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Exhaust Gas Recirculation in CI Engines

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Abstract: ***Exhaust Gas Recirculation (EGR) is being widely used to reduce and control the oxides of nitrogen (NOx) emission from diesel engines. When combustion chamber temperature reaches 2500ºF or 1370ºC, nitrogen and oxygen combine to form oxides of nitrogen (NOx). EGR controls the NOx because it lowers oxygen concentration and flame temperature of the working fluid in the combustion chamber. By this fuel economy and engine efficiency had been increased. But due to the over accumulation of carbon from the exhaust gas in the engine, creates consequences like knock and tears in the engine and even lead to the engine failure. As a solution for this issue we are introducing a small variation in the present EGR by fixing a carbon filter to separate the carbon content from the exhaust gas. The improvement in fuel consumption with increasing EGR is due to three factors: firstly, reduced pumping work; secondly, reduced heat loss to the cylinder walls; and thirdly, a reduction in the degree of dissociation in the high temperature burned gases. The use of EGR is, therefore, believed to be most effective in improving exhaust emissions.***
Keywords: Recirculation, Combustion Ignition Engine, Exhaust Gas, Carbon Air Filter

I. INTRODUCTION

In today's scenario we face lot of problems in the society and one of them is pollution. Here we address a remedy for pollution caused by vehicles. And also the consequence's faced due to EXHAUST GAS RECIRCULATION SYSTEM (EGR) which is implemented as to reduce exhausted pollution gas from the vehicle. In the internal combustion engine the EXHAUST GAS RECIRCULATION SYSTEM (EGR) was introduced to reduce the amount of nitrous oxide (NOx). The EGR recirculate a portion of the exhaust gas back into the engine cylinder which helps to increase the fuel efficiency and reduces the pollution. But likewise every technology has its own small or large drawbacks, unfortunately the EGR was having a large drawback and that was the accumulation of carbon in the valve and the piston cylinders which lead to the major consequences like engine wear, decrease in efficiency, and severe damage to the piston. So as solution for this issue we made a small change in the existing circuit by fixing a carbon air filter. In this paper we are going to discuss further about this concept and its uses, working and advantages.

II. HISTORY

The first EGR systems were difficult and tough to handle. Itwas as simple as an orifice jet between the exhaust and intake which processed exhaust to the intake when the engine was running. But the problems were difficult starting, rough idling, reduced performance and fuel economy. By 1973, an EGR valve controlled by manifold vacuum opened or closed to process exhaust to the intake only under certain conditions was found. The systems grew more difficultly as automakers gained much experience on the system. "Coolant Controlled Exhaust Gas Recirculation" system of Chrysler's in 1973 proved this evolution. A coolant temperature sensor was used to block vacuum to the EGR valve until the engine reached the operating temperature. This reduced many problems due to unnecessary exhaust induction. NOx forms under high temperature conditions and they are not generally present in a cold engine. Moreover, the EGR valve was controlled by the vacuum formed from the carburetor's , which allowed more precise EGR to flow only to those engine load conditions under which NOx is likely toform. Afterwards backpressure transducers were added to the EGR valve to control further increase in the EGR flow with the engine load conditions. Most modern engines now use exhaust gas recirculation system (EGR) to reduce emission problems.

The implementation of the carbon filter to the existing EGR system will reduce the huge accumulation of the carbon content in the engine. This will also give a relief to the engine wear as well as the engine problems at load conditions and at the working conditions. The characteristics and the specifications of the carbon filter were studied. This gives a great reduction to the

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environmental pollution. This will give a boost to the green revolution in the coming future.

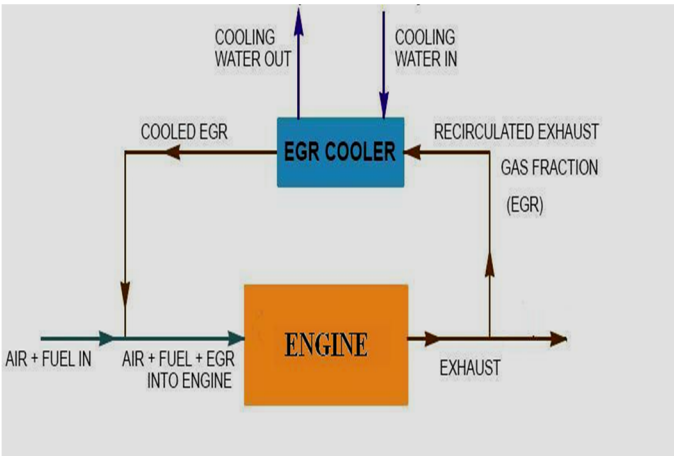
III. WORKING OF EGR

In modern diesel (CI) engines, the EGR gas is cooled with a heat exchanger to increase the rate of recirculated gas. The exhaust which is recirculated back into the cylinder can increase engine wear as carbon particles wash the rings and get into the oil in the engine. But this is controlled and reduced by the carbon filter.

