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Analysis of Performance and Emission of Two Wheeler Engine with Implementation of Combined EGR and SCR System: A Review

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Abstract: Major problem in today's world is harmful environment caused by pollution. The exhaust of engines has prime role in this. The exhaust gases mainly include CO, CO₂, HC, NO_x etc. Due to these emissions, phenomena like photochemical smog, acid rain, death of forest, reduced visibility has their adverse effects on environment. Emissions of green house gases from combustion of fossil fuels are associated with global warming of Earth's climate. Out of these NO_x is particularly very harmful among all other gases. It is produced due to high temperature in cylinder. So to reduce the emission of exhaust gases and reduced the effect of pre ignition in two wheelers vehicles as they are widely used in our nation, we are going to recirculate the exhaust gas and also adding an exhaust fluid to control the emission. We are going to install it in a single cylinder engine to examine changes in the production of emission and engine temperature thereby trying to prove that an exhaust gas recirculating (EGR) and selective catalytic reduction (SCR) is an effective strategy to control emission in IC engine.

Keywords: IC Engine, Exhaust Gas Recirculation, Selective Catalytic Reduction, Emission Control, Performance

I. INTRODUCTION

As the population is increasing day by day, our usage of fossil fuel is also increasing simultaneously and thus the emission. Through the time, technology has only focused on improving the efficiency of the engines and never on emission produced. The prevention of emission is never got studied thoroughly except some laws which mainly focuses only on CO and CO₂. Other components like NO_x, SO₂ and hydrocarbons which are far more dangerous than CO and CO₂ are never controlled systematically. So we have tried to build a method which can control emission by not affecting the engine efficiency on considerable extent. It is the need of current world as we are on the verge of buying fresh air to breathe.

A. Various Methods To Control Emissions

Since the invention of IC engines, ample of modifications have been done to achieve maximum performances while paying heed on cost, safety and environment concerns. Emission can be controlled by applying different techniques.

Following are some techniques to improve emission system.

- 1) Modification of fuel
- 2) Modification in engines design and parameters
- 3) Catalytic converter
- 4) Water injection
- 5) Exhaust gas recirculation
- 6) Selective catalytic reduction

However, all of the above mentioned methods are not feasible since some of these methods have various disadvantages which are listed below. Fuel mixed with methanol will reduce the emission but it is only suitable for diesel engine. Changing compression ratio can improve engine's performance but it will increase the temperature and tendency of detonation of the engine. NO_x reduction is function of water injection rate but it is not advisable as it is only feasible in ideal conditions not in practical methods. The only viable method to control the emission is remaining two. Exhaust gas is recirculated in a small quantity back to the engine cylinder which will absorb the heat and lowers the oxygen concentration. Selective catalytic reduction will be accomplished by converting the harmful contents like NO_x and other gaseous components in other eco friendly chemical compositions. NO_x is the substance which is found in exhaust gases reacts with other pollutants in the presence of sunlight to form ozone which can damage vegetation at high concentration. It also plays important role in the formation of smog, producing brown haze often observed over cities, particularly during summer. In the presence of rain, nitrogen oxides form nitric acid, contributing to the problem of acid rain.

Many more health and environment related issues are caused by NO_x, but sadly there is not any particular specified system to control it specially in two wheelers. In our country, two wheelers occupy major role in transportation if compare to four wheelers. So development of such system which can control NO_x and other harmful emission is need of current time as we are not so far from buying fresh air to breath.

B. Working of Exhaust Gas Recirculation

In internal combustion engines, exhaust gas recirculation is nitrogen oxide emissions reduction technique used in petrol and diesel engines. EGR works by recirculating a portion of engine's exhaust gas back to the engine cylinders. The device which is used to control the quantity of exhaust gas is called EGR valve, which is connected with the engine computer. PCM gives the command about how much portion and when the gas will enter to the cylinder from the exhaust manifold. The gas coming from exhaust manifold will be mixed with the fresh air fuel mixture and together enter in the cylinder. This mixture ignites with lower temperature. Due to lower temperature, quantity of NO_x produced is low.

