

Design, Development and Fabrication of Automobile Silencer for Exhaust Flow

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ABSTRACT

Air pollution is most important from the public health point of view, because every individual person breathes approximately 22000 times a day, inhaling about 15 to 22 Kg of air daily. Polluted air causes physical ill effect decides undesirable aesthetic and physiological effects. Air pollution can be defined as addition to our atmosphere of any material, which will have a dexterous effect on life upon our planet. The main pollutants contribute by automobiles are carbon monoxide (CO), unburned hydrocarbon (UBHC), oxides of nitrogen (NO_x) and Lead. Automobiles are not the only source of air pollution, other sources such as electric power generating stations, industrial and domestic fuel consumption, refuse burning, industrial processing etc. also contribute heavily to contamination of our environment so it is imperative that serious attempts should be made to conserve earth's environment from degradation. An aqua silencer is an attempt in this direction, it is mainly dealing with control of emission and noise. An aqua silencer is fitted to the exhaust pipe of engine. Sound produced under water is less hearable than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property water is used in this silencer and hence its name AQUA SILENCER. The noise and smoke level is considerable less than the conventional silencer, it is cheaper, no need of catalytic converter and easy to install.

Keywords : Carbon Monoxide, Unburned Hydrocarbon, Oxides of Nitrogen, AQUA SILENCER, Automobile Silencer

I. INTRODUCTION

An aqua silencer is used to control the noise and emission in IC engines. The reason why we go for aqua silencer is, in today life the air pollution causes physical ill effects to the human beings and also the environment. The main contribution of the air pollution is automobiles releasing the gases like carbon dioxide, unburned hydrocarbons etc. In order to avoid this type of gases by introducing this aqua silencer. It is fitted to the exhaust pipe of the engine, Sound produced under water is less hearable than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its

amplitude thus, lowers the sound level. The emission can be controlled by using the activated charcoal layer and it is highly porous and possess extra free valences so it has high absorption capacity. So, absorb the gases from the engine and release much less position to the environment. The noise and smoke level are considerable less than the conventional silencer, no need of catalytic converter and easy to install.

II. LITERATURE REVIEW

K. Kannan[1] et al.(2009) This paper reports on the effect of water emulsified diesel fuel combustion on

brake thermal efficiency, brake specific fuel consumption and NO_x and hydrocarbon emissions in a diesel engine. The experiments were conducted on a single cylinder four stroke cycle direct injection diesel engine at constant speed with a fuel injection pressure of 200 bars. Tests were conducted using commercial diesel fuel and diesel fuel with 10% and 20% water by volume. From the test results, it was found that the water emulsification has a potential to improve brake thermal efficiency and brake specific fuel consumption. The NO_x and hydrocarbon emissions were found to decrease with increase in water percentage in the emulsified diesel.

Patil Snehal S.[2]et al.(2013)This paper consists of experimental research work for implementing aqueous ammonia solution as an absorber for the reduction of CO₂, SO₂ and NO_x from exhaust gases of I.C. Engines. The aqueous ammonia process can simultaneously remove CO₂, SO₂, NO_x and also hydrocarbons that may present in the exhaust gas. There could be oxidation of SO₂ and NO_x prior to contacting the aqueous ammonia absorbent. A concept pertaining to the ammonia/carbon dioxide reaction in an exhaust system is presented.

Mankhiar Ajay B[3]et al.(2014) To overcome pollution many new inventions is existing yet here would be some drawback behind those. This paper is all about Aqua silencer, its working and also the method to overcome the drawback of using charcoal in it. The Aqua Silencer is used in the exhaust to direct the gas from the engine after going through the process of reducing the toxic gases and also water is used to reduce the exhaust noise. In this silencer, the main drawback is using charcoal to reduce the exhaust toxins which should be replaced in the span of 3 years approximately. Hence, in this research I have made an attempt to increase the life time of the silencer functioning by using Titanium Nano-tubes along with charcoal which has the ability to absorb the toxin gases.

P.Balashanmugam[4]et al.(2014)It is a well-known fact that the toxic gases emitted in diesel engines are less than the petrol engines. Due to the high cost of

petrol; diesel engines are more in use. Anticipating the use of diesel engines, even more in the near future; this system developed can be used to control the toxic gases, coming out of the diesel engines. These toxic gases are harmful not only to the atmosphere, but also to the human & animal race. The objective of this project is to design & fabricate a simple system, where the toxin levels are controlled through chemical reaction to the more agreeable level. This system acts itself as a silencer; there is no need to separate the silencer. The whole assembly is fitted in the exhaust pipe; it does not give rise to any complications in assembling it. This system is very cost effective and more economical.

