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Exhaust Emissions Analysis on VCR Diesel Engine with Varying the Compression Ratio

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Abstract — *Increasingly stringent emissions and fuel economy standards have long remained challenges for research in automobile engine technology development towards the more thermally efficient and less polluting engine. Increasing the consumption of fuel in power and automobile sector, increase the pollution of the environment. Smoke and NOX are main pollutants of emission from diesel engine and it is very difficult to control them simultaneously Petroleum based fuels is a finite resource that is rapidly depleting. An experimental investigation is carried out to study the effect of compression ratio on variable compression ratio engine using diesel oil. In this paper the performance characteristics are studied at various compression ratios. Better combustion and better utilization of fuel at compression ratio 16.So Smoke density is less for CR 16 which is the optimum compression ratio for this engine. Carbon monoxide emission is lower at CR 18 and highest at CR 14. At CR 16 the value of CO emission is moderate. Hydro carbon emission is lower at CR 18 and highest at CR 14.At CR 16 the value of HC emission is moderate. For this engine optimum compression ratio is 16.*

Keywords- Variable compression ratio (VCR), smoke density, Hydro carbon, Carbon monoxide

I. INTRODUCTION

The compression ignition engines are widely used due to reliable operation and economy. A diesel engine is an internal combustion engine which operated using the diesel cycle. The distinguishing feature of diesel engine is that the combustion takes place when diesel is mixed with the compressed air. This compressed air helps in auto ignition and also plays a vital role in complete combustion as the atomized fuel needs oxygen to combustion. This necessary oxygen is supplied by the air. Along with compression ratios the performance of an engine is affected by the load. Therefore analyzing various parameters of engine at different loads is also crucial to optimize the engine for better performance.

The concept of variable compression ratio (VCR) promises improved engine performance, efficiency, and reduced emissions. The main feature of the VCR engine is to operate at different compression ratios, depending on the vehicle performance needs. A VCR engine can continuously vary the compression ratio by changing the combustion Chamber volume.

II. VARIABLE COMPRESSION RATIO ENGINE (VCR)

One successful method to increase specific output is the use of VCR engine. The high peak pressure problem faced when specific output is increased to reduce the compression ratio at full load and provide high compression ratio at part load operation. A constant compression ratio engine cannot fulfil the above mentioned requirements and therefore VCR engine can be used.

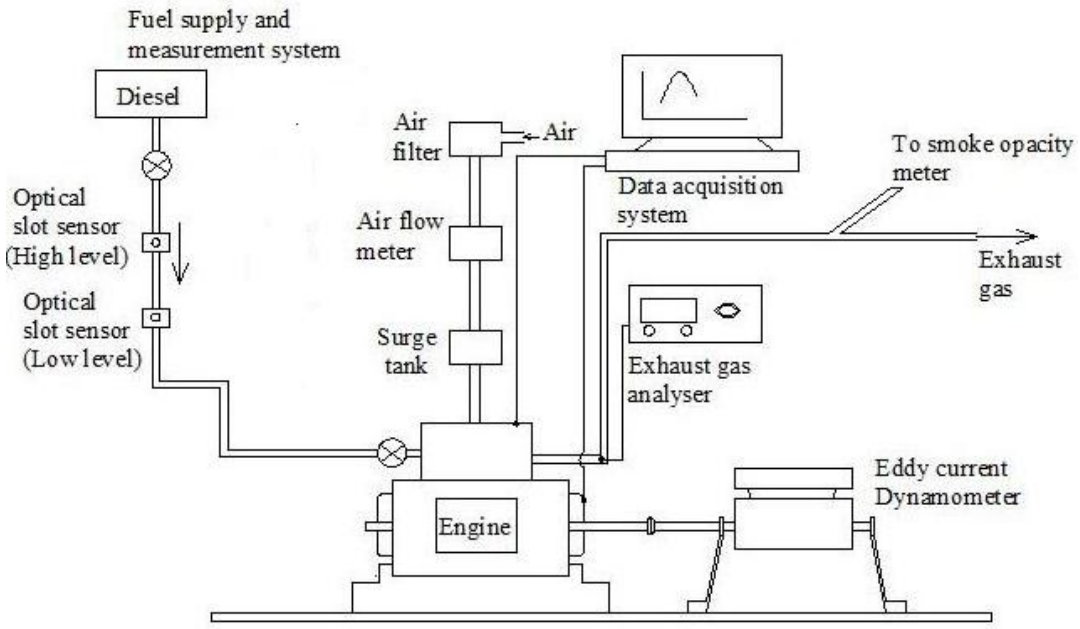
In VCR engine, high compression ratio is used at part load and low compression ratio at full load on the engine to allow turbo-charger to boost the intake pressures without increasing the peak cycle pressure. At starting the turbo-charger output is zero and therefore, high compression ratio is essential. As the engine starts, the exhaust temperature increases which is sufficient to run the turbo-charger. When the engines runs at full load, the turbocharger output is highest and to utilize it efficiently without increasing peak pressure of the cycle, the compression ratio of the engine should be reduced. The greater clearance volume at lower compression ratio results in increased air intake for the same peak compression pressure and gives more output.

