# EXPERIMENTAL PERFORMANCE ANALYSIS ON VARIABLE COMPRESSION RATIO ENGINE USING DIESEL AS FUEL

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***Abstract*—***An experimental investigation is carried out to analysis the performance of IC engine under variable compression ratios. The experiment has been conducted in variable compression ratio engine, single cylinder, 4-stroke, water-cooled diesel engine. Performance of the engine at the compression ratios of 14:1, 16:1, 18:1 and 20:1 are analyzed. From the analysis an attempt has been made to find the optimal compression ratio of engine based on considering the engine performance like brake thermal efficiency, specific fuel consumption, brake mean effective pressure and exhaust gas temperature. The compression ratio CR20 has less specific fuel consumption and more brake thermal efficiency, brake mean effective pressure and exhaust gas temperature compared to other compression ratios. However the exhaust gas temperature has increasing with increase in compression ratio, so which will affect the environment due to increase in atmospheric temperature. Hence based on the investigation the optimal compression ratio of this engine has been 18:1*

***Keywords*— *Variable compression ratio, Engine performance, Exhaust gas temperature***

## 1. INTRODUCTION

Since the invention of the internal combustion engine, automotive engineers and race car designers have been searching for ways to boost its power. One way to add power is to build a bigger engine. But bigger engines, which have more weight and more cost to build and maintain. The compression ignition engines are mainly used to find the smooth operation, better eco system and economy. A variable compression ratio engine (VCR) will help to reduce the fuel consumption and improve the performance of IC engine under different conditions. The compression ratios can be changed according to the requirement of the conditions. This will help the engine to produce more power without increasing the engine capacity. However increasing the compression ratio, the exhaust gas temperature will increase and it will affect the eco system of the environment. The optimal compression ratio has been evaluated for each engine to produce more power and less exhaust gas temperature to the atmosphere.

## 2. VARIABLE COMPRESSION RATIO ENGINE [VCR]

The first Variable compression ratio engine was tested by Harry Ricardo in the 1920s. Variable compression ratio is a method to adjust the compression ratio of an internal combustion engine under running conditions. This method is used to increase the fuel efficiency under different loads. Higher compression ratio is used for engine stability and lower load condition. Low compression ratio is used for full load condition and to increase the intake pressure without increasing the cycle peak pressure.

## 3. EXPERIMENTAL

The experiment is conducted on Variable compression ratio engine, which is a four stroke, single cylinder, diesel engine. The engine is initially started by cranking. The engine is run for a few minutes to attain steady state. Then the readings are taken at no load condition. The diesel engine arrangement diagram is shown in figure 1. The engine specifications are given in Table 1 below,

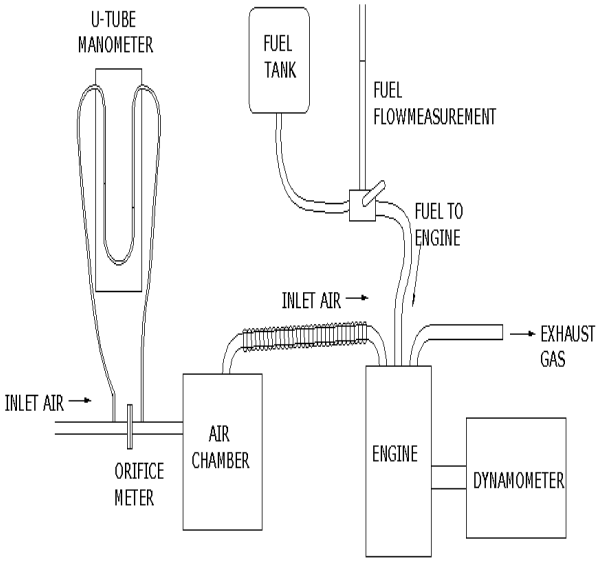


*Fig.1. Schematic arrangement of the IC engine*

TABLE 1 ENGINE SPECIFICATION

| Parameter | Specification |
|---|---|
| Type | Single cylinder, four stroke diesel engine, VCR |
| Bore in [mm] | 80 |
| Stroke in [mm] | 110 |
| Rated [rpm] | 1500 |
| Rated power [HP] | 5 |
| Type of cooling | Water cooled |

The engine is gradually loaded and the corresponding readings are taken for the applied load. The above procedure is repeated for different loads and for various compression ratios – 14:1, 16:1, 18:1 and 20:1.

