ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 433 – 436 (2013)
Special Issue of ICACSE 2013 - Held on 7-8 January, 2013 in Lords Institute of Engineering and Technology, Hyderabad

PERFORMANCE OF DIESEL ENGINE USING EXHAUST GAS RECIRCULATION

RAHUL CHANDRA[1], ABHISHEK JHA[2] , A.V.LAXMI[3]

1. Faculty, Department of Mechanical Engineering. Lords Institute of Engineering &Technology, Hyderabad AP-500080. Email:rahulchandra.liet@gmail.com
2. Student, Department of Mechanical Engineering. Lords Institute of Engineering &Technology, Hyderabad AP-500080. Email:abhishek.jha2324@gmail.com
3. Student, Department of Mechanical Engineering. Lords Institute of Engineering &Technology, Hyderabad AP-500080. Email:laxmi.av23@gmail.com

Abstract— In this project, an experimental investigation was carried out on a single cylinder where exhaust gas recirculation is provided for compression ignition engine to optimize the performance characteristics and to find out the best blend of air and exhaust gas substitution. Experiments were conducted at different substitution of Exhaust gas recirculation values and performance characteristics were calculated. The engine used in the present study is a Kirloskar AV-1, single cylinder direct injection, water cooled diesel engine with the required specifications. Diesel injected with a nozzle hole of size 0.15mm.the engine is coupled to a dc dynamometer. The intake temperature and pressure are chosen to give stable and knock free engine operation. Engine exhaust emission is measured where load was varied as 13.66%,27.32%,40.98%,54.64%. The amount of exhaust gas sent to the inlet of the engine is varied and it's corresponding brake thermal efficiency is calculated. The experiment is carried out by keeping the compression ratio constant i.e., 16.09.

Index Terms— Brake Thermal, Blends, Exhaust Gases, Efficiency, Exhaust Gas Recirculation

INTRODUCTION

In internal combustion engines, **exhaust gas recirculation** (**EGR**) is a nitrogen oxide (NOx) emissions reduction technique used in petrol/gasoline and diesel engines. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders. In a gasoline engine, this inert exhaust displaces the amount of combustible matter in the cylinder. In a diesel engine, the exhaust gas replaces some of the excess oxygen in the pre-combustion mixture[1]Because NOx forms primarily when a mixture of nitrogen and oxygen is subjected to high temperature, the lower combustion chamber temperatures caused by EGR reduces the amount of NOx the combustion generates. Most modern engines now require exhaust gas recirculation to meet emissions standards

The first EGR systems were crude; some were as simple as an orifice jet between the exhaust and intake tracts which admitted exhaust to the intake tract whenever the engine was running. Difficult starting, rough idling, and reduced performance and fuel economy resulted.[2] By 1973, an EGR valve controlled by manifold vacuum opened or closed to admit exhaust to the intake tract only under certain conditions. Control systems grew more sophisticated as automakers gained experience; Chrysler's "Coolant Controlled Exhaust Gas Recirculation" system of 1973 exemplified this evolution: a coolant temperature sensor blocked vacuum to the EGR valve until the engine reached normal operating temperature.[3] This prevented driveability problems due to unnecessary exhaust induction; NOx forms under elevated temperature conditions generally not present with a cold engine. Moreover, the EGR valve was controlled, in part, by vacuum drawn from the carburetor's venturi, which allowed more precise constraint of EGR flow to only those engine load conditions under which NOx is likely to form.[4]

In diesel engines

By feeding the lower oxygen exhaust gas into the intake, diesel EGR systems lower combustion temperature, reducing emissions of NOx. This makes combustion less efficient, compromising economy and power. The normally "dry" intake system of a diesel engine is now subject to fouling from soot, unburned fuel and oil in the EGR bleed, which has little effect on airflow but can cause problems with components such as swirl flaps, where fitted. Diesel EGR also increases soot production, though this was masked in the US by the simultaneous introduction of diesel particulate filters.[5]EGR systems can also add abrasive contaminants and increase engine oil acidity, which in turn can reduce engine longevity[6]

ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 433 – 436 (2013)
Special Issue of ICACSE 2013 - Held on 7-8 January, 2013 in Lords Institute of Engineering and Technology, Hyderabad

Concept of the study

In this project, an experimental investigation was carried out on a single cylinder's variable compression ratio, exhaust gas recirculation provided, compression ignition engine to optimize the performance characteristics and to find out the best blend of air and exhaust gas substitution. Experiments were conducted at different substitution of E.G.R (exhaust gas recirculation) values and performance characteristics were calculated