The VCR engine concept can be used for S.I. as well as for C.I. engines. But this concept is more suitable for C.I. engine as this concept is more suitable for C.I. engines. But this concept is more suitable at part load and part load η of C.I. engine is always higher than S.I. engines.

1 EXPERIMENTAL SETUP

Experimentation will be carried out on single cylinder four stroke variable compression diesel engine made by Eternal Engineering Equipment.

A diesel engine is coupled to an eddy current dynamometer. The testing is carried out at various loads from no load condition to full load condition. The governor of engine will adjust the engine speed. The compression ratio varies from 18: 1 / 16: 1 and 14: 1.



Schematic diagram of the experimental set up

2 Technical specifications

Table 1 Engine Specification	
MAKE	Eternal Engineering Equipment
TYPE	Four stroke single cylinder variable compression ratio, water cooled engine.
No. OF CYLINDER	One
STROKE	76mm
BORE	76mm
CYCLE	2
COMPRESSION RATIO	18:1/16:1/14:1
RPM	1500
RATED POWER	3.5 H.P. (2.6 kW)
FUEL USED	High speed Diesel

III. OBSERVATION TABLES

READING TABLE FOR PURE DIESEL AT CR 14:1

Sr. No.	Load in kg	Speed RPM	Fuel Consumption Time (100 CC) Seconds	Air Pressure mmWC	Engine Temp. °C	Exhaust Temp. °C	DBT °C	WBT °C	CO %	HC ppm	Smoke Density (%)
1	0	1575	1102	65	31	95	28	25	0.1	22	0.6
2	1	1559	909	64	32	110	28	25	0.23	33	10
3	2	1546	763	64	32	118	28	25	0.34	60	14
4	3	1535	700	63	32	139	28	25	0.38	70	18
5	4	1530	619	63	32	149	28	25	0.4	93	23
6	5	1515	532	62	32	155	28	25	0.44	160	28
7	6	1512	485	62	32	165	28	25	0.53	175	39
8	7	1505	408	60	33	200	28	25	0.57	190	43
9	8	1490	351	60	32	222	28	25	0.68	205	53

READING TABLE FOR PURE DIESEL AT CR 16:1

Sr. No.	Load in kg	Speed RPM	Fuel Consumption Time (100 CC) Seconds	Air Pressure mmWC	Engine Temp. °C	Exhaust Temp. °C	DBT °C	WBT °C	CO %	HC ppm	Smoke Density (%)
1	0	1578	1150	66	31	110	26	23	0.1	18	3.2
2	1	1564	1054	66	31	120	26	23	0.2	25	6
3	2	1540	878	65	31	125	26	23	0.26	49	7.3
4	3	1538	790	65	31	145	26	23	0.29	67	9
5	4	1534	698	64	31	154	26	23	0.31	80	12.2
6	5	1515	600	64	32	175	26	23	0.34	140	15.5
7	6	1512	542	63	32	180	26	23	0.37	150	27.4
8	7	1508	460	61	32	220	26	23	0.46	160	36
9	8	1494	390	61	32	237	26	23	0.63	190	50.2

READING TABLE FOR PURE DIESEL AT CR 18:1

Sr. No.	Load in kg	Speed RPM	Fuel Consumption Time (100 CC) Seconds	Air Pressure mmWC	Engine Temp. °C	Exhaust Temp. °C	DBT °C	WBT °C	CO %	HC ppm	Smoke Density (%)
1	0	1576	1102	67	32	118	26	23	0.1	8	5.1
2	1	1562	1048	67	32	130	26	23	0.12	21	8
3	2	1543	822	67	32	142	26	23	0.2	42	10.1
4	3	1537	730	66	33	155	26	23	0.21	53	11
5	4	1532	682	66	33	169	26	23	0.22	65	13
6	5	1514	558	65	33	187	26	23	0.24	133	24
7	6	1509	500	64	34	204	26	23	0.25	152	33
8	7	1507	442	64	34	235	26	23	0.32	160	53
9	8	1492	364	64	34	266	26	23	0.47	172	69

