the results obtained from the present investigation using diesel, biodiesel and biodiesel blend with EGR following conclusion may be drawn:

1) Brake power are reduced by 12% at 15% EGR compared to that of neat diesel due to reduced oxygen availability. Also 20% butanol addition causes 7% less BP compared to the ROME. CR18 showing the maximum brake power for all fuels.
2) SFC is reduced by 35%when CR is increased from 14 to 18 also butanol addition shows a small decrease in SFC. At CR 18 all tested fuels shows minimum specific fuel consumption.
3) BTE is increases by 17%when CR is increased from 14-18 also butanol addition shows a 14% increase BTE. At CR 18 all tested fuels shows maximum BTE.
4) Mechanical efficiency slightly increased as CR is increased .for diesel fuel CR 18 shows the optimum result, also EGR shows small decrease in mechanical efficiency. As butanol addition is increased the mechanical efficiency is decreased in small extent.

REFERENCES

[1] Mohammed EL_Kassaby, Medhat A Nemit_allah. Studying the effect of compression ratio on an engine fueled with waste oil produced biodiesel/diesel fuel. Alexandria Engineering Journal; Volume 52, Issue 1, March 2013, P.1–11.
[2] Sejal Narendra Patel, Ravindra Kirar. An Experimental Analysis of Diesel Engine Using Biofuel at Varying Compression Ratio. International Journal of Emerging Technology and Advanced Engineering; Volume 2, Issue 10, October 2012, ISSN 2250-2459.
[3] M. K. Duraisamy, T. Balusamy, T. Senthilkumar. Effect of Compression Ratio on CI Engine Fueled With Methyl Ester of Thevetia Peruviana Seed Oil. ARPN Journal of Engineering and Applied Sciences; Vol. 7, No. 2, February 2012, ISSN 1819-6608.
[4] R. Anand, G.R. Kannan, K. Rajasekhar Reddy, S. Velmathi. The performance and emissions of a variable compression ratio diesel engine fuelled with bio-diesel from cotton seed oil. ARPN Journal of Engineering and Applied Sciences; Vol 4, p. 72-86, 2009.
[5] Kass MD, Thomas JF, Wilson D, Lewis SA. Assessment of corrosivity associated with exhaust gas recirculation in a heavy-duty diesel engine. SAE Paper No. 2004-05-660; 2004.
[6] T. Ashok Kumar, R.chandramouli, T.Mohanraj. A study on the performance and emission characteristics of esterified pinnai oil tested in VCR engine. Ecotoxicology and Environmental safety. 95 (2015) 101-106.(ELSEVIER)
[7] Polu Vidya Sagar, Lokesh Agarwal, M.V.L sravan Kumar, K.Nanthagopal. "Effect of EGR on Emission from a single cylinder Diesel Engine using Jatropha biodiesel blends" IEEE 2013
[8] Mr. S. S. Sajane , Prof. S. M. Shaikh , Dr. S. N. Bobade, "Experimental Investigation of Rapeseed Oil Methyl Ester Powered by Variable Compression Ratio (VCR) Diesel Engine with Effect of Exhaust Gas Recirculation (EGR), IJIRST –International Journal for Innovative Research in Science & Technology| Volume 3 | Issue 02 | July 2016 ISSN (online): 2349-6010