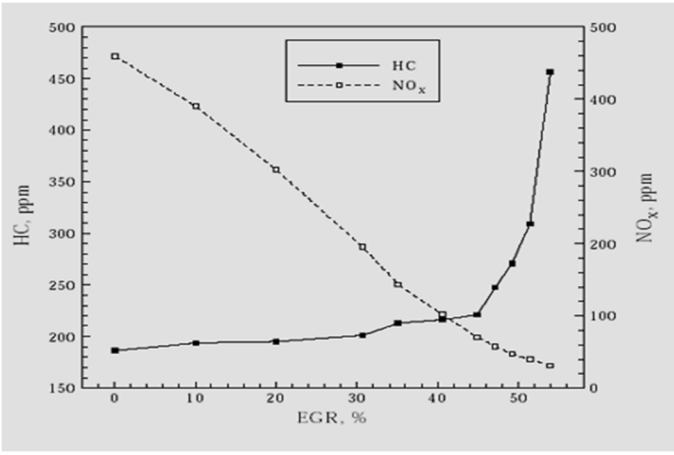
Exhaust gas constitute largely to the carbon dioxide and water vapor and has a higher specific heat ratio than the air, and reduces combustion temperature. By adding the EGR to a diesel it also reduces the specific heat ratio of the combustion gases in the power stroke of an engine. This reduces the amount of power that is to be used by the piston. EGR also helps to reduce the amount of fuel burned in the power stroke of a CI Engine.

Particulate matter which is mainly carbon does not get burned in the power stroke. The most commonly used diesel particulate filter in the exhaust system reduces the fuel efficiency.

By introducing the lower oxygen exhaust gas into the intake, EGR systems lowers combustion temperature, and reduces emissions of NOx. This proves combustion less efficient, and also compensates the economy and power. EGR systems may also have abrasive contaminants that increase engine oil acidity, which as an effect can reduce engine life.



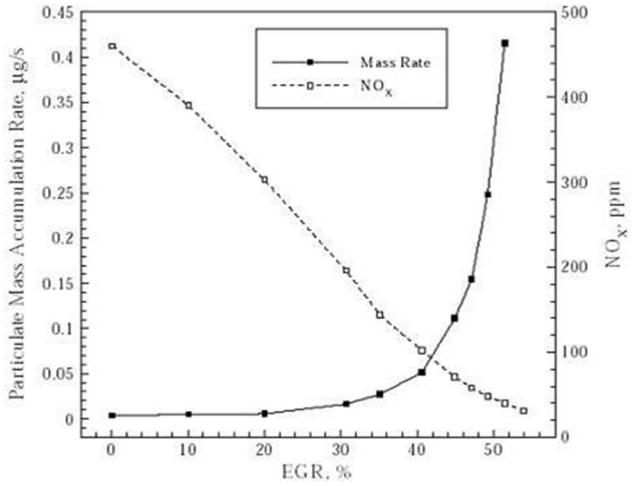
The graph representing Hydrocarbon (HC) and NOx in ppm as a function of EGR in % is given below. The graph shows a greater reduction and increase in the concentration of these particles in the Combustion Ignition Engine.



This graph shows that there is a continuous reduction in the case of NOx from (440 ppm to 20 ppm) and there is a sudden increase in the case of HC from (190 ppm to 460 ppm).

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The graph representing Particulate mass accumulation rate in (µg/s) and NOx in ppm as a function of EGR in % is given below. The graph also shows that they are inversely proportional to each other when comparing with the function.



The NOx feels like a slope and it is proved that by using the EGR a greater amount of NOx can be reduced. This is an effective method of reduction in the CI Engines from (420 ppm to 0 ppm). The other curve represents the Particulate mass accumulation rate (PM). There is an increase in the concentration from (0.01µg/s to 0.43µg/s).

