

Contrivance in a Two-Wheeler Exhaust System

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Abstract - One of the major cause of the air pollution is the emission from vehicles and this cause has turned out to be a major concern as the no. of vehicles has significantly increased over the years, hence it is predicted that the level of pollutants present in the air will escalate in the coming years as the exhaust emissions from automobile contains oxides of nitrogen, carbon monoxide, hydrocarbons and particulate matters. In South Asian countries like India, Bangladesh, Pakistan etc, two wheelers are found out to be a major contributor of this harmful exhaust emission. So, to control the emission level for reducing air pollution, various methods can be used and one of them brings the use of catalytic converters. But the problem associated with using the conventional catalytic converters (which incorporates the use of Platinum group metals like Platinum (Pt), Palladium (Pd) and Rhodium (Rh)) is the cost of this system, which makes it difficult for the two wheeler manufacturers to use a catalytic converters in the motorcycle and scooters [1]. These factors lead to an idea behind the application of materials like ZrO_2 , $CuSO_4$, $CuNO_3$, etc as a catalyst in the two-wheeler exhaust system. This step can help in reducing the emissions of carbon monoxide and hydrocarbons from the exhaust of the two-wheeler vehicles.

Key Words: Catalytic Converter, Emissions, Effectiveness, Auto catalyst.

1. INTRODUCTION

Over the past few decades, there has been a significant increase in the number of vehicles moving on the road, which can be termed as one of the major causes of poor air quality. So, the use of catalytic converters comes into the picture here. A catalytic converter is nothing but an exhaust emission control device that reduces toxic gases and pollutants in exhaust gas from internal combustion engine into less toxic pollutants by catalyzing a redox reaction [2].

1.1 Need of Catalytic Converter

The catalytic converter is the best device to meet the strict exhaust emission limits as it converts the hydrocarbon, carbon monoxide and oxides of nitrogen into less harmful gases by using catalyst [3]. The converter forms a chamber for the catalytic material in the in the exhaust gases in the presence of hydrocarbons (HC) and carbon monoxide (CO) compounds combine with the oxygen giving rise to harmless by products.

2. OBJECTIVE

Our main aim is to limit the concentration of the harmful emissions such as Carbon monoxide, Hydrocarbons coming out of 4-stroke petrol engine of two-wheeler by replacing a conventional silencer with a modified setup having a catalytic converter.

3. TYPES OF CATALYTIC CONVERTER

Two Way Catalytic Converter- A two-way catalytic converter performs two tasks simultaneously, oxidation of carbon monoxide to carbon dioxide and oxidation of hydrocarbons to carbon dioxide and water, as shown in figure 1. It has two separate elements one for nitrogen oxide and other for hydrocarbons/carbon monoxide. The converter has axial has axial flow and secondary air is injected ahead of first element.

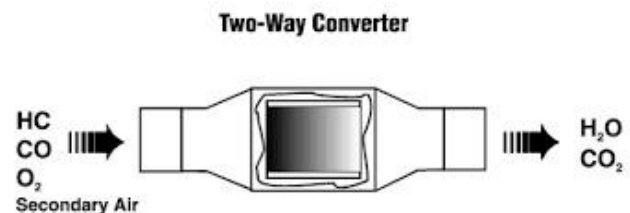
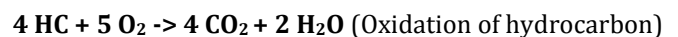


Figure 1: Two-way catalytic converter



Three Way Catalytic Converter- Three-way catalytic converters have the advantage of regulating the emissions of oxides of nitrogen. A three-way catalytic converter performs simultaneous tasks, reduction of nitrogen oxides to nitrogen, oxidation of carbon monoxide to carbon dioxide and oxidation of unburnt hydrocarbons to carbon dioxide and molecules of water. In this type of converter, the front inlet treated with platinum and rhodium and rear end is coated with palladium and termed as oxidizing agent [4].

