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Experimental Investigation on Exhaust Gas Emission (Co and Co_2) Reduction in Automobile System

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ABSTRACT

Automobiles system plays a significant role of polluting the air in the atmosphere, and which very much needed for day to day life, and there are many ways to reduce the pollution, by making advancement in engine configuration, using catalytic converters in the exhaust manifold, using biodiesel.In this paper, the experiment is conducted with 4 stroke IC engine in which two exhaust pipe design which embedded in a single housing using a rectangular design box. In which one has used a typical exhaust pipe and another coated with copper-zirconium alloy material in the exhaust pipe to absorb and reduces the exhaust emission of carbon monoxide and carbon dioxide after the catalytic converter. The catalytic converter reduces the exhaust emission into 90%.The gas sensor measures the exhaust emission continuously, and the measured data is more than the preset value (as per the Indian emission norm), the stepper motor was mounted over the housing box rotates thereby rotating the throttle plate hence changing the path of gas from uncoated pipe to the copper-zirconium alloy coated tube which reduces the emission before leaking to the atmosphere. By using this technique, the exhaust emission is reduced further. The result shows that the copper-zirconium alloy coated exhaust pipe absorbs and reduces the carbon monoxide (CO) emission by 0.3% and carbon dioxide (CO_2) emission by 0.8 % compare non-coated exhaust pipe.

KEY WORDS: 4 stroke I.C engine, copper-zirconium alloy material, catalytic converter, stepper motor, exhaust pipe, emission of CO and CO_2.

1. INTRODUCTION

The pollutants consist of Hydrocarbons, Carbon Monoxide, Nitrogen Oxides, Particulate matter, Sulphur oxides and other volatile organic compounds. In typical engine combustion - Fuel, Air, Nitrogen Oxides, Carbon Monoxide, Carbon Dioxide and Water are utilized. The emission of these gasses may cause many harmful diseases like cancer and respiratory problems.

Katherine (2015) used Carbon negative oil for reduction of CO_2 emission in automobile system. Piotr Bielaczyc (2014), made an assessment of regulated 2carbon dioxide emissions from the CNG-fueled vehicle. The results showed that the CO2 emission considerably reduced, and compared with the gasoline-fueled engine. I. Shancita (2014), analyzed the availability and capability of technologies to reduce fuel consumption and exhaust emissions from diesel and gasoline vehicles he revealed that the direct fired heaters, APUs and electrified parking spaces have a better reduction of fuel consumption and exhaust emissions compare with other technologies. Niveda Lakshmanan (2015), developed a transient model for a converter and tested under various operating conditions to reduce the NOx gas emission. Jibing Jiang (2016), designed exhaust temperature control and latent thermal energy storage device which is a more efficient system for reduction of NOx emissions. Paykani (2011), experimentally investigated the Performance of emission of Biodiesel Diesel Engine by recirculating the exhaust gas. The results have shown that the NOx emission reduces considerably to the lower value. Hardik (2014), methanol-diesel blended fuel is used in C.I engine, and the results observed that reduces the NOx emission and exhaust gas temperature and the HC, and CO was is increased.

2. METHODS & MATERIALS

Exhaust Emission Control System: Gas sensors embedded in the exhaust tail pipe which monitors the emissions continuously and sends data to the controller. The preset value has stored in the controller memory based on the Indian emission norms for vehicles. The schematic diagram of exhaust gas reduction system shown in Fig 1.The gas sensors measure the exhaust emission gas continuously and send the data to the controller. The sensor data is more than the preset value the stepper motor mounted over the housing box rotates thereby rotating the throttle plate hence changing the path of gas from uncoated pipe to the copper-zirconium alloy coated tube which reduces the emission before leaking to the atmosphere.

Exhaust Pipe Design: The exhaust pipe consists of a rectangular mild steel (M.S) box with one inlet and two output pipe. One of the output pipe coated with the absorbing/reducing material that will absorb/reduce the carbon content (carbon monoxide and carbon dioxide) from the exhaust. The rectangular box provides the housing for throttle plate and a mounting surface for the stepper motor. Stepper motor actuates this throttle plate and thereby exhausts emission data continuously taken by sensors in the exhaust pipe.

Inlet pipe: The inlet tube is a mild steel pipe with 44mm inner diameter (ID) and 46mm outer diameter (OD). The exhaust gas after exhaust stroke from exhaust manifold will through this inlet pipe reach into the rectangular box where it will be directed to one of the outlet pipes (tailpipes).

Rectangular box: The rectangular box provides housing for throttle plate and mounting surface for the stepper motor. This rectangular box is a mild steel box with dimensions 100mm,10mm,10mm length breadth, and height respectively.

Outlet pipes (tailpipes): There are two vent pipes (tailpipes). These are mild steel (M.S) pipes one is like regular exhaust and other coated from inside with absorbing/reducing materials. These pipes have 75mm inner diameter (ID), 77mm outer diameter (OD) and 220m length.

