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Effect of Various Parameters on Engine Performance and Emissions for a Single Cylinder VCR Diesel Engine

Naveen Kumar Sain, Ashish Nayyar, Chandan Kumar*
Department of Mechanical Engineering, Swami Keshvanand Institute of Technology and Management, Jaipur, Rajasthan, India

ABSTRACT

Diesel Engines are playing crucial role in field of automobile in current scenario. In Present world there are so many research works are going on in the field of renewable energy sources to replace conventional sources. Variable Compression Ratio (VCR) Engine provides facility to change engine parameters to optimize the power output and the emissions. From experimental Investigation it is clear that the better performance is obtained at 18.5 CR and 210 bar Injection pressure.

Keywords: diesel engine, emissions, smoke, variable compression ratio

***Corresponding Author**
E-mail: naveen.sain90@gmail.com

INTRODUCTION

Diesel Engines are playing crucial role in field of automobile in current scenario. In Present world there are so many research works are going on in the field of renewable energy sources to replace conventional sources. But it is not very easy to replace diesel engines with other engines when the matter comes about power and reliability. The Emissions from Diesel Engines are very harmful for the environment as well as for humans. The Major Emissions are NO_x and Smoke which need to be controlled in an effective manner. Due to smoke formation power output from the engine is reduced and this phenomenon is known as smoke limited power. So to improve the engine performance smoke must be minimizing by any means. A lot of research is going on to reduce the emissions from Compression Ignition engines by using some additives, use of alternative fuels etc. An another method for reducing the emissions is to find the optimum engine parameters like Compression Ratio, Injection Pressure, Injection timing etc. in common engines we cannot change the engine parameters easily without any modification. But Variable Compression Ratio (VCR) Engine provides facility to change engine parameters to optimize the power output and the emissions. In this study we are using a single cylinder VCR Diesel Engine to determine the engine parameters to find the improved performance with reduced emissions [1–5].

EXPERIMENTAL SETUP

The schematic layout of the experimental setup for the present investigation is shown in Figure 1. It consists of a test-bed, having a diesel engine, eddy current dynamometer, fuel tank, air box, computerized data acquisition panel having controls and displays for different thermocouples, speed sensor, and flow meters. Fuel supply is measured using load cell. AVL 437C smoke meter will be used to measure exhaust smoke. Other emissions will be measured with the help of i3syssix gas analyzer.

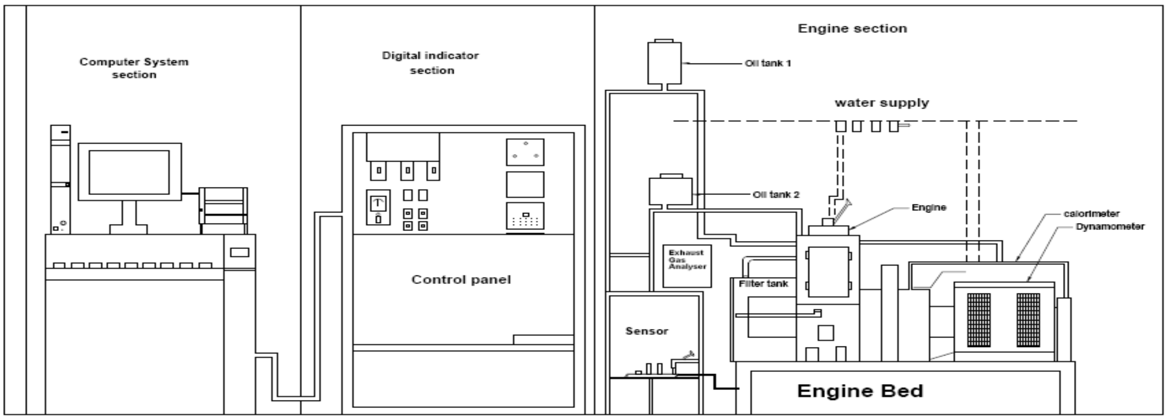

Fig. 1. *Schematic layout of experimental setup.*

The engine coupled through suitable coupling to eddy current dynamometer. The engine and dynamometer are mounted on rigid steel C-channel frame. It is provided with air tank with orifice meter, exhaust gas calorimeter with digital temperature indicators, necessary sensors for cylinder pressure and crank angle measurement, with necessary software for acquiring the data with appropriate display panel (Figure 2).