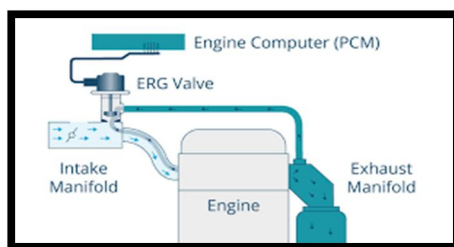


Fig. 1 Schematic diagram of EGR

C. Working of Selective Catalytic Reduction

Selective catalytic reduction is means of converting nitrogen oxides with aid of a catalyst into diatomic nitrogen and water. A reductant, typically ammonia or an urea solution is added to a stream of flue or exhaust gas and reacted onto a catalyst. It is advanced active emission control technology system that injects a liquid agent through a special catalyst into the exhaust stream.

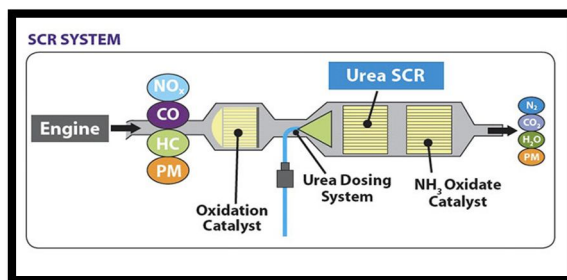


Fig. 2 Schematic diagram of SCR

D. Proposed System

Some portion of the exhaust gas from exhaust manifold is returned to the cylinder, which lowers the temperature and thus the production of NO_x is reduced, then rest of the exhaust passes through the SCR system, in which harmful composition will be converted into water and N₂. It is supposed to be implemented in two wheelers system as it has no such kind of emission control system.

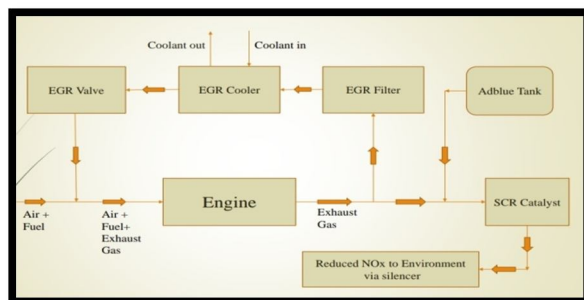


Fig. 3 Schematic diagram of proposed system

E. Advantages

It reduces NOx and saves environment. It decreases the engine temperature. Fuel consumption improves. Increases the efficiency of engine. It reduces formation of toxic gases. It reduces Pre Ignition in Engine. It reduces Pumping Loss. It can reduce CO, CO2 up to 50% and NOx up to 90%.

F. Disadvantage

Due to continuous depositing of carbon in cylinder, service is needed. As it recirculates the exhaust gas slightly fuel consumption is increased. EGR is effective on constant speed, so cannot be applied on higher rpm of engine. Basically, Exhaust gas recirculation has a lot of disadvantages but the advantages offered by exhaust gas recirculation easily outweigh the disadvantages and hence it should be widely used in two wheeler engines.

II. OBSERVATION AND IMPLEMENTATION

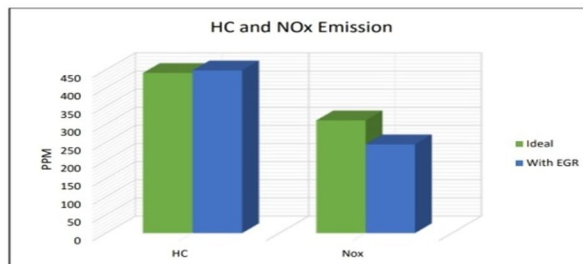
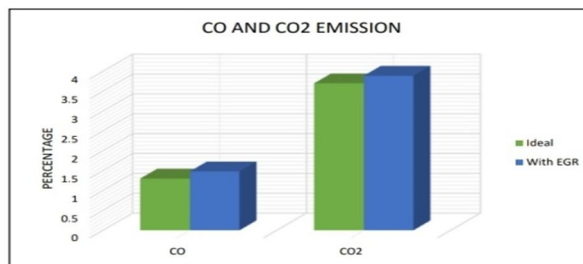


