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An Experiment on Emission Control in Exhaust Gas Muffler of Two Wheeler

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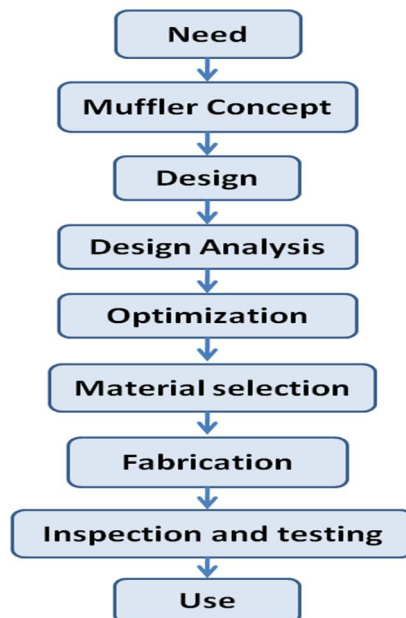
Abstract: In present day situation pollution in the world has become very harmful. Research work should be carried out to reduce pollution in the world to possible low value. During the starting day of automobiles, exhaust system was only considered to remove exhaust gases out of the cylinder of engine and has no importance at all. In two wheel automobiles rider and pillion rider can be directly exposed to harmful gasses coming out of the engine. Thus these exhaust gas mufflers are used take these exhaust fumes away from the rider and pillion rider to ensure a clean and healthy air supply. For these said purposes we are doing research in exhaust gas muffler to reduce pollution through two wheeler engine.

Keywords: Modified muffler, Reduce Air Pollution, Noise pollution, Analysis of Exhaust gasses, Asbestos fiber, glass wool, Two wheeler muffler

I. INTRODUCTION

In most of the internal combustion engine propelled automobiles, mufflers are installed in the exhaust system. The muffler is nothing but an acoustic device to reduce the noise of the sound created by the engine by method of acoustic quieting. The burning-hot exhaust gas noise leaving the engine at a very high speed is sent through series of chambers and passages lined with fiberglass insulation and/or chambers creating resonance which are used to cause destructive interference, due to which sound waves opposite each other cancel out. Engine efficiency can be decreased as noise reduction processes restricts exhaust gas flow which in turn creates back pressure. This effect is because of muffler is designed with inbuilt complex exit pathway such that sound pressure may get reduced at the exit of muffler. All the interior chambers and pipes can be seen in cut section view of the muffler. Some of the mufflers may claim to increase fuel economy and output power of engine by reducing back pressure on engine. But due to this noise reduction may be decreased. In many of the developed countries like Australia, Canada and United States modifications in mufflers are thoroughly regulated due to back pressure reduction.

II. METHODOLOGY



III. PROPOSED STYSTEM

A. Catalytic Converter

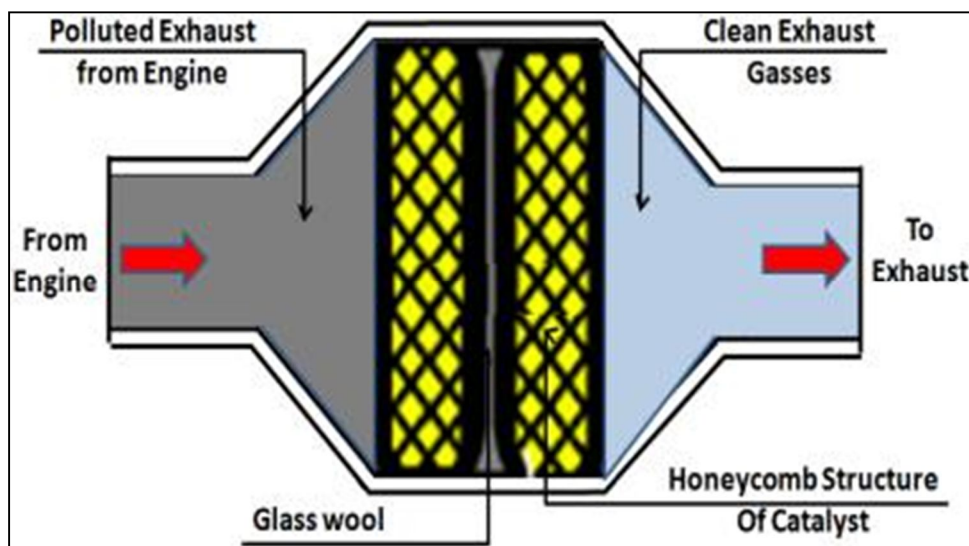


Figure No 1- catalytic converter

The device which is used to convert various toxic pollutants and gasses at the exit of an internal combustion engine into comparatively less toxic gasses by using different catalysts by different redox reactions is called as catalytic converter. It is basically exhaust emission control device used in automobiles.