The specifications of the diesel engine are given in Table 1.

Table 1. *Specifications of the engine.*

Type	Vertical/single acting, totally enclosed, high speed compression ignition diesel engine
	1 Cylinder
No of Cylinder	5 hp
Power Rating	1500 rpm
Speed	80.0 mm
Bore	110 mm
Stroke	556 CC
Cubic Capacity	16.5:1
Nominal Compression	Self start/crank start
Type of start	

Fig. 2. *AVL smoke meter.*

OBSERVATIONS, RESULTS AND DISCUSSION

First we start the engine and took observations at different compression ratios i.e. 16.5, 17.5 and 18.5. Other parameters were 210 bar injection pressure and 23deg btdc as injection timing selected. For these three compression ratios we draw the characteristics for break specific fuel consumption, break thermal efficiency and smoke emissions [6, 7].

Figure 3 shows curve between break power and break specific fuel consumption. At 18.5 CR bsfc is reduced slightly because at high compression ratio per kW energy is more produced by same amount of fuel. So for same break power bsfc reduced.

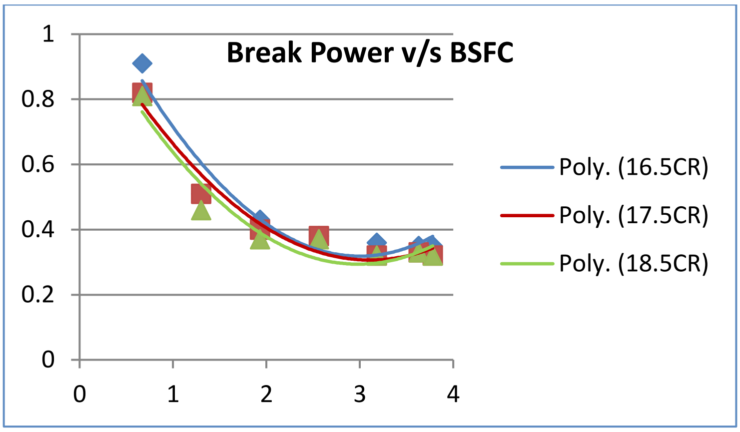

Fig. 3. *Break specific fuel combustion characteristics at different compression ratio.*

Figure 4 represents the curve between break power and break thermal efficiency (bthe). Curve shows as CR increases break thermal efficiency is also increases. This is because the possibility of emission of unburn hydrocarbon is reduced, more utilization of fuel in combustion chamber is obtained, so more power produced. At high CR delay period reduces because of that mean effective pressure is increased so the power output increases. The temperature of air is increases due to high compression ratio which leads to reduction in chemical delay because rate of reaction is directly proportional to temperature.

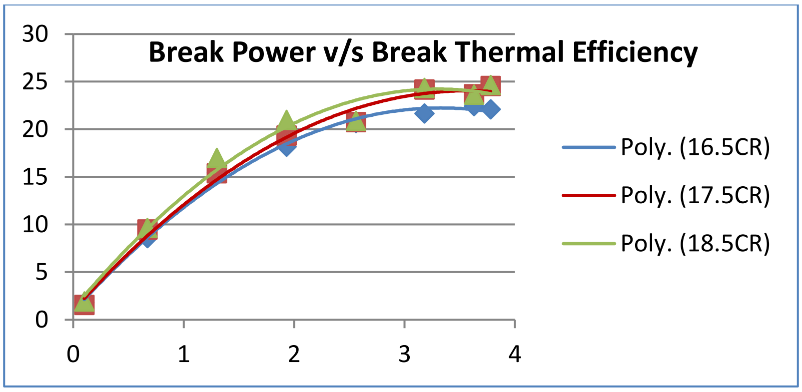

Fig. 4. *Break thermal efficiencies characteristics at different compression ratio.*

Figure 5 shows the Smoke Emission characteristics at different Compression Ratios as CR increases smoke decreases. Proper combustion is achieved in combustion chamber which gives less smoke due to effective utilization of fuel.

