INQUISITIVE ANALYTICS OF DIVERSE EXHAUST SYSTEM CONTINGENT TO POLLUTION

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Abstract - *In the contemporary world, the pollution has become a major concerned to discuss about. Study of environmental pollution, especially air pollution, has become a major threat to developing countries.*

Increase in pollution have led to the fast degradation of our natural resources. Only fewer attempts have been made towards the environmental pollution problems. Air pollutants from automobile aspect has become one of the major cause to contaminate the atmosphere, the exhaust system in the vehicles has been introduced in order to minimize the level of toxic substances in the pleasant environment. In order to achieve the goal, the titled case study was undertaken with the aim of reducing air pollution in the atmosphere with the following method.

Key Words: **Air pollution, Exhaust System, Catalytic Converter, Resonator, Muffler, Back Pressure**

1. INTRODUCTION

One of the most essential inventions in automobile history is the invention of exhaust system which was a major step towards the betterment of environment. Despite the major efforts that have been made over recent years to clean up the environment, pollution remains a major problem in poses continuing risk to health. The air pollution is generally defined as the presence of undesirable toxic gases in the atmosphere. To minimize these harmful gases at some possible level from the automobile aspect the exhaust system has been introduced in vehicles. The whole exhaust system is basically designed in piping structure that helps in directing the reactive gases away from the combustion inside an engine. As the use of two wheelers is increasing rapidly and hence the emission of Hydrocarbon (HC) and Carbon monoxide (CO) is also increasing simultaneously. It is highly desirable to reduce the percentage of toxic substances in the exhaust gases in order minimize the pollution level in this pleasant atmosphere. There are different types of exhaust system available in market. Depending upon the market demands the system may come with the combination of header and intermediate pipes. The exhaust system of any vehicle consists of some essential parts like exhaust manifolds, oxygen sensor, catalytic converter, resonator, muffler and tail pipe. The following objectives of this paper are (a) To understand the results of HC emission in the exhaust gases. (b) To understand the results of CO emission in the exhaust gases. (c) To study the role of back pressure in the exhaust system.

2. LITERATURE REVIEW

Air pollution is the presence of contaminant or pollutant substances in the air that do not disperse properly and that interfere with human health or welfare or produce other harmful environmental effects. Emissions of some toxic gases like hydrocarbon, carbon monoxide and oxides of nitrogen are some of the unwanted contribution to air pollution by automobile domain. Urban people are most affected and amongst the worst sufferers are traffic policemen who are particularly close to the fumes of automobile exhaust. Studies made in Jaipur, India, indicate that there is high rate of occurrence of respiratory, digestive, ocular and skin problems amongst the traffic policemen and a significant number of them become victims of lung disorders in the very first few months of their posting to a traffic department. Traffic policemen everywhere should wear pollution masks for their own safety and to arouse public awareness of the risk of automobile pollution. [6]

Back pressure is generally defined as the pressure created to oppose the desired flow of exhaust gases in a confined area. It is caused by the obstruction or tight bends in pathway of exhaust pipe in which the gases travel. Back pressure caused by the exhaust system has a negative effect on engine efficiency resulting in a decrease in power output that must be compensated by increasing the fuel consumption. [3]

3. DETAILS OF EXHAUST SYSTEM

The main goal behind the invention of exhaust system in automobile was to minimize the pollution level in environment. The exhaust system is basically a pipe structured system which directs the flow of exhaust gases after being emitted from the combustion engine. The three major types of exhaust systems are header back, cat back, axle back. The exhaust system consists of four major components that are exhaust manifolds, catalytic converter, resonator and muffler.