Fig. 4 comparison of normal engine with EGR engine

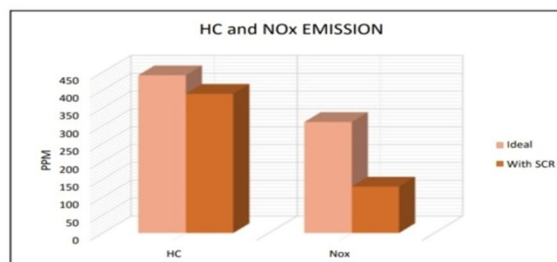
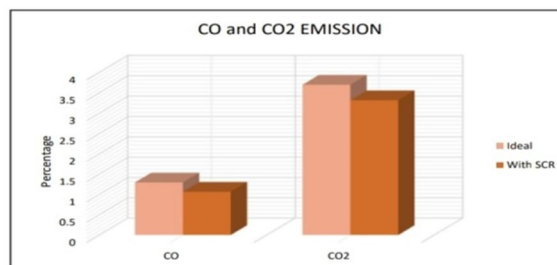


Fig. 5 comparison of normal engine with SCR engine

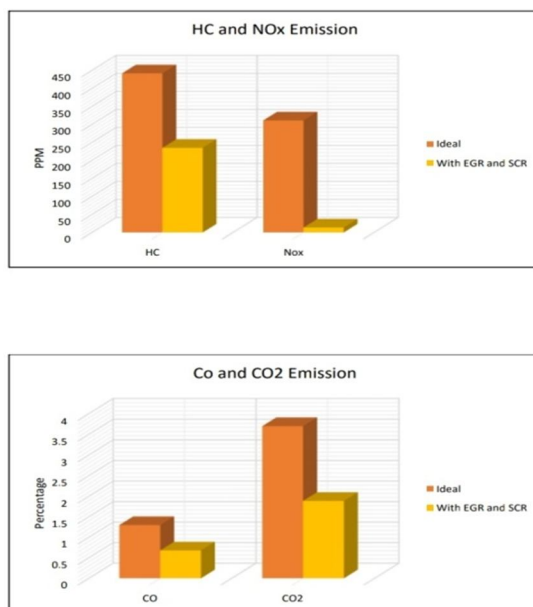


Fig. 6 comparison of normal engine with EGR + SCR engine

Firstly, we have measured the ideal fuel consumption of the bike engine by pouring 20 ml of fuel and running it till the fuel get finished and then counted its average by the ratio. We have done this process for 3rd and 4th gear and counted the values for rest of the gears according it as it was not feasible to run the bike on 1st and 2nd gear only. Then, we have taken the ideal values of exhaust gas emission with the help of exhaust gas analyzer. Furthermore, we implemented the EGR system and counted the fuel consumption same way as above. It is remarkable that we have only measured the value on 1st, 2nd and 3rd gear. As we have discussed before EGR can only useful on moderated speed only, on high speed engine needs full fresh air fuel ratio to reach optimum speed. By the observation it seemed that after implementation of EGR system fuel consumption is increased little more and carbon is also produced more as we are circulating a portion of exhaust gas again in the cylinder but there was considerable decrease in the amount of NOX produced. After that we have closed the EGR system and implemented the SCR system and did the same process. As SCR is only fitted in the silencer, it did not affect the fuel consumption. It can be taken as ideal engine. But there was great fall in the amount produced of CO, CO₂, HC and NOX which satisfies the aim. Numeric details are noted. Then, we have implemented both EGR and SCR system and took the readings. As a result, fuel was consume a bit more but there was a considerable loss of harmful emissions particles We have compared the final result with the ideal engine. We have prepared the bar charts for all conditions for better understanding, it can help in conclusion.

III.CONCLUSION

The effect of EGR and SCR on the performance of single cylinder 97cc 4 stroke engine has been analyzed and following conclusions can be drawn from the experiment.

The performance of the implemented system is optimum on moderated and constant speed where the emission of exhaust particles is decreased considerably.

Exhaust gas recirculation led to increase in production of carbon particles and fuel consumption but decreases the NOX emission.

SCR system reduces the amount of NOX, CO, CO₂ and HC without affecting the fuel consumption but it needs constant supply of exhaust fluid which is costly.

Application of combined system can reduce NOX up to 90% and CO, CO₂ and HC up to 50%.

This system can reduce the effect of pre ignition in the engine by reducing the temperature in the cylinder.

Reduced temperature in the cylinder led to longer piston cylinder life.

To differ the value of recirculated gas according to speed a computerised valve which can control the quantity as per need is required.

At the 4th gear the efficiency of the engine is decreased if the emission control system is in working condition.

Proper and time to time service of the bike is needed as carbon is deposited on inner parts of engine.

Reduction in harmful emission can led to good environment and healthy surroundings.



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