KevalI.Patel[5]et al. (2014)Automobiles are not the only sources of air pollution, other sources such as electric power generating stations, industrial and domestic fuel consumption, refuse burning, industrial processing etc. also contribute heavily to contamination of our environment so it is imperative that serious attempts should be made to conserve of our environment from degradation. An Aqua Silencer is an attempt, in this direction, it is mainly dealing with control of emission and noise. An Aqua Silencer is fitted to the exhaust pipe of engine. Sound produced under water is less hearable than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property water is used in this silencer and hence its name AQUA SILENCER. The noise and smoke level is considerable less than the conventional silencer, it is cheaper, no need of catalytic converter and easy to install.

Alen M. A.[6]et al. (2015)An Aqua Silencer is mainly dealing with control of emission and noise in automobile exhaust. By using activated charcoal, perforated tube and outer shell it is constructed. An aqua silencer is fitted to the exhaust pipe of engine. The activated charcoal filters the harmful Sulphur and nitrous content produced from the engine. Sound produced under water is less hearable than it produced in atmosphere. This mainly because of small

sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property water is used in this silencer and hence its name AQUA SILENCER. It is tested in single cylinder 4- stroke diesel engine the noise and smoke level is considerable less than the conventional silencer. The main pollutants contribute by automobiles are CO, UBHC, NO_x and Lead etc., other sources such as electric power generating stations, industrial and domestic fuel consumption, refuse burning, industrial processing. So, it is imperative that serious attempts should be made to conserve earth's environment from degradation. An aqua silencer is an attempt in this direction; it is mainly dealing with control of emission and noise.

Ankit Patel[7]et al.(2015) Air pollution is most important from the public health point of view and It's contribute heavily to contamination of our environment so it is imperative that serious attempts should be made to conserve earth's environment from degradation. An Aqua silencer is mainly dealing with control of emission and noise. An aqua silencer is fitted to the exhaust pipe of engine. Sound produced under water is less hear able than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property water is used in this silencer and hence its name AQUA SILENCER. The noise and smoke level is considerable less than the conventional silencer, it is cheaper, no need of catalytic converter and easy to install.

J.Soundhar[8]et al.(2015)A silencer is an attempt in this direction; it is mainly dealing with control of emission and noise. A silencer is fitted to the exhaust pipe of engine. Sound produced under water is less hearable than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property water is used in this silencer and hence its name aqua silencer. The noise and smoke level is considerable less than the conventional silencer, it is cheaper, no need of catalytic converter and easy to install.

G Maruthi Prasad Yadav[9]et al. (2015) Automobiles are not only source of air pollution, other sources such as electric power generating stations, industrial and domestic fuel consumption, refuse burning, industrial processing etc. also contribute heavily to contamination of our environment so it is imperative that serious attempts should be made to conserve earths environment from degradation. An aqua silencer is an attempt in this direction, it is mainly dealing with control of emission and noise. An aqua silencer is fitted to the exhaust pipe of engine. Sound produced under water is less hearable than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property, water is used in this silencer and hence its name as AQUA SILENCER. Due to this we reduce the noise and emissions from the exhaust.

Rohit Ramdas Thakare[10]et al. (2015) "Aqua Silencer" is an attempt made to deal with the control of overall emissions & undesirable sound at tail pipe of a vehicle, before it is emitted to the atmosphere. It can be fitted along with or instead of catalytic converter at the tail pipe of exhaust system of a vehicle. Sound produced due to operation of an engine can be controlled using water as sound produced under water is less hearable than produced in environment. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property, water is used in this silencer & hence its name, "Aqua Silencer". Also there is no effect of it after its installation on fuel efficiency of a vehicle, which may be petrol powered or diesel powered. Exhaust emissions can be controlled using a layer of activated charcoal which is highly porous & possesses few extra valances & has high adsorption properties, so it attracts the hazardous gases towards it & releases much less position to environment. The level of noise & smoke coming out of "Aqua Silencer" is considerably less compared to conventional silencer; also it is cheaper to build & maintain. There is no need of catalytic converter getting fitted with it , give no

rise to any complications in assembling it & easy to install.