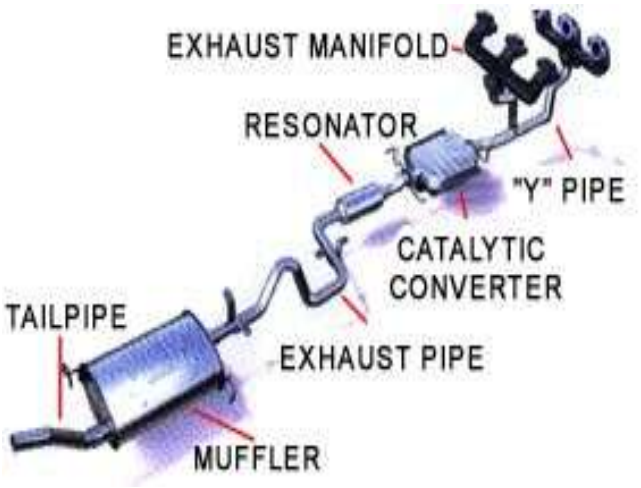


Fig-1: The exhaust system

3.1 Exhaust manifolds:

The very first part of the exhaust system which confronts the exhaust gases coming from the engine is exhaust manifolds. The exhaust manifolds collect the gases from multiple cylinders and wrap into one single pipe.

Fig-2: Exhaust manifold

The general materials used for making exhaust manifolds are simple cast iron or stainless steel.

3.2 Catalytic Converter:

The catalytic converter is a device which is used in the exhaust system to lessen down the hazardous substances such as carbon dioxide, hydrocarbon and nitrogen gas from the exhaust gases of the combustion. The catalytic converter consists of two ceramics blocks. The first block comprise of platinum and rhodium and second block is platinum and palladium. These elements act as catalyst.

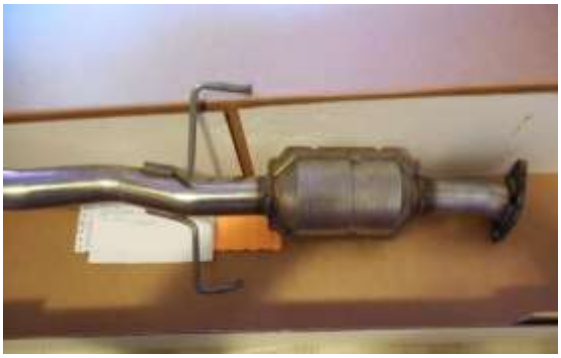


Fig-3: Catalytic converter

Toxic gases enter into a first ceramic block and heat up simultaneously, this causes catalysts to react with them. Nitrogen is the first molecule to react. These catalysts cause oxides of nitrogen to reform into nitrogen and oxygen respectively. Inside the second ceramic block the carbon monoxide reacts with oxygen molecules to form carbon dioxide. Unburned hydrocarbon also reacts with oxygen to form water vapour and carbon dioxide. Hence the exhaust gases become less hazardous.

Reactions involved:

The redox reactions held by the catalytic converter to lessen down the toxic gases, gives the following resultants.

1. Nitrogen oxide ⇒Oxygen + Nitrogen
2. Carbon monoxide + Oxygen ⇒ Carbon dioxide
3. Hydrocarbon + Oxygen ⇒ Water Vapour + Carbon dioxide

3.3 Resonator:

The resonator is a device which is used to either generate the waves of specific frequencies or to select the specific frequencies from a specific signal. The main purpose of resonator in automobile is to cancel out a certain range of sound frequencies according to the manufacturing requirements. In simple words the main purpose of resonator is to resonate. It is kind of an echo system, which deals with the different frequencies of sound pressure from exhaust gases. The resonator just not only remove the sound but it changes the sound too.

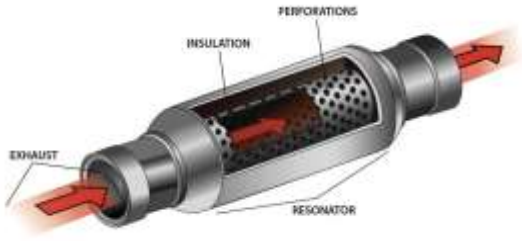


Fig-4: Resonator

Engineers have later realized that the sound of the exhaust gases can be modified according to them. With the help of resonator, the engineers can modify any sound by changing their frequencies before it reaches to the muffler.