## 4. RESULT AND DISCUSSION

Performance analysis of the engine is done by taking the readings like time taken for consumption of fuel, speed of the engine, air flow rate and load applied to the engine. The performance analysis is prepared for four different compression ratios of 14:1, 16:1, 18:1 and 20:1.

### 4.1 *SPECIFIC FUEL CONSUMPTION [SFC]*

Figure 2 graphically represents the variation of Brake power Vs specific fuel consumption. At the brake power of 2.39kW, the specific fuel consumption for Compression ratios 14:1, 16:1, 18:1 and 20:1 are 0.5, 0.45, 0.31 and 0.365Kg/KW-hr. The Specific fuel consumption has been reduced 0.19Kg/KW-hr for increase in Compression ratio from CR 14:1 to CR 20:1. It was observed that compression ratio increases the specific fuel consumption will be reduced.

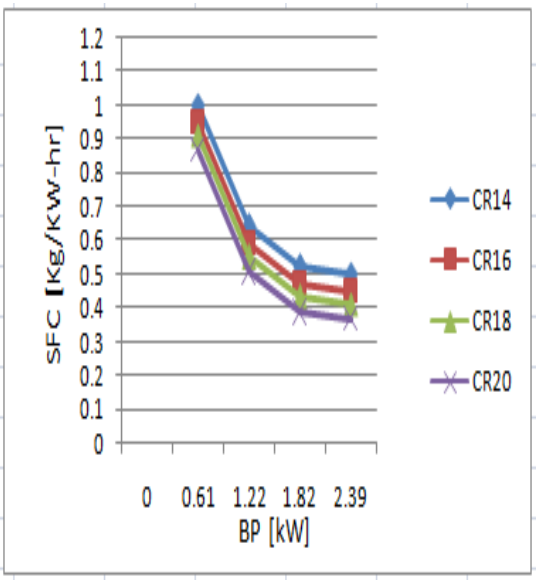


*Figure 2 Brake power Vs Specific Fuel Consumption*

### 4.2 *BRAKE THERMAL EFFICIENCY [BTE]*

Figure 3 graphically represents the variation of Brake power Vs Brake thermal efficiency. At the brake power of 2.39kW, the brake power for Compression ratios 14:1, 16:1, 18:1 and 20:1 are 17.6, 19.9, 21.3 and 22.5 %. The Brake thermal efficiency has been increased 4.9% for increase in Compression ratio from CR 14:1 to CR 20:1. It was observed that compression ratio increases the brake thermal efficiency will be increased.

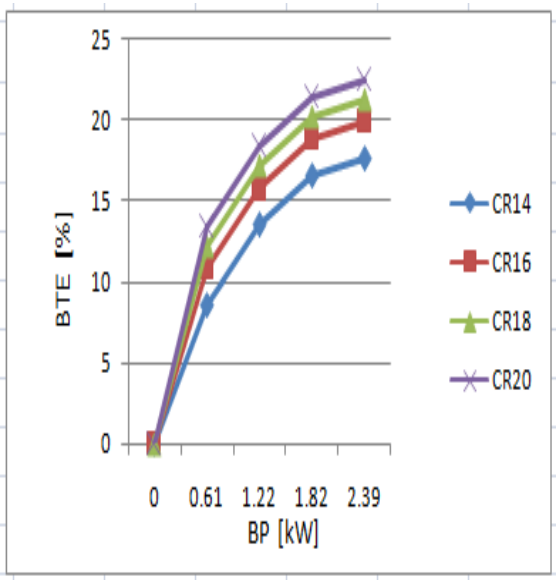


*Figure 3 Brake power Vs Brake thermal Efficiency*

### 4.3 *BRAKE MEAN EFFECTIVE PRESSURE [BMEP]*

Figure 4 graphically represents the variation of Brake power Vs Brake mean effective pressure. At the brake power of 2.39kW, the brake mean eve pressure for Compression ratios 14:1, 16:1, 18:1 and 20:1 are 3.5, 3.85, 4.05 and 4.23 bar. The Brake mean effective pressure has been increased 0.73bar for increase in Compression ratio from CR 14:1 to CR 20:1. It was observed that compression ratio increases the brake mean effective pressure will be increased.

