

Design and Analysis of Aqua Silencer

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Abstract - An *aqua silencer* is a concept which is designed to replace conventional single unit engine silencers on board structure. It is made to deal with the control of overall emissions and undesirable sound at the engine exhaust of the vehicle. Sound produce due to working of the engine can be controlled by using water as sound produce in water is less hearable than produce in open air. This is mainly because of small sprockets in water molecules which lowers its amplitude, thus lowers the sound level. Exhaust emissions are controlled by applying a layer of activated charcoal on a perforated tube. Activated charcoal is highly porous and possesses free extra valances and has good absorption properties. So it absorbs the gases from the engine and releases much less portion to the atmosphere. The level of the sound and smoke coming out of the *aqua silencer* is considerably less than conventional silencer. Therefore serious attempts should be made to conserve the earth's environment from degradation.

Key Words: Aqua silencer, exhaust emissions, activated charcoal, noise, perforated tube, Water

1. INTRODUCTION

Aqua silencer is made to reduce the level of noise and emission in IC engines. The main objective why we go for aqua silencer is, in today's life the air pollution causes physical ill effects to the human beings and also to the nature. The main reason behind the air pollution is automobile releasing the gases like carbondioxide and unburnt Hydrocarbon. Carbon emission is the release of carbon into the atmosphere. The carbon emissions are directly referred to the greenhouse gas emissions. The main contributors to climate change. Since greenhouse gas emissions are often calculated as carbon dioxide equivalents, they are called as carbon emissions, when discussing global warming or the greenhouse effect. In industries the burning of fossil fuels has growing in high value, simultaneously increasing of carbon dioxide levels in our atmosphere and thus the rapid increase of global warming. In order to avoid this type of gases, aqua silencer is introduced.

Currently, overall exhaust emissions, crankcase blowby & evaporative losses are the main constituents contributing towards exhaust emissions in case of automobiles catalytic converter is used for getting control over carbon monoxide (CO), unburnt hydrocarbons (UBHC) & oxides of nitrogen (NOx), and many more gasses. Muffler is used for controlling

undesirable noise at tail pipe of vehicle exhaust system. It also controls the exhaust gas recirculation (EGR) for controlling crankcase blow by. Evaporative losses are occurred due to vehicle parking it under direct sunlight. The reason of continuously increasing air pollution is the vehicle exhaust, releasing hazardous gases like Carbon Monoxide (CO), Oxides of Nitrogen (NOx), Unburnt Hydrocarbons (UBHC) & Lead (Pb), etc. Automobile exhaust is not the only cause of air pollution, other sources like electric power generation stations, thermal power plants, industrial processing, domestic fuel consumption, refuse burning etc. also contributes heavily to degradation of our environment.

1.1 Objectives

The immense study and research is going to reduce emission level in auto-mobiles at various levels. Our main objective of work is to contribute our knowledge to control the emission level at lowest value as possible in IC engine, reduce noise level and also reduce back pressure as much as possible. There has been an increasing issue in recent few years about transportation and discharge outlets of industrial waste into environment. The engine emission contains smoke which creates air pollutants and other species. Hence, removal of these pollutants was necessary concern over these years. There are many other expensive techniques which are in developed in countries. In which adsorption technique is less expensive and economically feasible. It has been used for present study using some cheap cost chemicals as an effective adsorbent. Therefore the objective of the project work is to test the ability of an Aqua Silencer in minimizing air pollutants and reduce noise of emission from engine.

1.2 Scope of the Project

Modifications and future scope for this project can be done by implementing nano tubes inside the perforated tube. The nano-tubes are polymers which have the manganese in its which will trap the exhaust pollutants inside it and separates the hydrogen molecules. These hydrogen molecules then can be used as regenerative to charge the fuel cells. The nano tubes are fitted in perforated tube which is immersed inside the water. So the purification process is reduced and does not require separate technique. Nano tubes can be used instead of charcoal in Aqua Silencer. As it is comparatively expensive, further modifications are being carried out to enhance more abilities.

2. CONSTRUCTION & WORKING

Basically an aqua silencer is installed with a perforated tube which is mounted at the end of the exhaust pipe. The perforated tube is having holes of different diameters. Generally 4 sets of holes are drilled on the perforated tube. The purpose of providing different diameter hole is to break up gas mass to form smaller gas bubbles which can be easily absorbed by the charcoal layer. The other end of the perforated tube is closed by plug.