3.4 Muffler:

The muffler is a device used to minimize the loudness of the sound pressure of the exhaust gases. After the resonating operation, the gases, now enters in the last major element that is muffler. The muffler is a device used for reducing the noise emitted by the exhaust gases of an engine. It reduces the sound pressure created by the engine by acoustic quieting. After the reduction of loudness of sound pressure, the finalized form of gases goes into the tail pipe which is the final outlet of the whole exhaust system. The silencer or muffler is a sub part of an exhaust system, which is used to reduce the noise created by the exhaust gases after the combustion of internal combustion engine takes place.

Fig-5: Mufflers

4. METHODOLOGY ADOPTED:

The collective data methodology has been adopted in this case study. The data from different vehicles of their respective exhaust system length has been taken under investigation. With the source of pollution unit control check (PUC), the emission of toxic gases like carbon monoxide and hydrocarbon from various vehicles was taken and then further categorized on the basis of length of their exhaust system.

The gathered data was further analyzed and compared with the maximum pollution level range for both the gases. The detailed study on working of various exhaust system was performed in order to elucidate its role in controlling the emission of toxic gases at some possible level.

In the following survey, the vehicles were discriminated on the basis of the length of their exhaust system, segmented as short, medium and long. Five different vehicles of each segment were taken under investigation and the average figure of each segment has been taken and further compared with each other in order to find out the emission of pollutants. The gathered data were then arranged in the tabular form to elucidate the results with respect to emitted exhaust gases.

Table 1: Results of PUC Test

Vehicles	Length of Exhaust System	Emission of gas CO (%)	Emission of gas HC (ppm)
Vehicle 1	Short	0.1	70
Vehicle 2	Medium	2.24	393
Vehicle 3	Long	3.5	3000

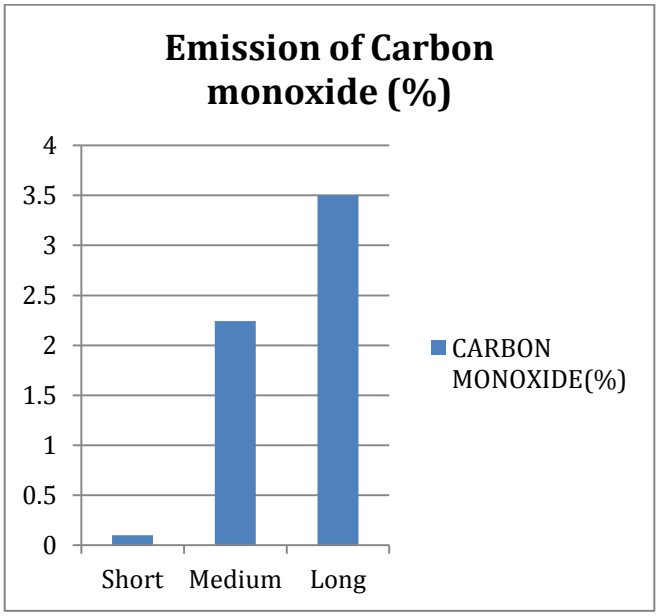
The ideal mathematical figures for the emission of gases should not exceed the following limit in order to lessen down the pollution level.

- Maximum limit for carbon monoxide - 3.5%
- Maximum limit for hydrocarbon - 4500 ppm

The tabular form display can also be illustrated in form of graphical figures for better understanding.

