EMISSION ANALYSIS OF SINGLE CYLINDER DIESEL ENGINE BY VARYING CR

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Abstract : This study has been undertaken to investigate the single cylinder diesel engine by varying CR with pure diesel and further these results will be used for comparative study of diesel engine with HCNG at different blend ratios at various loads by varying CR. At different CR 15:1, 16:1 and 18:1 and by varying the load from 0 to 12 KG at constant 1500 rpm. At 15:1 and 16:1 there were effects on the emissions such as the HC and CO were the lower but NOX values were increases with increases the load and with increasing the CR.

Index Terms **– Dual fuel, HCNG, VCR, CI.**

I. INTRODUCTION

Nowadays as we have seen that pollution is increasing day by day and diesel fuel which is petroleum product is conventional sources of energy therefore we are moving towards non conventional sources of energy i.e. an alternative fuels such as CNG, vegetable oil, alcohol, methane, ethane, LPG, etc. many researchers study shows the possibility of running engine a diesel engine by using hydrogen fuel along with CNG by having some mass proportion . This is known as dual fuel technology. Dual fuel combustion using diesel and natural gas is a promising technique for controlling both NO and PM emissions even on existing DI diesel engines and requires only slight modification of the engine structure. This is an important advantage over the CI operation due to the NOx-PM trade-off that is difficulties in simultaneously controlling both pollutants NO and PM in DI diesel engines. The observed analysis concerning BSFC, HC, and CO can be possibly reduced by applying modifications in engine tuning, that is injection timing of the pilot diesel fuel at part load conditions. Dual fuel engines offer a number of potential advantages like fuel flexibility, lower emissions, higher compression ratio, better efficiency and easy conversion of existing engines.

II. LITERATURE REVIEW

Many of researchers studies shows that it is possible to run the engine by using hydrogen as a fuel along with the CNG in diesel engine with some minor modifications . K.A. Subramaniam 2017 at.el[1] research study shows that effects of hydrogen enrichment as a dual fuel increases the thermal efficiency of engine and reduces the emission level of HC, CO and CO2 gases, exhaust gases temperature increases at lower and moderate load but NOX increases with increase of hydrogen enrichment. Yusuf Malkoc at el.[2] investigates the effect of compression ratio on engine performance and emission characteristics by using HCNG in which had CR of 17.5 was modified to a natural gas engine by replacing four spark plugs in place of fuel injectors and then, pistons were arranged for different compression ratio (15, 12.5, and 9.6 CR). from that lowest BSFC values were obtained at CR of 12.5 for all blends. As CR increased, torque values were also increased by addition of hydrogen to CNG for all CR. Emissions like the values of HC and CO were lower than EURO VI standards and NOX emissions were increased by hydrogen addition for all CR. The data obtained from all above researchers to do experimental test to find out the optimum compression ratio for different HCNG blends at various loads.