C. Experimental setup and Experimentation

The engine used in the present study is a Kirloskar AV-1, single cylinder direct injection, water cooled diesel engine with the specifications given in Table 1. Diesel injected with a nozzle hole of size 0.15mm.the engine is coupled to a dc dynamometer. The intake temperature and pressure are chosen to give stable and knock free engine operation. Crank angle resolved in cylinder pressure and the diesel injection pressure is measured. Engine exhaust emission is measured. Load was varied from 1 kilo watt to 2 kilo watts. The amount of exhaust gas sent to the inlet of the engine is varied. At each cycle, the engine was operated at varying load and the efficiency of the engine has been calculated simultaneously. The experiment is carried out by keeping the compression ratio constant i.e., 16.09.

In this experiment, by varying the load from 0.5KW to 2KW, the brake power is being calculated at variable percentages of the exhaust sent to the inlet of the engine. This calculated brake power is further used to calculate the brake thermal efficiency of the engine and hence can be used to identify the amount of exhaust that can be recirculated to the inlet manifold at maximum efficiency produced. The calculations and analysis has been done accurately at different speed of the engine which changes accordingly by varying the load.

In the present study, experiment has been conducted on a single cylinder, diesel engine under variable compression ratio and variable load. The flow of air which is sent to the inlet manifold along with the flow of exhaust gas recirculated is calculated through manometers provided to the system. The flow rate changes with the change in amount of exhaust recirculated and also with varying load.

The main objective of this study is to find out at what percent the exhaust gas can be recirculated to the inlet manifold of the engine along with the air in order to get an increment in the efficiency of the engine

The entire specifications of the engine that has been used for the experimental purpose is given below:

Fig:1 table of engine specification

Type	Four- stroke, single cylinder, Compression ignition engine, with variable compression
Make	Kirloskar AV-1
Rated power	3.7 KW, 1500 RPM
Bore and stroke	80mm×110mm
Compression ratio	16.09:1, variable from 13.51 to 19.69
Cylinder capacity	553cc
Dynamometer	Electrical-AC Alternator
Orifice diameter	20 mm
Fuel	Diesel
Calorimeter	Exhaust gar calorimeter
EGR	Exhaust Gas Recirculation provided
Cooling	Water cooled engine
Starting	Hand cranking and auto start also provided

Fig: 1 table of engine specification

ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 433 – 436 (2013)
Special Issue of ICACSE 2013 - Held on 7-8 January, 2013 in Lords Institute of Engineering and Technology, Hyderabad

Formulae used in the experiment:

The important formulae and the method used to calculate the brake power and hence the brake thermal efficiency of the engine from the values obtained from the experiment is as follows:

1)brake power

$Bp = (V*I*0.7)$ kW
V- Volt meter reading
I-ammeter reading
0.70 = 70% efficiency of the alternator

2) $SFC = (TFC/Bp)$ kg/kw-hr
3) $HI = (TFC*C_v)/(60*60)$ kw
Where 'TFC' is in kg/hr
'C_v' = 43000 kJ/kg
(Cv is calorific value of diesel)
4) Brake thermal efficiency
$\eta_{th} = (BP/HI)*100$
5) $EGR\% = (h_{egr}/h_{eg}) *100$

where

TFC	total fuel consumed in kg/hr
SFC	specific fuel consumption in kg/kw-hr
HI	heat input in kW
BP	brake power in kW
η_{th}	brake thermal efficiency
h_{egr}	manometric reading of Exhaust gas recirculation.
h_{eg}	manometric reading of Exhaust gas

Fig:2 nomenclature

The above formulae are required to calculate the overall thermal efficiency of the engine by recirculating the amount of exhaust in the inlet manifold at varying load. In order to calculate the fuel consumption, the engine is started and values are taken accurately according to the requirements.

Results:

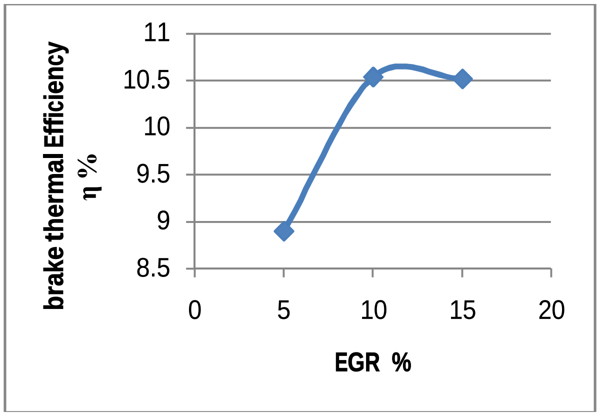

Fig: 3 Graph between EGR and brake thermal efficiency at 13.66%

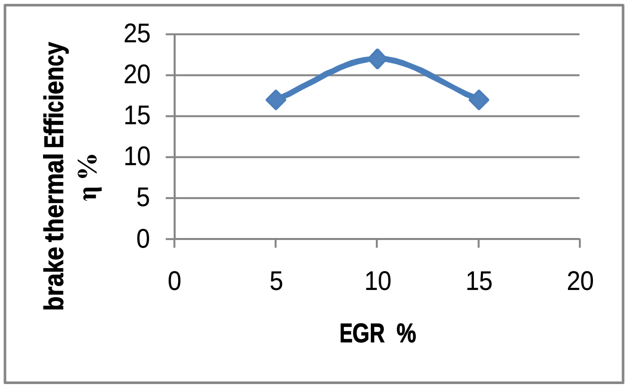

Fig: 4 Graph between EGR and brake thermal efficiency at 27.32%

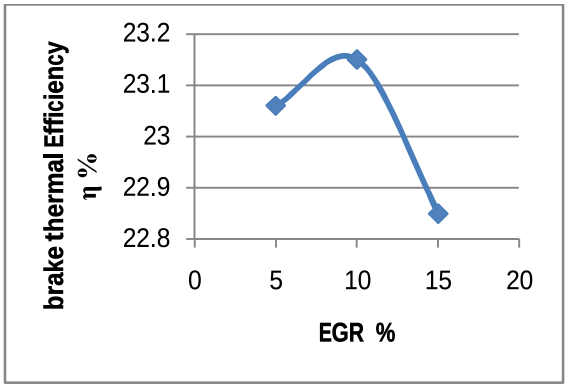

Fig:5 Graph between EGR and brake thermal efficiency at 40.98%

ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 433 – 436 (2013)
Special Issue of ICACSE 2013 - Held on 7-8 January, 2013 in Lords Institute of Engineering and Technology, Hyderabad

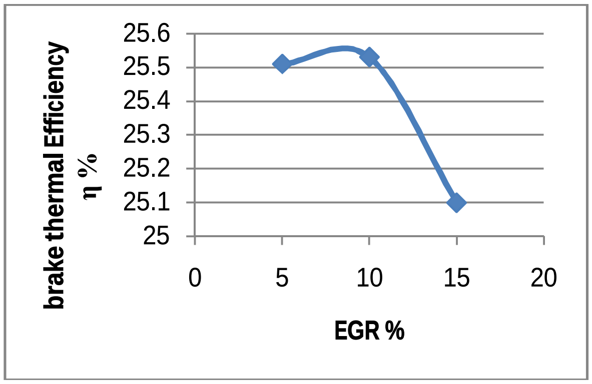

Fig: 6 Graph between EGR and brake thermal efficiency at 54.64%

Conclusion

The following conclusions can be drawn as the result of experimental results and discussions:

- As the amount of exhaust is recirculated to the inlet of the engine, the value of brake thermal efficiency first increases and then decreases at variable load percentages.
- As the amount of exhaust gas recirculated in the inlet manifold of the engine increases, the value of brake power also increases.
- As the amount of exhaust gas is recirculated into the inlet manifold of the engine, efficiency increases but decreases again. We can also notice that, the amount of EGR acceptable for increase in efficiency is at 0.5KW, since there is a considerable increase in the efficiency at 0.5KW load.

REFERENCES

[1] ^ Exhaust Emissions and Driveability — Chrysler Corporation, 1973.

[2] ^ a b Rosen (Ed.), Erwin M. (1975). *The Peterson automotive troubleshooting & repair manual. Grosset & Dunlap, Inc.. ISBN 978-0-448-11946-5.*

[3] ^ a b Rosen (Ed.), Erwin M. (1975). The Peterson automotive troubleshooting & repair manual. Grosset & Dunlap, Inc.. ISBN 978-0-448-11946-5.

[4] ^ a b Rosen (Ed.), Erwin M. (1975). The Peterson automotive troubleshooting & repair manual. Grosset & Dunlap, Inc.. ISBN 978-0-448-11946-5.

[5] ^ *SCR or EGR? - FleetOwner magazine.*

[6] Bennett, Sean (2004). *Medium/Heavy Duty Truck Engines, Fuel & Computerized Management Systems 2nd Edition*, ISBN 1-4018-1499-9. Page: 206.