Stepper motor: Stepper motor by readings from gas sensors actuates the throttle. A standard value is set in the controller according to the emission norms now whenever the emission is more than the set value controller will actuate the stepper motor and it will rotate the throttle plate thereby changing the direction of flow of exhaust gas. The standard value set as 500mg of CO emissions after which controller will rotate the stepper motor for 52 degrees in 7 steps and direction of flow of exhaust gas will change from regular pipe to the coated tube.

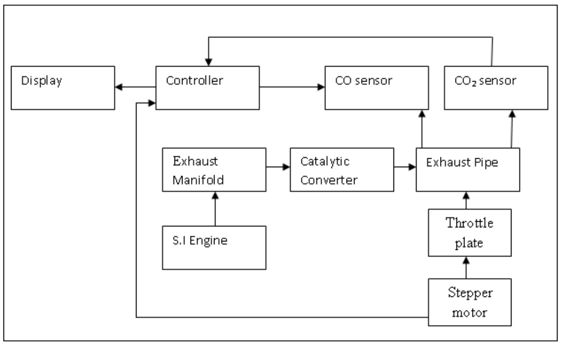

Figure.1.Schamatic diagram of exhaust emission gas system set up

3. RESULTS AND DISCUSSION

The IC engine is operated at three different load conditions and tested the exhaust gas emission performance with the coated and uncoated exhaust pipe design. For 0 kW load, the CO and CO_2 emission are less, and the load increases the CO, and CO_2 emission also increased. The exhaust emission system tested with two different conditions in which under the normal condition the CO and CO_2 is increased on the other hand the coated pipe design reduces the exhaust emission of CO and CO_2 into 0.3% and 0.8% compare with the normal condition.

Under normal condition:

Table.1. CO and CO2emission gas under normal condition

Load(kW)	CO (ppm)	CO_2(ppm)	O_2(ppm)
0	5000	29000	
1.25	6000	35000	171400
2.5	6500	37000	169000

The Fig 2 shows that the Load Vs CO and CO2 emission under normal condition. The CO2 gas reached the maximum of 37000ppm under 2.5 kW, and CO gas reaches to the highest value of 6500ppm under the same load condition.

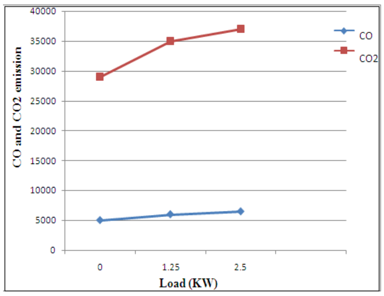

Figure.2. Load Vs CO and CO2 emission under normal condition

Using copper-zirconium alloy Coated Pipe:

Table.2. CO and CO2emission gas copper-zirconium alloy using coated pipe

Load(kW)	CO (ppm)	CO_2(ppm)	O_2(ppm)
0	4985	28768	172600
1.25	5980	34720	171600
2.5	6475	36700	170000

Fig 3 shows the Load Vs CO and CO2 emission with copper-zirconium alloy coated exhaust pipe. The CO2 gas reached the maximum of 36700ppm under 2.5 kW, and CO gas reaches to the highest value of 6475 ppm under the same load condition.

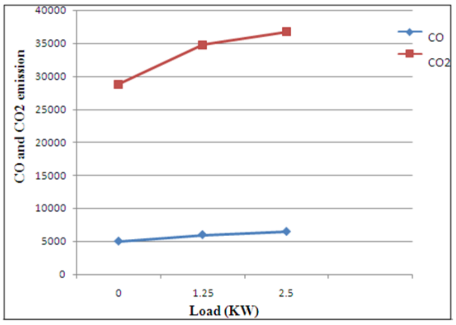

Figure.3. Load Vs CO and CO2 emission undercoated with copper-zirconium alloy

Molybdenum Material have used which are lighter in weight and can be a very effective catalyst for the reduction of carbon monoxide hence it can be a very efficient and cheap material option to be coated in the tail pipe. Ceramics like alumina porcelain and titanate ceramic should be as a coating material for absorption of carbon monoxide because of their excellent absorbing properties against carbon dioxide and their porous nature which is helpful in enhancing their absorbing capacity as compared to absorbing materials. Different kind of materials should use for various types of vehicles like charcoal which is excellent absorbent carbon monoxide, carbon dioxide, and hydrocarbons but cannot sustain high temperatures. That can utilized as an absorbent in the tailpipe of two wheelers and three wheelers which because of their small engine size and capacity produce less heated emissions. Similarly, ceramics and metals which are tolerant to high temperatures can be used as coating materials in tailpipes of cars and trucks having big and powerful engines.

4. CONCLUSION

The experiment is carried out with three different load condition.The result shows that the amount of carbon monoxide (CO) emission reduced by 0.3% and carbon dioxide (CO2) emission has reduced by 0.8 % after applying the material coating.Hence using adsorbing materials in exhaust tailpipe, emission of carbon monoxide and most importantly carbon dioxide reduced considerably low value

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