PRIMARY DESIGN AND DEVELOPMENT OF EGR SYSTEM FOR COMPUTERISED SINGLE CYLINDER FOUR STROKE DIESEL ENGINE

Mudssar M. Bagwan[1], Sanjay T. Satpute[2]

[1] Automobile Engineering Department, RIT Islampur.
Email:[1]mbagwan2@gmail.com,[2]sanjay.satpute@ritindia.edu

Abstract: **The aim of present work is to study effect of exhaust gas recirculation system on engine performance and emission. EGR system is designed and then fabricated by considering specification of engine. Single cylinder four stroke computerised diesel engine is selected for design. Theoretical study is carried out to design EGR system. At successful completion of design work it is expected that developed EGR system will work effectively.**

***Keywords*— EGR system, engine performance, emission**

1. Introduction

The Theory of compressed-ignition (CI) Engines is developed by Rudolf Diesel. The survey of CI engine application it is found that there is challenge to increases engine performance and reduces emission from the engine. As we know that CI Engines are better power source due to higher compression ratio, higher efficiency, performance, and reliability than SI Engines. Hence, in most of on-road transportation, and off- road stationary applications, CI Engines are widely used . Exhaust gas from the engine is re-circulated by using outside bypass provided. Exhaust gas having capability of absorbing oxygen content from the air because of these combustion flame temperature is decreases. EGR is to reduce NOx by decreasing oxygen content and combustion flame temperature.

Some researcher had concentrated on this technique which reduces emission from the engine. N.V. Deshpande et al.(2008) had given emphasis to control oxides of nitrogen (NOx). He reported the effect of EGR rate on NOx, smoke, and on performance parameter like BSFC, and brake thermal efficiency etc. He was found that with increasing rate of EGR for different torque there was marginal decrease in brake thermal efficiency. This was due oxygen deficiency at higher load, which lead to incomplete combustion. In addition, BSFC was also marginally increased at high load.

A.K. Agrawal et al.(2004). worked out an experimental investigation to observe effect of EGR on exhaust gas temperature and exhaust opacity in CI Engines. He was observed that, as EGR rate increases exhaust gas temperature decreases significantly. However, this result surely concludes that NOx can be decreased by increasing EGR rate. The reason for decreasing exhaust gas temperature was stated as considerable decrease in oxygen content in recirculation of exhaust gas to fresh air/charge.

Timothy Jacobo et al.(2003) investigated that, the coupling between EGR, the variable geometry turbo-charging (VGT), and EGR cooler critically affects boost pressure, air/fuel ratio (A/F), combustion efficiency and pumping work. Engine thermal efficiency tends to decrease with EGR rate.

M. Ghazikhani et al. (2010)carried out an experimental study to investigate effect of EGR on various exergy terms of IDI diesel engine cylinder. In this study, also the effectiveness of total in-cylinder irreversibility on brake specific fuel consumption (BSFC) was investigated.

Alain Maiboom et al.(2009) studied the influence of cylinder-to-cylinder variations in EGR distribution on the resulting NOx–PM trade-off had been experimentally investigated on an

automotive high-speed direct injection Diesel engine. It was reported that, Unequal EGR distribution results in increased NOx and PM emissions compared to engine running with well mixed air and EGR gases. Furthermore, the increase in emissions was due to cylinder-to-cylinder variations in both gas composition and intake temperature. He was also concluded that, the suppression of unequal cylinder-to-cylinder EGR distribution results in a large reduction of NOx and PM emissions, especially when running with high EGR rates. An optimized air–EGR connection will be one of the ways to achieve future emissions standards.

2.Expremental Set up

Single cylinder four stroke computerised diesel engine is selected. Computer can be used for the control of a test and data acquisition, thus improving the efficiency of engine testing. The computer can also process all data, carry out statistical analysis, and plot all the result. Engine Soft is useful for testing and analysing performance of various parameter of engine.EGR system is designed and then fabricated by considering specification of engine. There are two type of EGR system by considering temperature, first is hot EGR system, in this system hot gasses is directly recalculated in the engine and second is cold EGR system, in this exhaust gasses is cooled by using EGR cooler. Cold EGR system is more effective than hot EGR system. Fig1. show that photograph of computerised single cylinder four stroke engine without installing EGR system. Brief specifications of engine are given below. Moreover, all tests will be conducted and parameters will be measured under steady state operation.

a) Specification of engine

Manufacturer - Kirloskar oil engine Ltd, Pune. Single cylinder four stroke diesel engine. Cubic capacity - 661 cc Bore - 87.5 mm-110 mm Cooling system- Water Power- 7 hP @ 1500 rpm.