Keval I. Patel[11] et al. (2015) Perforated tube is one of most important part in Aqua silencer. Perforated tube converts high mass bubble in to low mass bubble. The charcoal layer is putting 5mm from the perforated tube. The charcoal layer has more absorbing capacity because it has more surface area. Exhaust gas is more contact with charcoal layer, in this direction perforated tube is design. Using CFD for validification of perforated tube design because in short time a different design of perforated tube experiment is not possible. So different design is made in software and check it's result from the CFD analysis. CFD analysis of different design of perforated tube is carried out. The effects of different diameter of hole are find out from the CFD analysis.

Rahul S. Padval[12] et al. (2016) Aqua silencer is one of the attempt taken in reduce the air pollution. It is fitted to the exhaust pipe of engine or system. These Silences is used to reduce the noise and control the emission of dangerous gases. In aqua silencer, the main component perforated tube which consists of number of different diameter holes. Generally, these are 4 set of holes on perforated tube. Charcoal layer is pasted over that tube and it is used to convert high mass bubbles to low mass bubbles. The aqua silencer reduces emission noise because, the sound produced in aqua silencer under water having less amplitude than the sound produced in open atmosphere. These is happening because of in water molecules there are small sprockets which lowers amplitude of emission gases and lower the sound level. The charcoal layer which is pasted over perforated tube can control the emission using the activated charcoal and highly porous extra free valences so these layers having high absorption capacity.

Akhil ChowdaryBellam[13] et al.(2016) Aqua silencer is mainly used for dealing with the emission and noise. An aqua silencer is generally attached to the exhaust of 2-stroke engine. In this Aqua silencer both the Lime water wash method and Absorption method are used. The gases like HC, CO from the engine exhaust are

absorbed. The final emission is analyzed using an automobile gas analyzer and the reduction of gases HC, CO is measured.

Akhil Anil Kumar[14] et al. (2016) Aqua Silencer is a modified version of a conventional silencer aimed at the reduction of toxic emission from the exhaust of an IC engine into the atmosphere and also to reduce the noise that is produced by damping methods which involves water and hence the name. It incorporates the usage of cheap chemicals like lime water, activated charcoal and water with the help of simple but effective change in the design and fabrication of the silencer to reduce the noise and toxic emission levels.

Karansingh K.Naglot[15] et al.(2016)An aqua silencer fitted to the exhaust pipe of engine can control exhausts emission and noise effectively as compared to that of conventional silencer, it is cheaper, no need of catalytic converter and easy to install. Sound produced under water is less hear able than it is produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property of water is used in this silencer and hence its name AQUA SILENCER.

Harshal S. Khairnar[16] et al. (2016)An AQUA SILENCER is mainly dealing with control of emission & noise in automobile exhaust system. By using the perforated tube, activated charcoal layer, Outer shell, non-return valve, Flange, H-Nipple it is constructed. AQUA SILENCER is fitted at the exhaust of the engine. The activated charcoal filters the harmful gases produced from the engine such as Sulphur. sound produced under water is less hearable than sound produced in the atmosphere. It is mainly due to small sprockets in water molecules which lower the amplitude Thus ,Lowers the sound level. It is tested in single cylinder 4-stroke diesel engine the smoke level & Noise is considerably less than conventional silencer.

Rishikesh Acharekar[17] et al. (2016) Aqua Silencer deals with control of emission and noise in automobile exhaust which is achieved by using

activated charcoal, perforated tube and outer shell. An aqua silencer is fitted to the exhaust pipe of engine. The main pollutants contributed by automobiles include CO, UBHC, NO_x and Lead etc. The activated charcoal layer filters this harmful nitrous and Sulphur content produced from the engine. Sound produced under water is less audible than it produced in atmosphere. This is mainly because of small sprockets in water molecules, which lowers its amplitude thus, sound level decreases. Due to this water is required in this silencer and hence its name AQUA SILENCER. Serious attempts should be made to reduce this pollutant and save our environment.