IV. EGR IMPLEMENTATION

An engine recirculates exhaust gas by piping it from the exhaust manifold to the inlet manifold of an engine. This design is mainly known as External EGR. A control valve within the EGR circuit regulates the gas flow. A form of internal EGR also exists and it is used in the rotary Atkinson cycle engine.

EGR can also be implemented by using a variable geometry turbocharger (VGT) which also uses a variable inlet guide vanes to backpressure in the exhaust manifold. The pressure for the flow is given by the VGT.



V. CLASSIFICATION OF EGR SYSTEM

Various EGR systems have been classified on the basis of EGR temperature, configuration and pressure: S

A. Based On Temperature

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1) Hot EGR: Exhaust gas is recirculated without being cooled, and this result in increased intake temperature.
2) Fully cooledEGR:Exhaust gas is fully cooled before mixing with fresh intake air using a water-cooled heat exchanger in the system. By this, the moisture present in the exhaust gas may condense and the resulting water droplets may cause many effects inside the engine cylinder.
3) PartlycooledEGR:To avoid condensation in the particles, the temperature of the exhaust gas is reduced to its dew point temperature.

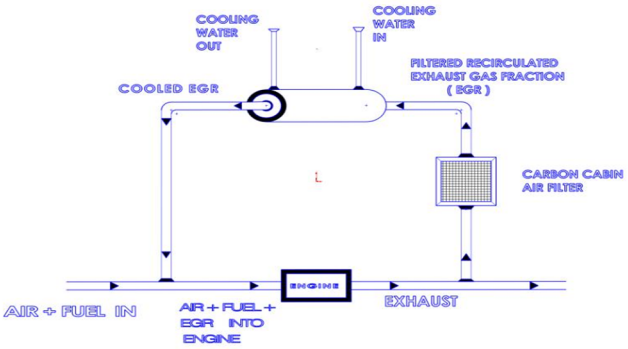
B. Based On Configuration

1) Long route system(LR):In an LR system the pressure drop across the air intake and the stagnation pressure make the EGR work suitably.
2) Short route system (SR): These systems differed mainly in the method used to set up a positive pressure difference across the EGR circuit.
3) Another way of controlling the EGR-rate is to use variable nozzle turbine (VNT). To this cooled EGR should be supplied effectively.

C. Based On PressurE

1) Low pressure route system: This systemhas a passage for EGR from downstream of the turbine to the upstream of the compressor.
2) High pressure route system: In thissystem the EGR is passed from upstream of the turbine to downstream of the compressor. This is mainly used in the high load regions.

VI. VARIATION IN THE EXICTING EGR



MODIFIED EGR SYSTEM

The new EGR is made with joining a carbon filter tank to the exciting EGR setup. This will increase the engine performance and the engine life. Alternative cleaning of the EGR valve can be reduced and the efficiency of the EGR valve can be increased.



CARBON AIR FILTER

This is the filter which is been set with the EGR valve for filtering the carbon content from the exhaust gas which comes out from the combustion chamber of a CI engine.

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VII. COMPANIES DEVELOPING EGR VALVE

A. BMW (e92 330d)
B. FORD (MK6 2000-2006 2.0.2.4 1333572)
C. LAND ROVER DISCOVERY 2
D. LAND ROVER DEFENDER (TD5)
E. FIAT (1.6 HDi/D/TDCi)
F. VOLVO (1.6 HDi/D/TDCi)
G. FORD(MK3 2000-2007 2.0 TDCI 257Q-9D475-AD)
H. RENAULT (1.9 dCi)
I. LAND ROVER FREELANDER (TD4)

VIII. ADVANTAGES

The EGR fixed with the carbon filter tank has much more advantages when comparing with the previous EGR. Such as:
A. This is the best way of reducing the combustion in the engine.
B. The pollution to the nature can be reduced.
C. Relief from the breathing illness.
D. Acid rain can be controlled.
E. Long lasting engine life can be ensured by reducing the accumulation of carbon content in the engine.
F. By this, the filter only wants to be cleaned once in a while and thereby increasing the efficiency of the EGR valve.
G. Increase in the efficiency of the engine and reduces the additional damage in the engine.
H. Maintenance cost is comparatively low.