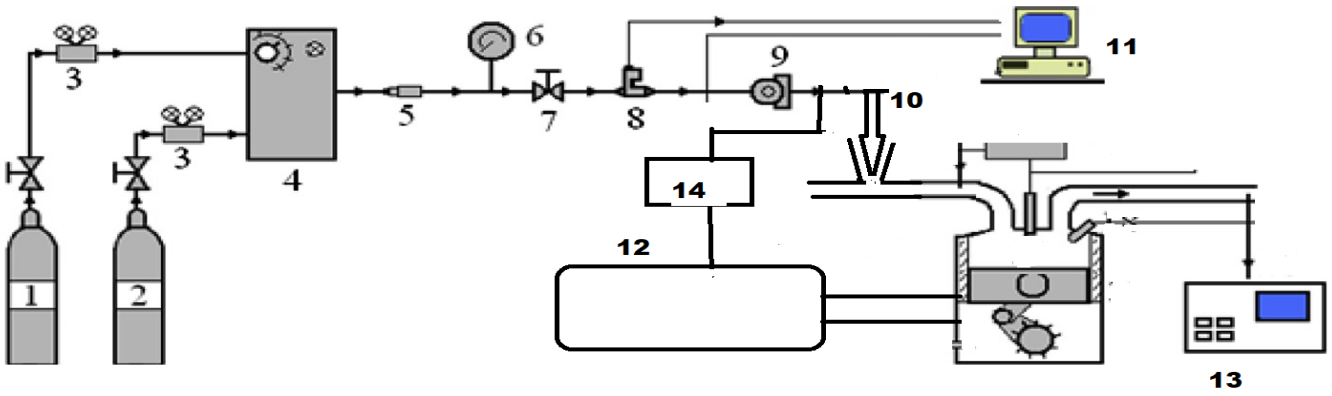
III. VARIABLE COMPRESSION RATIO

It is a technology to adjust the compression ratio of an internal combustion engine while the engine is in operation. This is done to increase fuel efficiency while under varying loads. Higher loads require lower ratios to be more efficient and vice versa.

$$CR = Vtdc + Vs / Vtdc$$

Where, Vtdc = volume of combustion chamber when piston is at TDC
Vs = swept volume due to stroke

IV. EXPERIMENTAL SETUP



1. hydrogen tank
2. cng tank
3. gas regulators
4. mixer unit
5. flame arrester
6. pressure indicator
7. check valve
8. mass flow meter
9. gas regulator
10. gas injector
11. computer
12. dynamometer
13. exhaust gas analyzer
14. controlling unit