IV. RESULTS AND DISCUSSION

SMOKE DENSITY

Better combustion and better utilization of fuel at compression ratio 16.So Smoke density is less for CR 16 which is the optimum compression ratio for the C.I. engine as shown in fig.1. According to the CPCB(Central Pollution Control Board) the permissible value for smoke density is 65%.The smoke emission at all compression ratio is less than 65% .

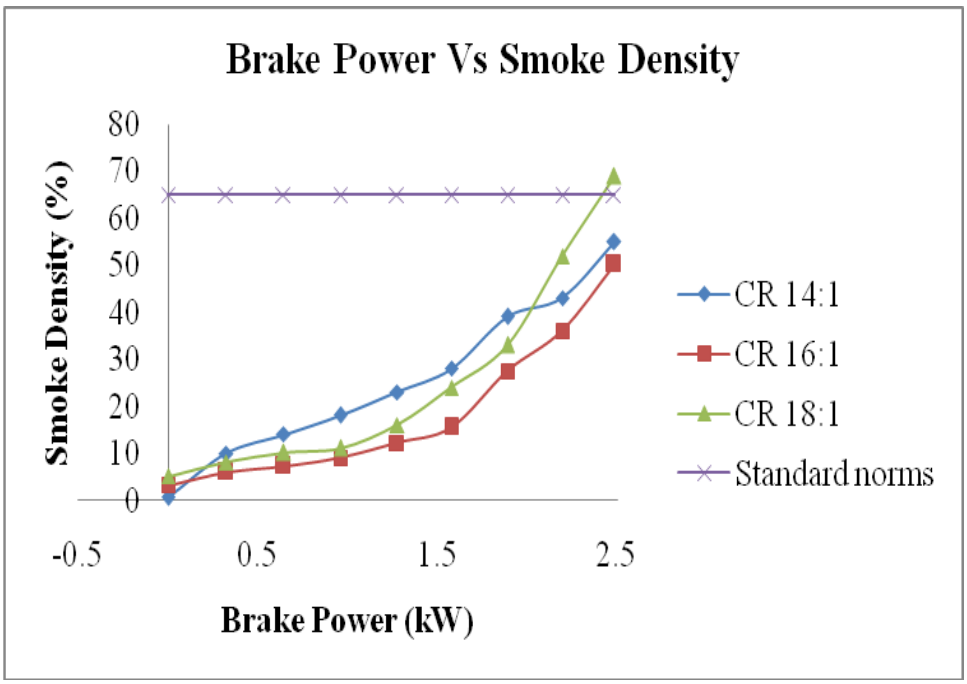


Figure 1 Brake Power Vs Smoke density for pure diesel

CARBON MONOXIDE EMISSION

Carbon monoxide emission is lower at CR 18 and highest at CR 14. At CR 16 the value of CO emission is moderate as shown in fig. 2.