Fig1. Engine set up without EGR system

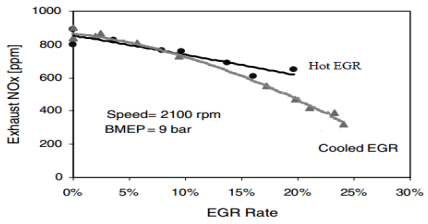

Fig 2. Comparison between cooled and hot EGR[Zing M et al 2004].

The EGR system will fabricated as per requirements. The set-up will then, modified by incorporating exhaust gas recirculation sub-system in the set-up as shown in Fig. 3. A short cooled EGR system will chosen for study due to its merits.

b) Various Instruments and Measuring Devices

i)Load and Speed Measurements

The engine will directly coupled to an eddy current dynamometer that permitted engine motoring fully or partially. The engine and dynamometer were interfaced to a control panel. A photo sensor along with a digital rpm indicator will used to measure the speed of the engine. The voltage pulses from the sensor are sent to the digital rpm meter for pulse conversion and display of the engine speed with an accuracy of 1 rev/min.

ii) Air Flow Measurement

Airflow rate will measured using air box method.

iii)The Fuel Supply and Measurement

Supply of fuel will done through a fuel tank placed at over head of M.S framed stand. The supply of fuel to fuel pump will done through three will solenoid valve. One will connection will taken fuel from tank while of the other two connections one will given to burette and remaining will connected to fuel pump filter. This will so to measure fuel consumption of

engine by closing valve of fuel tank line to restrict fuel from fuel tank allowing fuel consumption only from measuring burette.

iv)Temperature Measurement

Temperature of the exhaust gas will measured with thermocouples. A digital indicator with automatic room temperature compensation facility will used. The temperature indicator will calibrated periodically.

v)Pressure Measurement

In cylinder pressure will measured with a water-cooled piezoelectric transducer. The pressure pick up will mounted on to the cylinder head surface. A PCB Piezotronics make transducer with a sensitivity of 0.145mV/kPa will used for the purpose. A piezoelectric transducer produces a charge output, which is proportional to the in-cylinder pressure.

Fig 3. Engine fitted with EGR system

c) The necessary components for EGR set-up fittings are

i)Calorimeter ii)EGR Cooler iii) EGR Valve iv)Gas Pipe connection v)Control Valve

i) Calorimeter

Pipe in pipe type calorimeter is selected which is used to reduce the temperature of hot gasses

ii) EGR cooler

Shell and tube type heat exchanger is selected because it is operated with high temperature and pressure. It consist of Shell, round aligned type tube and baffles. Baffles are placed at equidistance from each other. Total length of Cooler is 600 mm. Flow arrangement is selected is counter flow because high rate of heat transfer.

iii) EGR Valve

Exhaust gas from the engine is again recalculated with help gas route pipe. Exhaust gas controlled by using EGR valve. It is operated with manually.

$$\% \text{ EGR} = \frac{M_{EGR}}{M_{Total\ Intake}} X100$$

However, mass of re-circulated exhaust gas will calculated based on difference in manometer column for consecutive revolution (position) of EGR valve. For respective EGR valve position decrease in difference in manometer column will observed compared to (without EGR) total intake charge suction. This decrease in column is nothing but mass of exhaust gas re-circulated during respective valve position. Therefore, this value of mass of exhaust gas re-circulated will determined. We have the total suction during without EGR. This interprets rate of EGR circulated. If EGR valve is totally closed no exhaust gas is circulated. Material of valve is withstand with high temperature and pressure.

iv)Control Valve

Control valve is used to control flow rate of exhaust gasses. if any back pressure is there then open the control valve so that engine operated smoothly.

v)Gas pipe connection

Material used for gas pipe connection is GI. Diameter of pipe is 2 inch. T connection of pipe consist of recirculated exhaust gasses, fresh air from air box and connected to intake manifold.

Table 1. Specification of exhaust gas recirculation system

Sr.No	Component	Specification
1	EGR cooler	Shell and tube
2	Type of flow	Counter flow
3	Shell fluid	Water (coolant)
4	Tube Fluid	Gas
5	Core length	600 mm
6	Shell diameter	150 mm
7	EGR valve (Gate valve)	Manually operated
8	Gas pipe GI	2 inch.
9	Control valve	Manually operated

Conclusion

From this Work getting the idea about selection of various parameter for EGR system. Cold EGR system is selected due to its merit. Based on theoretical design consideration, EGR system is fabricated. After installation of this system on the single cylinder four stroke computerised diesel engine various experimental test will be conducted and engine performance will be checked with or without EGR system.

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