Prof. Anup M. Gawande[18] et al. (2016) The main component due to which the air pollution is increasing are (Co), (NO_x) and lead which is get exposed from vehicles. The other sources such as big factories, electric power, generation plants, big industries etc. So, it is required to solve these problems by taking various serious attempts. Aqua silencer is one of the attempt taken in reduce the air pollution. It is fitted to the exhaust pipe of engine or system. These Silences is used to reduce the noise and control the emission of dangerous gases. In aqua silencer, the main component perforated tube which consists of number of different diameter holes. Generally, these are 4 set of holes on perforated tube. Charcoal layer is pasted over that tube and it is used to convert high mass bubbles to low mass bubbles. The aqua silencer reduces emission noise because, the sound produced in aqua silencer under water having less amplitude than the sound produced in open atmosphere. These is happened because of in water molecules there are small sprockets which lowers amplitude of emission gases and lower the sound level. The charcoal layer which is pasted over perforated tube can control the emission using the activated charcoal and highly porous extra free valences so these layers having high absorption capacity.

Harshit Saraswat[19] et al. The main component due to which air pollution is increasing are carbon- dioxide, which is get exposed from vehicles and other harmful gases which is comes out from the big factories,

electric power, generation plants, big industries etc. So, it is important to solve these problems by taking serious steps. Aqua silencer is the one of the step taken in reduce the air pollution. It is fitted to exhaust pipe of engine. These silencers are used to reduce the noise and control the emission of harmful gases. The aqua silencer reduces emission noise because, the sound produced in aqua silencer under water having less amplitude than the sound produced in open atmosphere. This is happened because of in water molecules there are small sprockets which lower amplitude of emission gases and lower the level of sound. The layer of charcoal which is pasted over perforated tube can control the emission by using the activated charcoal and highly porous extra free valences because these layers having high absorption capacity.

M Naveen kumar[20] et al. (2017) Objective of this project is to experimentally investigate a simple system using perforated tube, where the toxic levels are controlled through chemical reaction to more agreeable level. This system acts itself as a silencer; there is no need to separate the silencer. The whole assembly is fitted in the exhaust pipe; it does not give rise to any complications in assembling it. This system is very cost effective and more economical.

Shubham Ghule[21] et al. (2017) Automobiles are not only source of air pollution, other sources such as electric power generating stations, industrial and domestic fuel consumption, refuse burning, industrial processing etc. also contribute heavily to contamination of our environment so it is imperative that serious attempts should be made to conserve earth's environment from degradation. A twin filter silencer is an attempt in this direction; it is mainly dealing with control of emission and noise. An aqua silencer is fitted to the exhaust pipe of engine. Sound produced under water is less hear able than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property, water is used in this and hence its name

as "Aqua Silencer". Due to this we reduce the noise and emissions from the exhaust.

S. Santhosh Sathish Kumar[22]et al.(2017) The objective of this work is to develop an silencer that can rectify Air pollution and Noise produced in this conventional silencer. Air pollution is most important from the public health of view, because every individual person breaths approximately 22000 times a day, inhaling about 15 to 22 kg of air daily. Polluted air causes physical ill effect decides undesirable a esthetic and physiological effects. Air pollution can be defined as addition to our atmosphere of any material, which will have a dexterous effect on life upon our planet. The main pollutants contribute by automobile are carbon monoxide (CO), unburned hydrocarbon (UBHC), oxides of nitrogen (NOx) and Lead. And also contribute heavily to contamination of our environment so it is imperative that serious attempts should be made to conserve of our environment from degradation. An Aqua Silencer is an attempt, in this direction; it is mainly dealing with control of emission, heat and noise. An Aqua Silencer is fitted to the exhaust pipe of engine. Sound produced under water is less hearable than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property water is used in this silencer and hence its name AQUA SILENCER.

R.Sharavanan[23]et al. (2017)Fuel power inevitably finds a very important role in the development of the plant's economy and technical growth. In spite of their high thermal efficiency, one cannot ignore the fact about the effect of their exhaust, in the atmosphere. It is a well-known fact that the toxic gases emitted in petrol engines are less than the diesel engines. Anticipating the use of petrol engines, even more in the near future; this system developed can be used to control the toxic gases, coming out of the petrol engines. These toxic gases are harmful not only to the atmosphere, but also to the human & animal race. Objective of this project is to design & fabricate a simple system, where the toxic levels are controlled through chemical reaction to more agreeable level.

This system also acts itself as a silencer; The whole assembly is fitted in the exhaust pipe; it does not give rise to any complications in assembling it. This system is Very Cost Effective.