Fig 1 Experimental HCNG setup

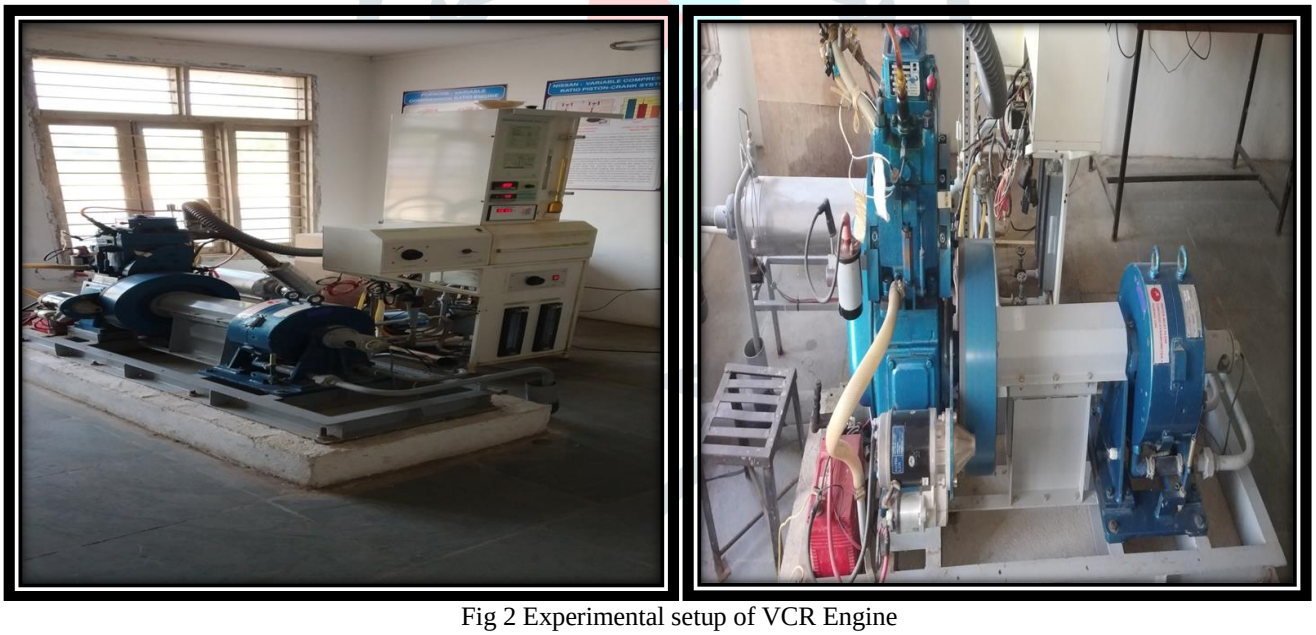


Fig 2 Experimental setup of VCR Engine

V. SETTING OF COMPRESSION RATIO

How to set the compression ratio in VCR diesel engine

- Slightly loosen 6 Allen bolts provided for clamping the tilting block.
- Loosen the lock nut on the adjuster and rotate the adjuster so that the compression ratio is set to “maximum”. Refer the marking on the CR indicator
- Lock the adjuster by the lock nut.
- Tighten all the 6 Allen bolts gently.
- You may measure and note the centre distance between two pivot pins of the CR indicator. After changing the compression ratio the difference (D) can be used to know new CR