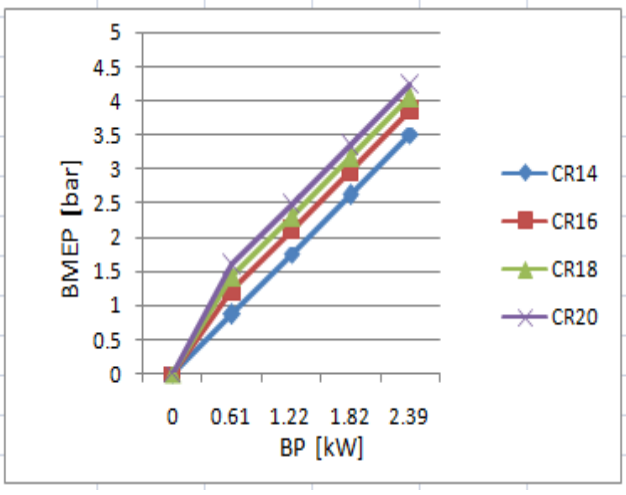


*Figure 4 Brake power Vs Brake Mean Effective Pressure*

4.4 *EXHAUST GAS TEMPERATURE [EGT]*

Figure 5 graphically represents the variation of Exhaust gas temperature Vs Brake power. At the brake power of 2.39kW, the brake power for Compression ratios 14:1, 16:1, 18:1 and 20:1 are 168, 175, 183 and 190°C. The exhaust gas temperature has been increased 22°C for increase in Compression ratio from CR 14:1 to CR 20:1. It was observed that compression ratio increases the exhaust gas temperature will be increased.

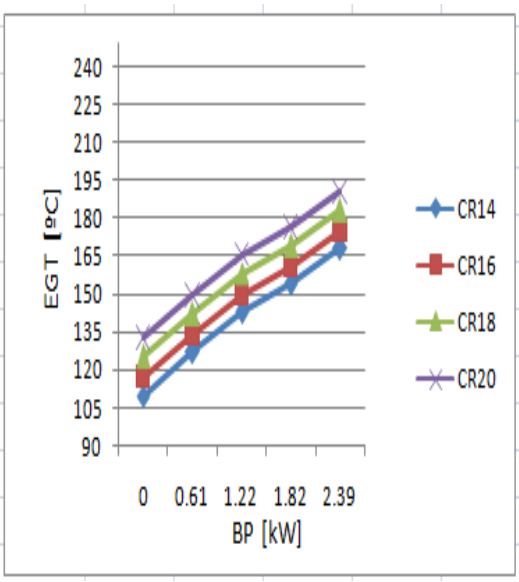


*Figure 5 Brake power Vs Exhaust gas Temperature*

## 5. CONCLUSION

The experimental performance of a diesel engine with various compression ratios 14:1, 16:1, 18:1 and 20:1 are analyzed and compared. Based on the above result and discussion, the following conclusions are:

- The Specific fuel consumption has been reduced from 0.5 to 0.365 Kg/KW-hr with increase in Compression ratio from CR 14:1 to CR 20:1 at maximum load.
- The Brake thermal efficiency has been increased from 17.6 to 22.5% with increase in Compression ratio from CR 14:1 to CR 20:1 at maximum load.
- The Brake mean effective pressure has been increased from 3.5 to 4.23bar with increase in Compression ratio from CR 14:1 to CR 20:1 at maximum load.
- The exhaust gas temperature has been increased from 168 to 190°C with increase in Compression ratio from CR 14:1 to CR 20:1 at maximum load.

The compression ration CR 20:1 has giving better result the other compression ratios, However the exhaust gas temperature has increasing with increase in compression ratio, so which will affect the environment due to increase in atmospheric temperature. With considering the exhaust gas temperature, we are selected the optimal compression ratio for this engine has been 18:1, which will produce better results then other lower compression ratios and less exhaust gas temperature then higher compression ratio.

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