Swapnil V. Kasar[24]et al.(2017) An Aqua Silencer is mainly commerce with control of emission and noise. An Aqua Silencer is fixed to the exhaust pipe of engine. Sound created under water is less hearable than it produced in environment. This mainly because of small cogs in water molecules, which reduce its range of amplitude thus, decreases its sound level. Hence water is used in this silencer and hence its name AQUA SILENCER. The noise and smoke level is less than the conventional silencer, it is cheaper, no need of catalytic converter and easy to install.

Shaikh L.T.[25]et al.(2017) An Aqua Silencer is mainly dealing with control of emission and noise in automobile exhaust. By using activated charcoal, perforated tube and outer shell it is constructed. An aqua silencer is fitted to the exhaust pipe of engine. The activated charcoal filters the harmful Sulphur and nitrous content produced from the engine. Sound produced under water is less hearable than it produced in atmosphere. This mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level. Because of this property water is used in this silencer and hence its name AQUA SILENCER. It is tested in single cylinder 4- stroke diesel engine the noise and smoke level is considerable less than the conventional silencer. The main pollutants contribute by automobiles are CO, UBHC, NO_xand Lead etc., other sources such as electric power generating stations, industrial and domestic fuel consumption, refuse burning, industrial processing. So, it is imperative that serious attempts should be made to conserve earth's environment from degradation. An aqua silencer is an attempt in this direction; it is mainly dealing with control of emission and noise.

III. Working Process of Aqua Silencer

The Smoke is collected from the silencer of a Truck. A High temperature house pipe is connected to the silencer and then connected to pressure drop unit.

Pressure Dropper

Pressure dropper is made of aluminum and is used to drop pressure and reduce pollution. Smoke at the discharge of 293-cubic meter per hour is injected in the pressure dropper at the temperature of 149°C. The temperature of the smoke is reduced to 42°C and the pressure is also dropped. The Injected CO₂ is reduced from 0.3 microns to 0.1 microns, CO is reduced from 213 ppm to 177 ppm, SO₂ is reduced from 6 ppm to 1ppm.

Aqua Silencer

Aqua silencer is made of mild steel. It is 1.5 * 1.5 feet in size and is fitted with 3 flappers. It has outlets at the top and bottom to release air. It is filled with 15 Liters of Water which is mixed with Sulphur Dioxide (NaOH). After Flappers 12mm * 12mm scrubbers are fitted in the unit.

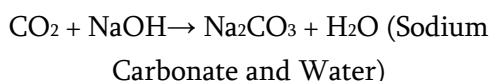
Filter

The mentioned filter is a Citric Polyester Filter and has a capacity of 0.3 microns. It is fitted at the outlet of Aqua silencer.

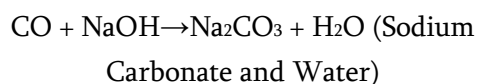
Process

CO₂ injected out from Pressure dropper in Injected in Aqua Silencer containing water mixed with NaOH and scrubbers.CO₂ is scrubbed in the first flapper and following chemical reactions take place in the NaOH mixed water.

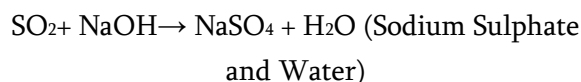
CO₂ is converted to



CO is converted as



SO₂ is converted to



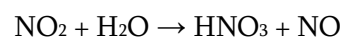
All the above-mentioned chemical outputs are mixed in Water, which reduces Ph. level of water. Hydro Carbons emitted due to combustion of Diesel and Petrol is light in mass and gets easily mixed in air, but the Hydrocarbons in Diesel and Petrol are heavy in mass. The hydrocarbons mixed in Aqua silencer makes them even heavier and they settle down at the bottom of the Aqua silencer. Other floating particles are sized 0.3 to 0.1 microns which cannot get out of filters. This reduces the smoke density and gives out clean and fresh air. Thus this NaOH mixed water becomes useless and has to be replaced after every 8 to 10 hours.

1. Vehicle exhausts reaction with:

Chemical reaction of Nitrogen oxide (NO₂) with water.

Chemical Reaction 1

The obnoxious product of combustion is NO_x – the oxides of Nitrogen. Water will absorb the oxides of Nitrogen to a larger extent. The following chemical reaction will enhance the proof, for the above statement.



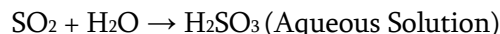
Balanced equation:



Chemical Reaction 2

When Sulphur dioxide reacts with water the following chemical reaction will take place.