Around the circumference of the perforated tube a layer of activated charcoal is provided and further a metallic mesh covers it. There are some charcoal pieces inside the perforated tube for increasing the absorption rate. It is highly porous and posses extra free valences so it has high absorption capacity. After passing over the charcoal layer some of the gases may dissolve into the water. We have added urea in the water due to which the hydrogen bonds between urea and water were found to be comparatively weaker than those between water molecules. It gets concentrated with water due to hydrophobic effect. It is found to be 20% effective for the water evaporation rate. The whole unit is then placed in a water container. A small opening is provided for the outlet of the exhaust gases at the top of the container and at the bottom a drain plug is mounted for periodically cleaning of the container. Also a filler plug from which water can be filled is mounted at the top of the container. A non-return valve is provided at the entry of the exhaust pipe which prevents the back flow of water and exhaust gases in the engine cylinder. Therefore aqua silencer reduces noise and pollution.

2.1 Methods to control water pollution

There are two processes in aqua silencer which are used to control water pollution. The water gets polluted by the dissolved gases. When these gases are mixed with water, they form acids like carbonic acid, sulfuric acid, and Nitrous acid etc. The petroleum products contain phenols which gives suffocating smell. The sulfur gas mixes with water to form hydrogen sulfide, which give rotten egg smell. These gasses are needed to be controlled to reduce the water pollution.

There are two methods:

1. Lime water wash method
2. Absorption process (using charcoal)

We have used Absorption process method i.e. (activated charcoal) in our project to control the water pollution. Activated charcoal is available in granular or powdered form. As it is highly porous and possess free valences. So it possesses high absorption capacity. Activated carbon is more widely used for the removal of taste and odorous from the public water supplies because it has excellent properties of attracting gases. The activated carbon is mostly available in the powdered form is added to the water either before or

after the coagulation with sedimentation. But it is always added before filtration.

2.2 Effects of dissolved gasses on water

The water gets polluted by the dissolved gases. When the gases dissolved in water, there are some of the following effects which are formed by the acids, carbonates, bicarbonates in water. The water is a good absorbing medium.

1. Action of dissolved SO₂

When SO_x is mixed in water, it form SO₂, SO₃, SO₄, H₂SO₄, H₂SO₃, i.e. sulfur Acid (H₂SO₃), it forms Hydrogen Sulphide which causes corrosion of metals and spread rotten egg smell.

2. Action of dissolved CO₂

The dissolved carbon dioxide forms bicarbonate at lower PH and Carbonates at higher PH. This levels 40-400 mg/liter. They form a scale in pipes and boilers. Carbonic acids are formed which corrosive to metals and causes green house effect.

3. Effect of dissolved NO_x

When NO_x is mixed in water, it undergoes oxidation to form ammonia as well as Nitrate, Nitrite and Nitric acid. This composite of protein and amino acids is affected by Nitrogen.

2.3 Work done

We have worked upon design of parts and drawing of aqua Silencer. The fabrication of aqua silencer requires the following components to complete the operation of the silencer.