B. Working of Catalytic Converter

In phase first catalytic converter is installed. At end of exhaust stroke all the exhaust gasses along sound waves generated are sent through exhaust valve to exhaust manifold. Due to partial combustion of exhaust gas it consist the harmful gases & that are carbon monoxide (CO), unburnt hydrocarbons (HC), nitrogen oxide (NOx). Inside the convertor ceramic block is present which carries the oxidation & reduction reaction of exhaust gas. The ceramic block consist two section & that are Platinum & Rhodium, Platinum & Palladium. These are helpful for to overcome the harmful gases specially NOx gas.

C. Glass wool

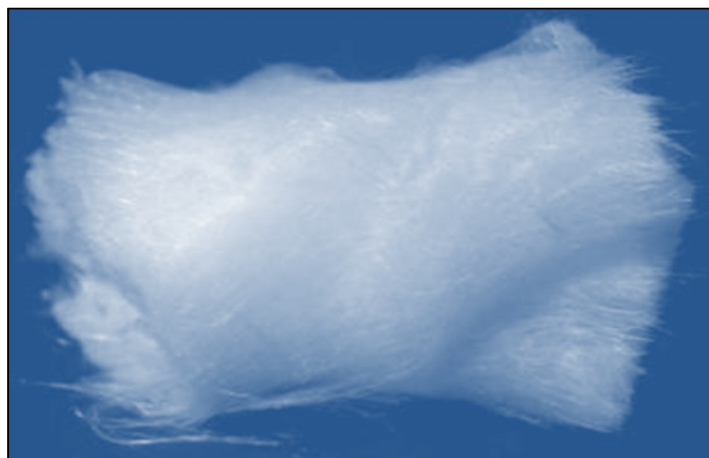


Figure No 2- Glass wool

The wool similar textured insulating material which is made up of some fibers of glass arranged by means of binder is called as glass fiber. In this process many small air pockets are trapped which results in very high properties of thermal insulation.

D. Working of Glass Wool in Silencer

High temperature and pressure of exhaust gasses passing through many perforated tube of muffler are reduced due to glass wool used in between nets. Glass wool absorbs sound intensity of exhaust gasses and reduces high pressure intensity there by reducing intensity of noise.

1) Net

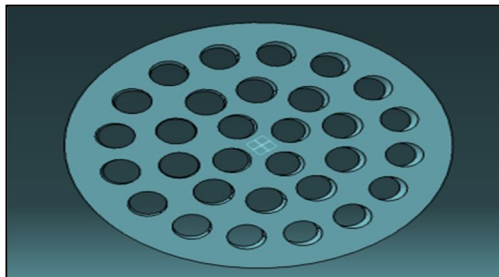


Figure No 3- Net

Exhaust gas muffler consists of number of nets spot welded inside the cylinder body thus the gases travel a short path in the muffler. There are many designs available for nets in the muffler. Due to the restricted flow of exhaust gases, back pressure increases which may cause low power output but the net holes are large which do not create the back pressure, so efficiency also increases.

2) Re-circulating Pipe

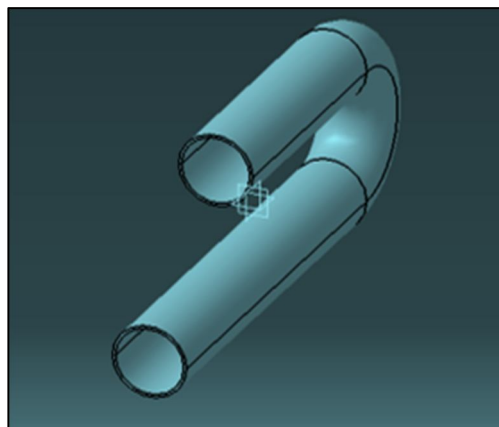


Figure No 4 – Re-circulating pipe

These pipes are used carry these exhaust gasses throughout the muffler and provides passage for exhaust gasses to flow out of the muffler