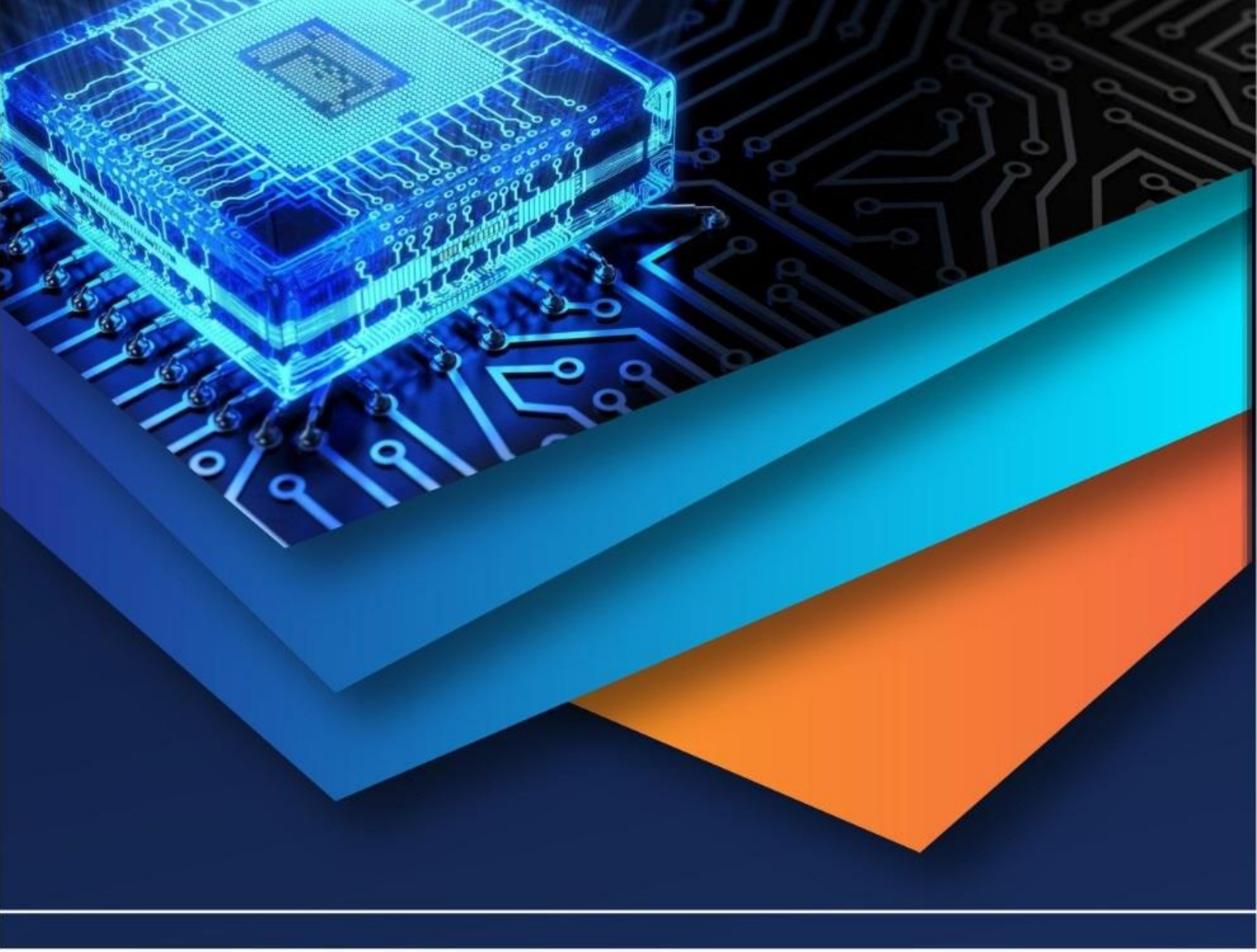
IX. CONCLUSIONS

A. In today's scenario, energy is a prime problem and to generate this energy is a huge task.
B. In automobiles large sum of money is spent on maintenance. Fuel which is a non-renewable source is being used beyond limitations.
C. Also the fuel usage adds up more pollutants to the environment which depletes the ozone layer.
D. Various proven methods of improving efficiency and reducing pollution being implemented, pollution are still a problem and depletion still continues.
E. With our concept we have tried to address this problem by fixing a carbon filter in the EGR circuit as discussed earlier.
F. This method is very suitable in increasing the engine efficiency.
G. Continuous cleaning of EGR valve is reduced and the efficiency of the valve is increased.
H. We hope that this concept will give a boost to green revolution in the future.

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