1. Perforated tube
2. U tube
3. Activated Charcoal layer
4. Exhaust gas from engine
5. Outer shell
6. Water

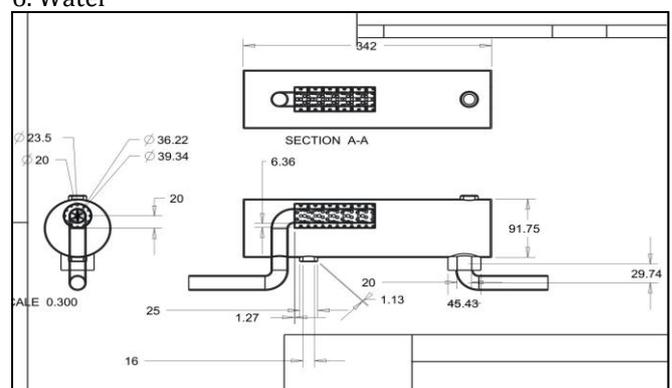


Fig -1: Drafted view of aqua silencer

3. CAD MODEL OF AQUA SILENCER

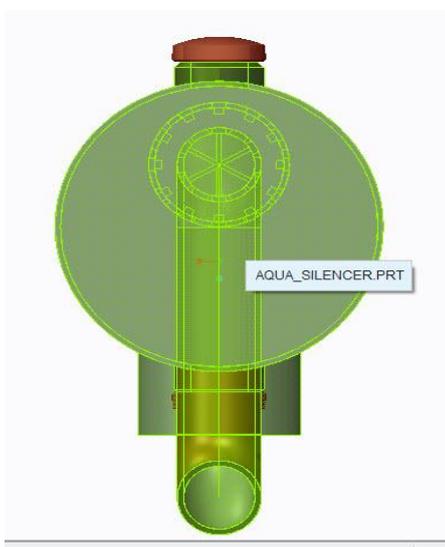


Fig- 2: Side view

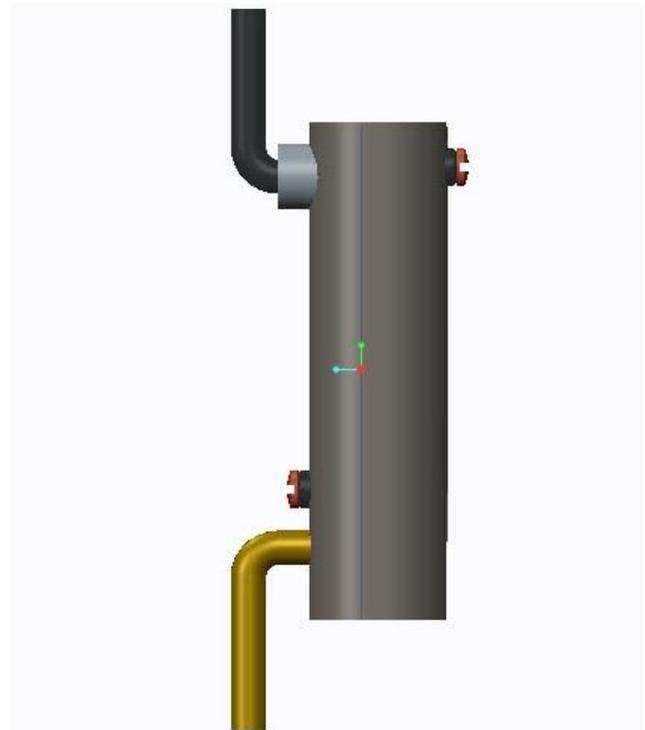


Fig - 4: Front view



Fig- 3: Top view

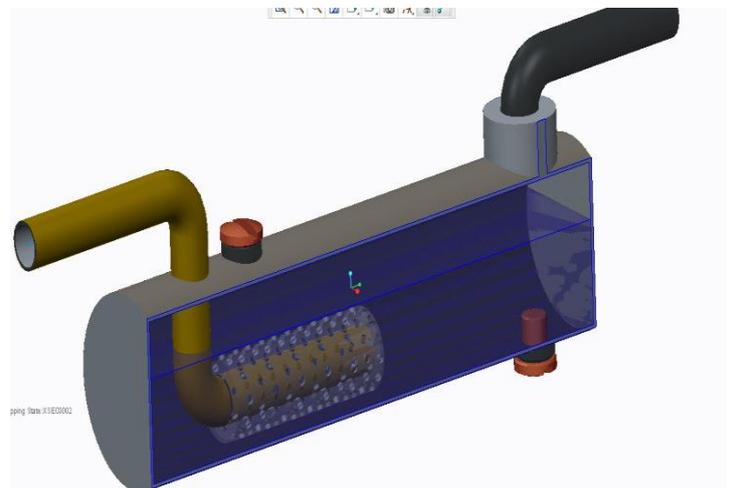


Fig - 5: Sectional view of aqua silencer

4. EXPERIMENTAL SETUP

Engine Specifications

Model: Hero Honda Splendor

Bore (D) = 50 mm

Stroke (L) = 49.5 mm

No. Cylinders (n) = 1

Engine power (P) = 6.15kw (8.36ps) @ 8000rpm

Max. RPM (N) = 8500 rpm

Allowable back pressure for muffler

= Not available (in H2O)

Transmission Loss Noise target (muffler) = 30 dB.