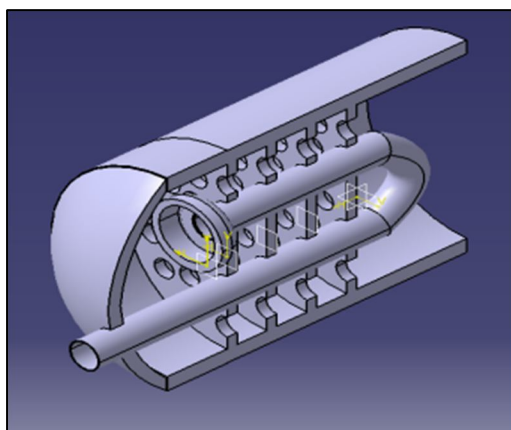


Figure No 5 - Isometric views

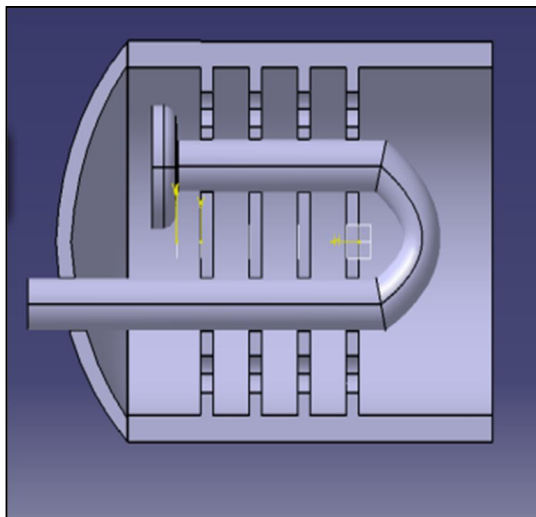


Figure No 6- Side view

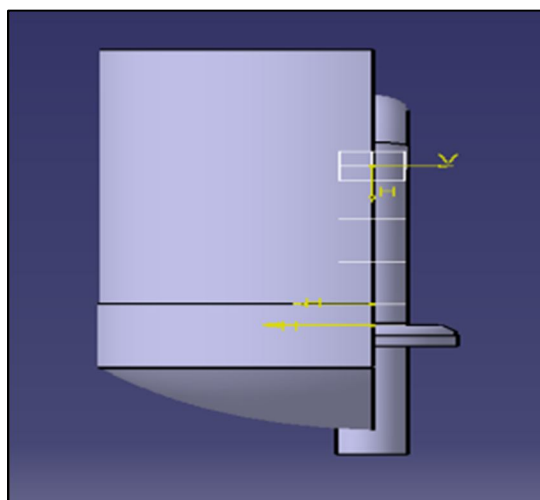


Figure No 7- Top view

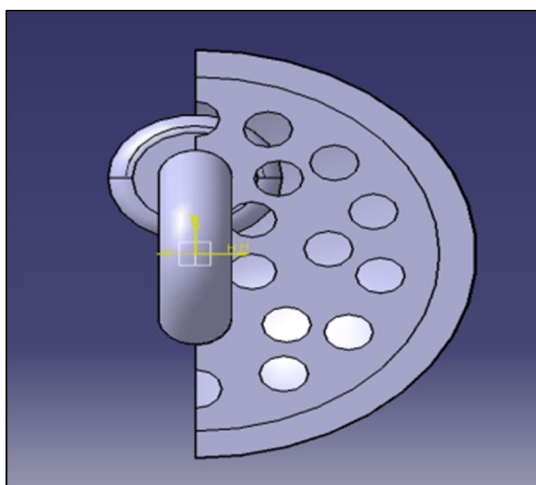


Figure No 8 - Back view

IV. HARDWARE

A. *Cut of the Silencer & Clean Carbon Particle Exist in it.*



Figure No 9 - Cut silencer

B. *Insert Recirculating Pipe with gas Welding*

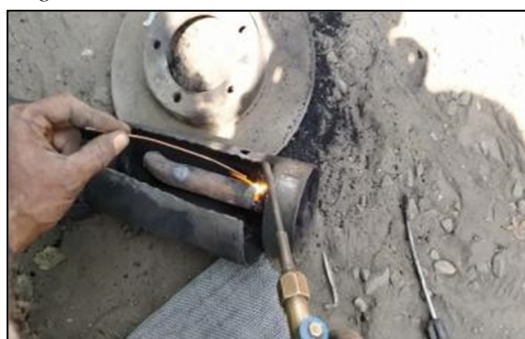


Figure No 10 - Insert recirculating pipe

C. *Fit Nets at Recirculating Pipe*



Figure No 11- Fit nets

D. *Fill the Charcoal and Glass Wool in Distributed Manner*



Figure No 12 - Fill the charcoal and glass wool

E. Completely Fit The Silencer Packing And Weld With Gas Wilding



Figure No 13- Completely fit with wilding

V. TESTING PROCEDURE

The testing procedure of muffler is based on idle tests of bike by using exhaust gas analyzer equipment. Figure shows general layout of the computerized testing system used by online PUC system. In this system sampling probe is inserted in muffler of a bike during engine idles upto 300 mm depth and this probe is connected to exhaust gas analyzer where emission of various gasses is calculated. The value of CO and HC concentration reading is recorded after engine speed becomes stable. This exhaust gas analyzer is connected to a computer having an inbuilt printer and a web camera. The emission values are sent to computer from the gas analyzer and simultaneously in built web camera captures photograph of the number plate of vehicle for the identification of the vehicle. This emission data of that particular vehicle is stored in the computer and sent to the required departments on-line as per government norms. Fig 14 shows the schematic diagram about the sequence of exhaust gas analyzing process.

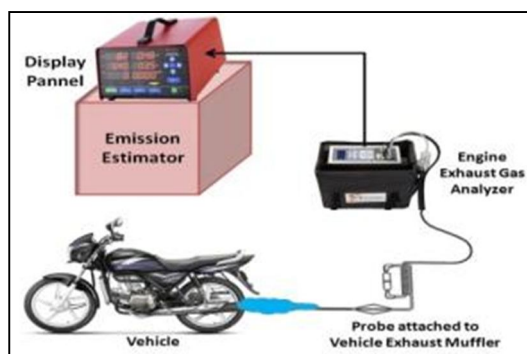


Figure No 14 - Exhaust gas analyzing process

A. Catalytic Converter Reactions

Sr. No.	Harmful Pollutant	Convert
1	CO	CO ₂
2	NO	N ₂
3	NO ₂	O ₂
4	HC	H ₂ O