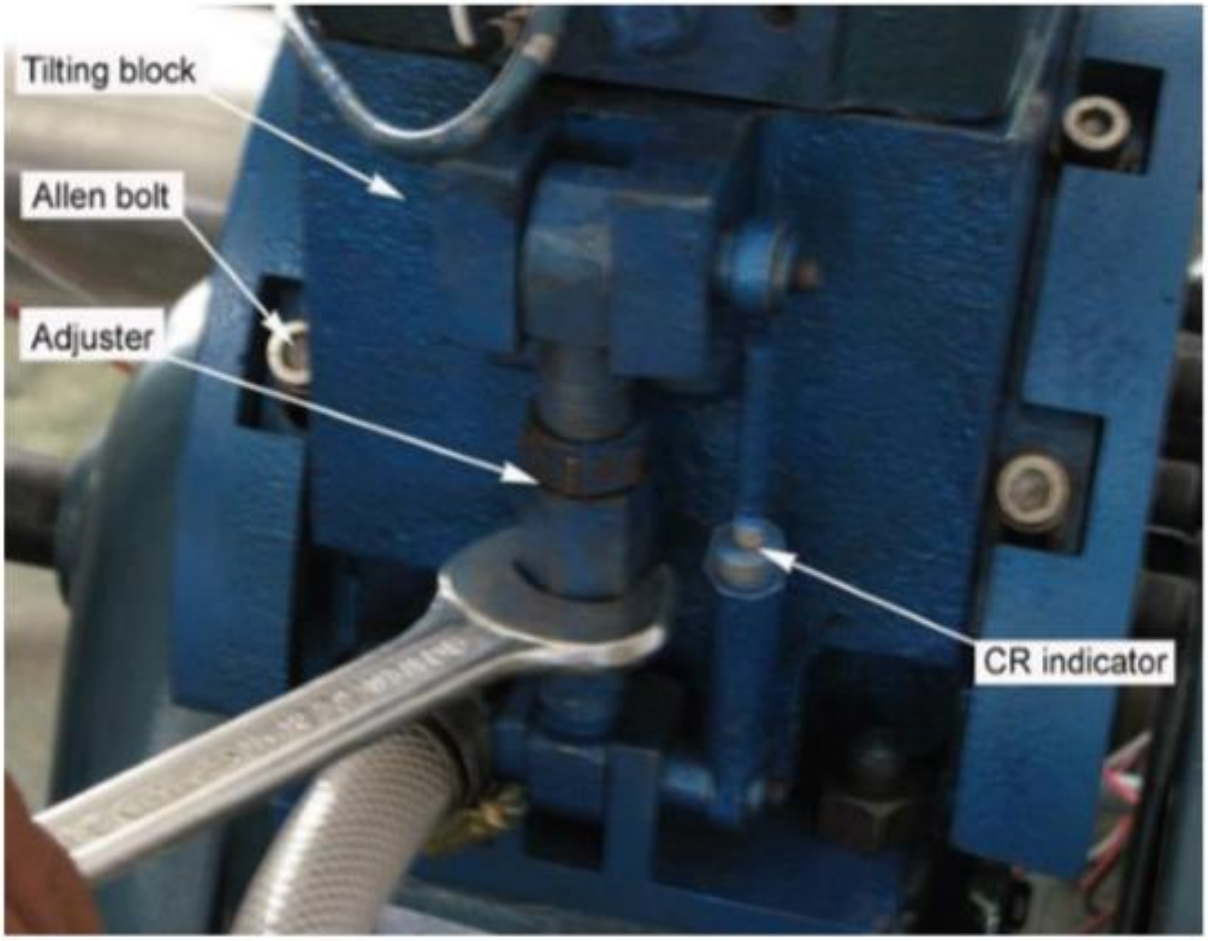


Fig 3 Setting of compression ratio in VCR Engine

3.1 Specifications of VCR Engine

Item	Unit
Model	Research Diesel Engine
Power (KW)	3.5
Operating Speed	1500
Cylinder bore (mm)	87.5
Stroke (mm)	110
Compression Ratio	12.1 : 18.1
Stroke type	4-S
No. of Cylinder	1
Cooling	Water Cooling
Compression Ratio	Variable
Swept Volume	661.5
Dynamometer	Eddy Current, Water Cooled
Air Box	M S Fabricated with orifice meter
Fuel Tank	15 Lit.
Piezo Sensor	Combustion : Range 500 PSI
Crank angle sensor	Resolution 1 Deg, 5500 rpm
Sensors for ECU	Air, Coolant, Throttle Position
Engine Control	Fuel Injector, Fuel Pump, Idle Air, Ignition Coil
Digital Voltmeter	0-20 V, Panel Mounted
Temperature Sensor	Thermocouple, Type K
Load indicator	0-50 Kg
Rotameter	Engine Cooling 40-400 LPH

Calorimeter	25-250 LPH
Lubricating Oil	20W40

Table 1 Specifications of VCR Engine

3.2 Experimental Results

The experimental tests was carried out by using pure diesel at different compression ratios from that results were obtained are mentioned in the following tables.

AT CR 16:1

SPEED (rpm)	LOAD (KG)	CO	HC	CO_2	NO_X
1500	0	0.06	8	0.4	69
1500	3	0.054	10	2.24	614
1500	6	0.053	16	3.36	716
1500	9	0.045	14	3.93	716
1500	12	0.036	15	4.59	666

Table 2 Results with CR 16:1

AT CR 15:1

SPEED (rpm)	LOAD (KG)	CO	HC	CO_2	NO_X
1500	0	0.06	10	0.4	0
1500	3	0.031	11	2.21	116
1500	6	0.093	12	3.02	537
1500	9	0.055	12	4.29	716
1500	12	0.045	13	5.03	716

Table 3 Results with CR 15:1

AT 18:1

SPEED (rpm)	LOAD (KG)	CO	HC	CO_2	NO_X
1500	0	0.06	10	0.4	153
1500	3	0.078	16	2.63	706
1500	6	0.053	24	3.48	665
1500	9	0.063	40	5.03	712
1500	12	0.064	35	5.33	705

Table 3 Results with CR 18:1

3.3 Discussion

We have taken the above results by using 100 percent pure diesel and by changing the compression ratio (15:1, 16:1 and 18:1). At CR 15:1 with increasing load the values of emissions like HC , CO, CO2, and NOX increases at constant speed , at CR 18:1 the values of emissions like HC , CO is comparability lowest but with increasing CR the values of NOX increases and in same case at CR 18:1 the values of emissions like HC and CO were comparability lowest and the values of NOX were increasing with increasing loads at constant speed. Hence we hereby undergoes the comparative study by using these three CR 15:1, 16:1, and 18:1 by using the various HCNG blends like HCNG5, HCNG10, HCNG20. And by taking various loads from 3 to 12 kg, at constant speed

CONCLUSION

From the above experimental study it will come to know that by changing the CR in VCR engine by using diesel as fuel the values of the emissions like HC, CO and CO2 will comparability lower but the values of the NOX were higher by increasing the CR and as well as increasing the load.

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