To find fundamental frequency

Cylinder Firing Rate (CFR)

CFR = RPM/120 for 4-cycle engines

CFR = 8000/120

= 66.66Hz

Engine firing rate (EFR)

EFR = No. of cyl. x Cylinder firing rate

EFR = 1 X 66.66

= 66.66Hz

Muffler volume calculations

Swept volume (V_s) = $(\pi \times d^2 \times L)/4$

= $(3.14 \times 50^2 \times 49.5)/4$

= 97193.022 cm³

= 0.09714375 Lit.

Volume to be consider for calculation

Volume = (No. of cylinders) x V_s

= (1) x 0.09714375

= 0.0971930 Lit.

As no. of cyl = 1 for hero splendor.

Silencer Volume (V_m) = Factor* x Consider Volume

= 25 x 0.0971930 Lit.

= 2.42982556 Liters.

*Assumed Factor = 25

For volume of silencer the factor should be at least 12 to 25 times the volume to be considered. Volume can be changed depending on the space constraint.

Internal configuration of muffler and concept design

Diameter of muffler calculated as

$V_m = (\pi/4) \times D^2 \times L$

2429825.5568 mm³ = $(3.14/4) \times D^2 \times 0.350$

D = 94.01mm OR D = 94 mm.

Here, we take L= 350 mm after studying various muffler lengths of similar engine mufflers and overall space available on a motorcycle for mounting of a muffler and hence we select the same length.

Tail pipe design

Generally Tail Pipe Diameter and shape is taken the same as selected by OEM or manufacturer for lesser flow resistance and optimum flow characteristics. Hence, Tail Pipe Diameter = 23.48mm (From Hero Honda splendor).



Fig - 6: Experimental Setup of Aqua Silencer

5. EXPERIMENTAL TESTING AND RESULTS



Fig - 7: PUC test conventional Silencer



Fig – 8: PUC test Aqua Silencer

Parameters	Before Installation of Aqua Silencer	Considered After Installation of Aqua Silencer
Carbon Monoxide (CO)	0.387 %	0.084 %
Non-Methane Hydrocarbons (HC)	524 PPM	239 PPM
Vibrometer Reading (Avg.)	113.66 db	99.33 db

Table – 1: Comparison of results.

5.1 Result Discussions

We obtained results by before installation and after installation of Aqua Silencer. Figure 7 show that the pollution under control reports for the model Hero Honda Splendor and vehicle no is **MH12 AL 5046** without connecting Aqua Silencer and Figure 8 with the Use of Aqua Silencer. Here we have seen that the total amount of pollution which producing by the conventional silencer. Here we clearly seen that the HSU % at different PPM.

6 CONCLUSIONS

We conclude from our experimental results that Aqua Silencer is more effective than conventional silencer by reducing the exhaust gasses emissions by using perforated tube and charcoal. The sound level is decreased by using urea based water. By using perforated tube the back

pressure will remain constant and vehicle's fuel consumption will remain same. With the help of PUC reports the HSU% is reduced.

REFERENCES

- [1] Miers, S.A., and R.D. Chalgren, "Noise and Emission Reduction", SAE Technical Paper Series 2000-01-2573.
- [2] J Keval I Patel, Mr. Swastik R Gajjar, "Design And Development Of Aqua Silencer For Two Stroke Petrol Engine", IJRST-International Journal for Innovative Research in Science & Technology, Vol: 1, Issue: 1, June 2014.
- [3] Martin C. Stumpe and Helmut Grubmuller, "Aqueous Urea Solutions: Structure, Energetics, and Urea Aggregation", J. Phys. Chem. B 2007, 111, Pg no 6220-6228
- [4] P.Balashanmugam, G.Balasubramanian, "Developments of Emission and Noise Control Device(Aqua Silencer)" International Journal of Modern Trends in Engineering and Research, Vol: 2 Issue: 1, January 2015.
- [5] Internal Combustion Engine by M.L. MATHURA & R.P. SHARMA
- [6] Crouse, W.H. and D.A. Anglin, 2003, Automotive Mechanics, 10th Edition, McGraw-Hill, New York.