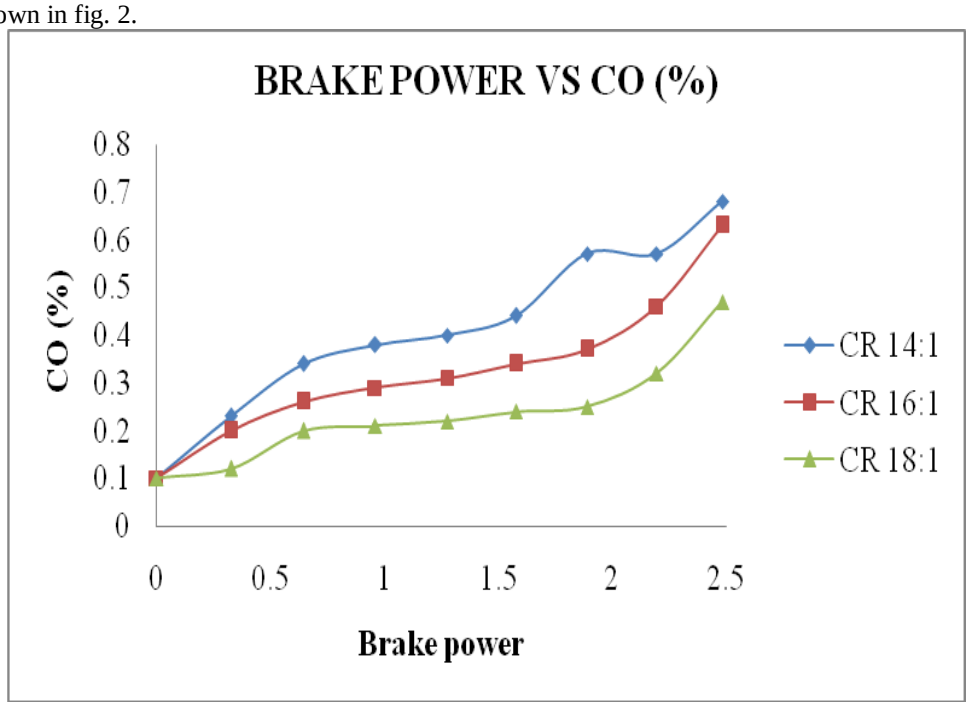


Figure 2 Brake Power Vs CO for pure diesel

HYDROCARBON EMISSION

Hydro carbon emission is lower at CR 18 and highest at CR 14.At CR 16 the value of HC emission is moderate as shown in figure 3.

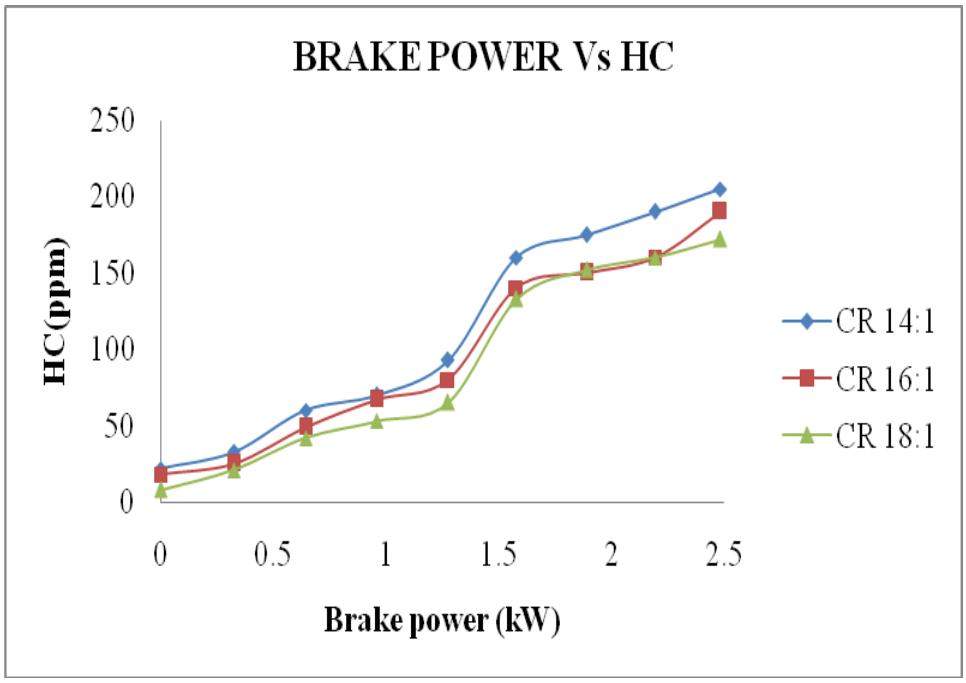


Figure 3 Brake Power Vs HC for pure diesel.

V. CONCLUSIONS

1. Smoke density is less at compression ratio 16 because of better combustion of fuel at this compression ratio. The engine fueled by diesel with additives the values of smoke density are all lower than that fuelled by neat diesel the reductions are from 8% to 96 %.According to the central pollution board for diesel vehicle the maximum allowable smoke density is less than 65%. In this engine for pure diesel and the diesel with additives at all three compression ratios the value of smoke density is less than 65 % from no load to full load.
2. Exhaust gas temperatures are moderate at compression ratio 16 from no load to full load.
3. HC emission reduced with increasing the compression ratio. HC emission is higher at CR 14 and lower at CR 18. The HC emissions of all the fuels are lower in partial engine load, but increased at higher engine load. This is due to relatively less oxygen available for the reaction when more fuel is injected into the engine cylinder at higher engine load.
4. CO emission is reduced with increasing the compression ratio. CO emission is higher at CR 14 and lower at CR 18.

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