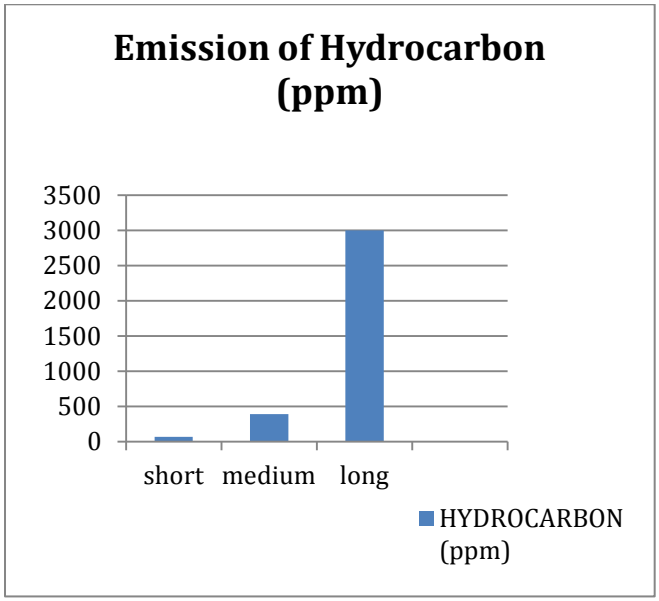
In the first analysis graph the different length of the exhaust system was compared with the percentage emission of carbon monoxide gas.

Chart 1: Emission of Carbon monoxide with respect to length of exhaust system



Similarly, the graph for emission of hydrocarbon gas was then compared with the different length of exhaust system.

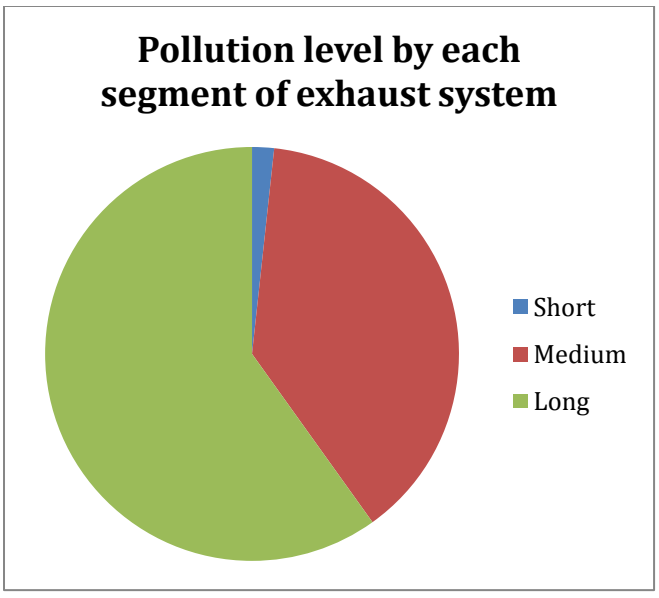
Chart 2: Emission of hydrocarbon with respect to length of exhaust system



4. CONCLUSION

As per the outcomes of the data and study, it is observed that vehicles having long length exhaust system are generating more pollution as compared to vehicles having short or medium length exhaust system.

Chart 3: Pollution level by different length of exhaust system



On shortening the length of the exhaust system, the pollution level also decreases. One of the major reason observed behind the following conclusion is back pressure. It is observed that with the increase in length of exhaust pipe, the magnitude of back pressure also increases which leads to the increase in fuel consumption and decreases the efficiency of the vehicle which again increases the emission level of the vehicle, resulting in more pollution. In order to lessen down the pollution level, backpressure needs to be reduced. Hence, with the following results we can conclude that the pathway of exhaust system should be of minimum length in order to achieve the goal of reducing pollution level for the better greenment of environment.

REFERENCES

1. Prof. Ganesha B, "Design and thermal analysis of motor bike exhaust silencer" ISSN:2278-0181, Vol.6 issue 9, September, 2017.

2. Abhishek Mhatre, "A review paper on exhaust manifolds" ISSN:2454-132X, Vol.4, issue 3.

3. Mohd Umair, "Modification in muffler design to reduce the back pressure" ISSN (print):2347-6710, Vol.5, issue 5, May 2016.

4. Johan wall, "Dynamic study of an automobile exhaust system" ISSN:1650-2140.

5. Department of civil engineering, "Study of air pollution due to vehicle emission in tourism centre, ISSN:2248-9622, Vol.2, issue 3, pp.1753-1763.

6. "Air pollution" OECD, Operation for economic co-operation and development.

7. Pooja mandal, "Causes of air pollution" Yourarticallibrary.com.