5	NOX	-----

Table 1. Harmful Pollutant

1) Reduction reaction under platinum and rhodium.(Ceramic Phase – 1)

Reaction:



2) Oxidation reaction under platinum and palladium. (Ceramic Phase – 2)

Reaction:



VI. RESULT AND ANALYSIS

Table 2 displays the values of the emission certificate of emissions from the conventional and modified silencer.

Sr. No	Pollutant	Conventional	Modified	Reduction	% Reduction
1.	CO (% by Vol.)	2.32	0.5	1.82	78.44
2.	HC in PPM	291.0	278.0	13	4.46
3.	CO ₂ % by Vol.	2.9	0.5	2.4	82.75
4.	O ₂ % by Vol.	23.31	16.39	6.92	29.68

Table 2. Values of emissions

A. PUC Certificate:

Before (12/03/2020)	After (18/03/2020)																																
<p>Testing Centre Name: CENTER MALKAPUR, Centre Address: NR. 46-49, SATARA, 415539, Test Conducted By: PATWEKAR</p> <p>TEST RESULT FOR PETROL/DI/GULF VEHICLE</p> <table> <tr><th>MEASURED VALUE</th><th>UNIT</th></tr> <tr><td>CO</td><td>2.32 %</td></tr> <tr><td>CO-CORRECTED</td><td>2.32 %</td></tr> <tr><td>HC</td><td>291.0 PPM</td></tr> <tr><td>CO₂</td><td>2.9 %</td></tr> <tr><td>O₂</td><td>23.31 %</td></tr> <tr><td>RPM</td><td>0.0</td></tr> <tr><td>OIL TEMP</td><td>0.0 DEGREE CENTIGRADE</td></tr> </table>	MEASURED VALUE	UNIT	CO	2.32 %	CO-CORRECTED	2.32 %	HC	291.0 PPM	CO ₂	2.9 %	O ₂	23.31 %	RPM	0.0	OIL TEMP	0.0 DEGREE CENTIGRADE	<p>Testing Centre Name: CENTER MALKAPUR, Centre Address: NR. 46-49, SATARA, 415539, Test Conducted By: PATWEKAR</p> <p>TEST RESULT FOR PETROL/DI/GULF VEHICLE</p> <table> <tr><th>MEASURED VALUE</th><th>UNIT</th></tr> <tr><td>CO</td><td>0.5 %</td></tr> <tr><td>CO-CORRECTED</td><td>0.5 %</td></tr> <tr><td>HC</td><td>278.0 PPM</td></tr> <tr><td>CO₂</td><td>0.5 %</td></tr> <tr><td>O₂</td><td>16.39 %</td></tr> <tr><td>RPM</td><td>8.8</td></tr> <tr><td>OIL TEMP</td><td>0.0 DEGREE CENTIGRADE</td></tr> </table>	MEASURED VALUE	UNIT	CO	0.5 %	CO-CORRECTED	0.5 %	HC	278.0 PPM	CO ₂	0.5 %	O ₂	16.39 %	RPM	8.8	OIL TEMP	0.0 DEGREE CENTIGRADE
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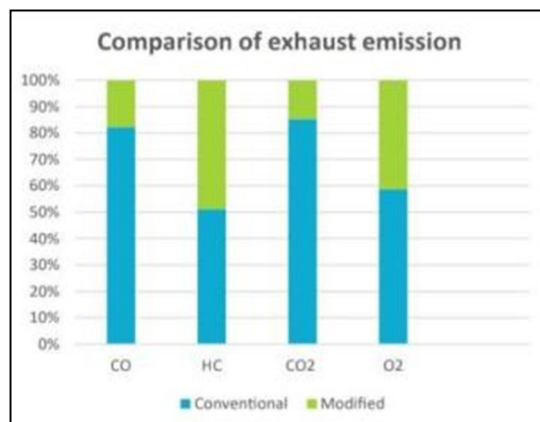