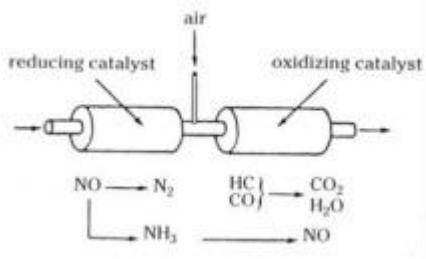
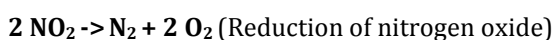
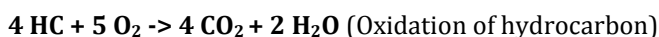


Figure 2: Three-way catalytic converter



4. EFFECTIVENESS OF VARIOUS MATERIALS

The process of selection of catalytic material that is best suitable for use in certain type of catalytic converter, out of all the options mentioned above the selection highly depends upon the result that a manufacturer wants to achieve and price to performance ratio is also considered as an important factor because materials like Palladium, Platinum, Rhodium are less abundant as compared to other alternatives. But the effectiveness of these alternative materials is far less when compared to platinum.

A.K.M. Mohiuddin et al. presented the outcomes having comparison of relative activities of noble group metals and base metal catalysts. The results were as follows, For Pd the relative activity was 500, For Pt it was 100, For Co_2O_3 it was 80, For CuO it was 45, For MnO_2 it was 4.4 and for Au the value was 15, all of these values were calculated for reactants having concentration of 1%. It can be observed from this data that the relative activities of Pd, Pt are superior to that of metal oxides like CuO, Co_2O_3 etc. [8].

5. RESEARCH METHODOLOGY

As discussed above, we know that the noble group metals like Platinum (Pt), Palladium (Pd) and Rhodium (Rh) are costly so, we need to find the alternatives of these metals. By going through the periodic table and studying about the various compounds of oxides, nitrites, etc. We found out that Zirconium dioxide (ZrO_2) and Copper Sulphate (CuSO_4) are such compounds which reacts with hydrocarbons and carbon monoxide and oxidize them into less polluting compounds like CO_2 and H_2O .

A metallic cylinder with holes drilled on it (for the passage of exhaust gases) coated with the paste of ZrO_2 . The cylinder was then attached with small circular nets coated with CuSO_4 . The whole set-up was then fitted inside a case like structure. This arrangement was then placed at the end of silencer of the vehicle. The exhaust gases goes inside this arrangement and passes through the surface of the cylinder

and nets and gets oxidized by the catalysts ZrO_2 and CuSO_4 . Finally, the exhaust gases comes out of the holes made by drilling on the set-up.



Set-up having ZrO_2 coated cylinder & CuSO_4 coated nets

6. EXPERIMENTAL OBSERVATIONS

We made a comparison between the values of the exhaust gases composition, first without catalytic converter and then using a catalytic converter. The table clearly shows that after using the catalytic converter emission level from the exhaust was reduced by considerable amount.

Case	Measured level of CO (in ppm)	Measured level of HC (in ppm)
Without using catalytic converter	1.03	476
Using catalytic converter (taking ZrO_2 & CuSO_4 as catalysts)	0.78	322

7. CONCLUSIONS

In this paper, we have selected ZrO_2 & CuSO_4 as a catalyst as they are cheaper than most of the materials and they have ability to absorb the reactant molecules strongly enough to activate the reactants which results in the increment in the rate of the reaction that is responsible for conversion of harmful emission into products which have less harmful impact on the environment. Due to this, it was noted that the pollutants level in the emission from 2 wheelers exhaust system was reduced which was a desirable outcome. The main concept behind working of this arrangement is to expose the utmost surface area of the catalyst bed to the exhaust emission & hence minimize the concentration of harmful by products present in the emission from the IC engine.

To obtain a physical result, we have performed a practical experiment to get an idea how effectively other alternatives

of platinum group metals can perform as a catalyst. The result of this experiment suggested that the competence of the Zirconium Dioxide and Copper Sulphate were comparable to that of the noble group metals. Hence considering the cost to performance ratio it can be observed that these compounds can be a good alternative to the conventional catalyst that are used in catalytic converters.

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