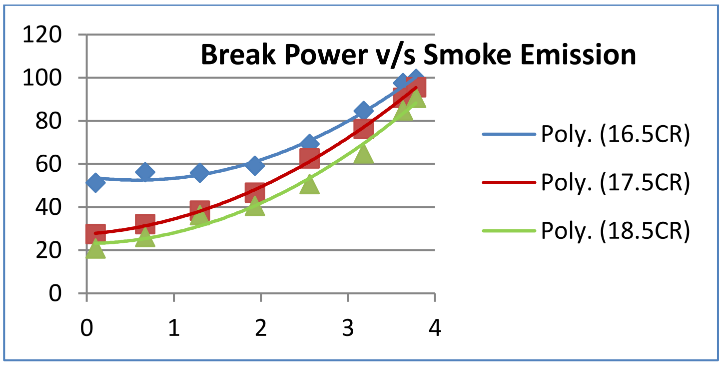

Fig. 5. *Smoke emission characteristics at different compression ratio.*

With this series of experiments for different compression ratios (16.5, 17.5, 18.5) we select the 18.5 CR having more efficiency with less emissions. Now we fix CR and injection timing and record observations at different injection pressures i.e. 200, 210 and 220 bar.

From Figures 6–8 it is clearly shown that best performance and minimum emission is obtained at 210 bar injection pressure. Initially at 200 bar performance is poor due to increase in delay period in losses are high and efficiency decreases. Also droplet size of fuel is more so bsfc increases and maximum temperature in combustion chamber is not achieved due to that possibility of emission of unburned HC increases and smoke emission is also increases.

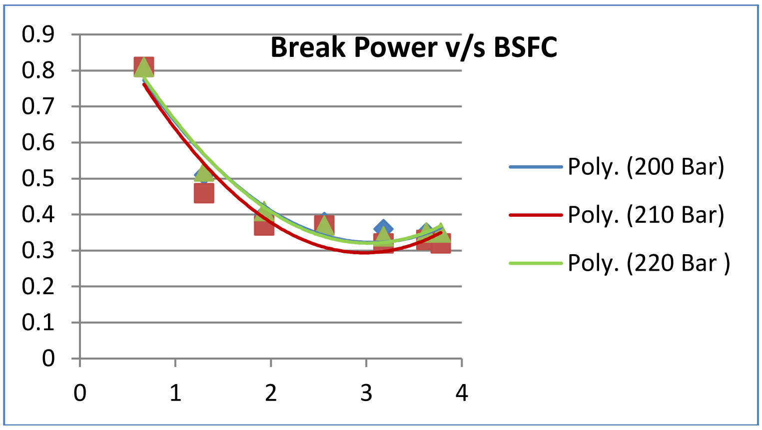

Fig. 6. *Break specific fuel combustion characteristics at different injection pressures.*

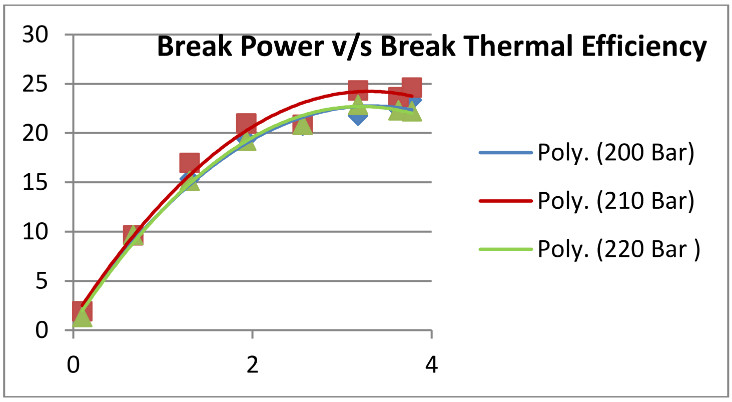

Fig. 7. *Break thermal efficiencies characteristics at different injection pressures.*