Figure No 15 - Comparison of exhaust emission

The data presented by graph represent the pair of emissions of specific pollutants before and after modification. Bar lines (Y-axis) represent the emission factor chosen for comparison of two pollutants. From this graphical representations we can clearly see percentage of decrease in various pollutants after modification in muffler is done.

VII. EQUIPMENT OR TOOL REQUIRED

- A. Tool box.
 - 1) Piler
 - 2) Screw Driver
- B. Hand Grinder (Model :H135)
- C. Cutting machine
- D. Hammer
- E. Vernier
- F. Measuring tape.
- G. Hex saw
- H. Punch
- I. File
- J. Bench vice
- K. Catalytic Convertor
- L. Glass Wool
- M. Nets
- N. Recirculating Pipe

VIII. ADVANTAGES, DISADVANTAGES AND APPLICATIONS:

- A. *Advantages*
 - 1) It reduces emission gasses and noise very effectively.
 - 2) It is very easy to do Maintenance.
 - 3) Measurable reduction in smoke and pollution of gasses.
 - 4) Higher performance compared to conventional silencer.
 - 5) May be at low cost by mass production.
 - 6) Source of energy used is non exhaustible.
 - 7) This muffler system is eco friendly.
 - 8) Simple construction and good appearance
 - 9) Sound level is also reduced by a good margin.
- B. *Disadvantages*
 - 1) More weight compared to the old muffler.
 - 2) More cost compared to the old muffler.
- C. *Applications*
 - 1) All SI engine propelled two wheelers.
 - 2) All types of SI engine propelled generators.
 - 3) Can be used in the small scale industry.

IX. FUTURE SCOPE

- A. Tube mufflers with different porosities and different inlet/outlets can be designed..
- B. Hybrid muffler can be designed easily and quickly for excellent performance.
- C. Hollow iron pipe can be replaced by folded stainless steel sheet. We can use glass wool in all three phase for better performance.
- D. All three phase present inside silencer get connect to each other regarding for maintenance.
- E. We can modify third phase of muffler by mixing the charcoal & vinegar solution.

X. CONCLUSION

- A. On basics results obtained from the experimental investigation on both the original silencer and modified silencer of a single cylinder petrol engine used in two wheeler, we can conclude that:
- 1) Reduction in CO (% by Vol.) is about 78.44%.
 - 2) Reduction in HC in PPM is about 4.46%.
 - 3) Reduction in CO₂ % by Vol. is about 82.75%.
 - 4) Reduction in O₂ % by Vol. is about 29.68%.
- B. Quicker heat dissipation rate is observed than the original silencer. Its value decreases about 20⁰c approximately. This is due to uniform distribution of heat with the help of glass wool added in it. The silencer failure due to cracks are reduced with the help of heat dissipation material.
- C. Noise pollution is also decreased by a good margin and we can feel it by naked ears.
- D. Depending upon the conclusions we can say that modifications done in the muffler are successful and this design is optimize for various applications of spark ignition IC engines.

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