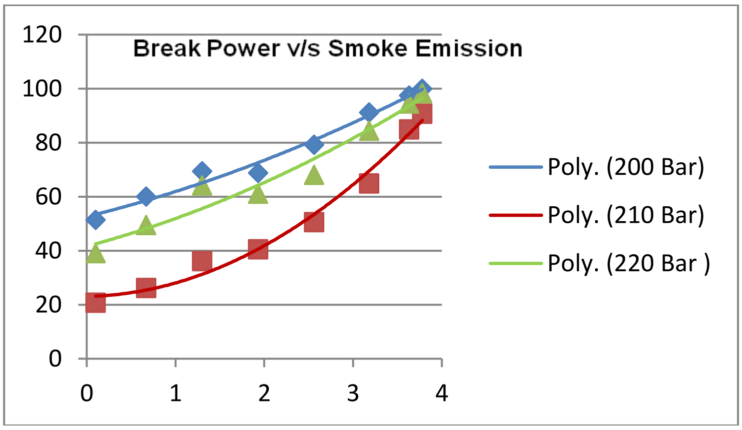

Fig. 8. *Smoke emission characteristics at different injection pressures.*

At 210 bar size of droplet reduces and fine atomization achieved which leads towards the proper utilization of fuel. Delay period decreases which minimizes the power losses results in better efficiency. Because of effective burning of fuel smoke emission is also minimum with 210 bar pressure. At this pressure bsfc is also reduces as more power output with same quantity of fuel.

At very high injection pressure i.e. 220 bar uncontrolled combustion increases and due to that tendency to knock increases so power loss occurs and smoke emission increases. At 220 bar ignition starts early due to very short delay period before piston reaches to TDC and power is lost during this time. The temperature of combustion chamber at the end of compression stroke is high at 18.5 CR and due to high injection pressure rate of vaporization of fuel increases and combustion starts early. In this situation piston in moving in upward direction and combustion tend to move piston in downward direction; these both are counter reacted and energy losses increases. For same power amount of fuel needed is more so bsfc also increases [8–11].

CONCLUSION

Variable Compression Ratio (VCR) Engine provides facility to change engine parameters to optimize the power output and the emissions. From experimental Investigation it is clear that the better performance is obtained at 18.5 CR and 210 bar Injection pressure. At high CR combustion characteristics are improved and tendency of smoke emission decreases. Another variation can be done by taking observations by changing the injection timings. However at high CR and IP formation of NO_x is very high and need to be control. To control NO_x some additives can be used with diesel like alcohols, oxygenated additives, Exhaust gas recirculation technique, etc.

REFERENCES

[1] Heywood J.B. *Internal Combustion Engine Fundamentals*. McGraw Hill Book Company; 1988.
[2] Raheman H., Ghadge S.V. Performance of diesel engine with biodiesel at varying compression ratio and injection timing, *Fuel*. 2008; 87: 265966p.
[3] Mathur Y.B., Poonia M.P., Jethoo A.S., et al. Optimization of compression ratio of diesel fueled variable compression ratio engine, *IJEE*. 2012; 99–101p.
[4] Duraisamy M.K., Balusamy T., Senthilkumar T. Effect of compression ratio on CI engine fueled with methyl ester of Thevetia Peruviana Seed Oil, *APRN J Eng Appl Sci*. 2012; 229–34p.
[5] Jindal S., Nandwana B.P., Rathore N.S., et al. Experimental investigation of the effect of compression ratio and injection pressure in a direct injection diesel engine running on Jetropha Methyl Ester, *Appl Therm Eng*. 2010; 442–8p.
[6] Murlidharan K., Vasudevan D. Performance, emission and combustion characteristics of variable compression ratio engine using methyl esters of waste cooking oil and diesel blends, *Appl Energy*. 2011; 88: 3959–68p.
[7] Laguitton O., Crua C., Cowell T., et al. The effect of compression ratio on exhaust emissions from a PCCI diesel engine, *Energy Conserv Manage*. 2007; 48: 2918–24p.
[8] Heywood J.B. *Internal Combustion Engine Fundamentals*. McGraw Hill Book Company; 1988.
[9] Bakar R.A., Semin, Ismail A.R. Fuel injection pressure effect on performance of direct injection diesel engines based on experiment, *Am J Appl Sci*. 2008; 5(3): 197–202p.

[10] Lee S.-w., Tanaka D., Kusaka J., et al. Effects of diesel fuel characteristics on spray and combustion in a diesel engine,. *JSAE Rev*. 2002; 23: 407–14p.
[11] Venkanna B.K., Wadawadagi S.B., Venkataramana Reddy C. Effect of Injection pressure on performance, emission and combustion characteristics of direct injection diesel engine running on blends of Pongamia Pinnata Linn oil (Honge oil) and diesel fuel, *Agr Eng Int: CIGR eJ*. Manuscript number 1316. 2009; XI.