Balanced equation:

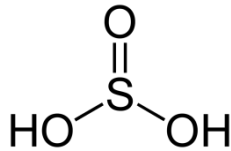


It is known as the Sulphurous acid, but it exists only in aqueous solution and can't be isolated in pure form it is an acid with moderate strength.

Formula: H₂SO₃

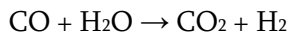
IUPAC ID: Sulfurous acid

Molar mass: 82.07 g/mole



Chemical Reaction 3

When the carbon monoxide present in the exhaust gas comes in contact with the water. The adsorption of CO, the interaction and the reaction of CO and water have been investigated over supported Ir catalysts. The adsorption of CO was studied by infrared spectroscopy. At higher temperature above 473 K CO induces the agglomeration of Ir, but the H₂O hindered this process. In the interaction and in the reaction of CO and water, format formation was observed on the surface of the catalysts. The IR spectra of the adsorbed CO in the presence of water differed from that observed during the adsorption of CO; the band due to linearly bonded CO was shifted to lower wavenumbers. The reaction of CO + H₂O was studied in a fixed-bed continuous-flow reactor. The production of H₂, CO₂ (with ratio about 1) and small number of hydrocarbons proceeded readily above 523 K. The following is the chemical reaction:



Chemical Reaction 4

Bicarbonate is naturally produced by the reaction of carbon dioxide (CO₂) with water (H₂O) to produce carbonic acid (H₂CO₃), which dissociates to a bicarbonate ion and a proton (H⁺). Bicarbonate is naturally produced by the reaction of carbon dioxide (CO₂) with water (H₂O) to produce carbonic acid (H₂CO₃), which dissociates to a bicarbonate ion and a proton (H⁺). Acid/base metabolism in the body is regulated by this chemical equation:



2. Effect of Dissolved Gases on Water

The water is a good absorbing medium. In aqua silencer, the gases are made to be dissolved in water. When these gases dissolved in water they form acids, carbonates, bicarbonates etc.

(1) Action of dissolved SO₂

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

(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. The form a scale in pipes and boilers. The carbon dioxide mixes with water to form Carbonic acid. It is corrosive to metals and causes greenhouse effect.

(3) Effect of dissolved NO_x

The Nitrogen in water under goes Oxidation to form ammonia, Nitrate, Nitrite, Nitric acid. This synthesis of protein and amino acids is affected by Nitrogen. Nitrate usually occurs in trace quantities in surface water.

IV. DESIGN PROCEDURE

Material selected for the silencer is C 45 (mild steel).

Take FOS = 2

$$\sigma_t = \sigma_b = 540 / \text{FOS} = 270 \text{ N/mm}^2$$

$$\begin{aligned} \sigma_s &= 0.5 \sigma_t \\ &= 0.5 \times 270 \\ &= 135 \text{ N/mm}^2 \end{aligned}$$

Material for shell selected is C45 = 0.45 % carbon.

Material C45 – 0.45 % carbon

$$\sigma_{ut} = 320 \text{ N/mm}^2$$

FOS for pressure vessel, take = 4

Now,

$$\begin{aligned} \sigma_t = \sigma_b &= \sigma_{ultimate} / \text{FOS} \\ &= 320 / 4 \\ &= 80 \text{ N/mm}^2. \end{aligned}$$

$$\sigma_s = \sigma_t / 2 = 80 / 2 = 40 \text{ N/mm}^2.$$

Let the total weight (P) of our machine be 60 kg, now this 60-kg weight is kept on four angle,

$$\begin{aligned} P &= 60 / 4 \\ &= 15 \text{ kg} \\ P = W &= 15 \times 9.8 \end{aligned}$$

$$\begin{aligned}
 &= 147 \text{ N.} \\
 L &= 300 \text{ mm.} \\
 M &= WL/4 \\
 &= 147 \times 300/4 \\
 &= 11025 \text{ N-mm} \\
 Z &= B^3/6 - b^4/(6 \times B) \\
 Z &= 30^3/6 - 26^4/(6 \times 30) \\
 Z &= 1961 \text{ mm}^3 \\
 &= M/Z \\
 &= 11025/1961 \\
 &= 5.622 \text{ N/mm}^2
 \end{aligned}$$

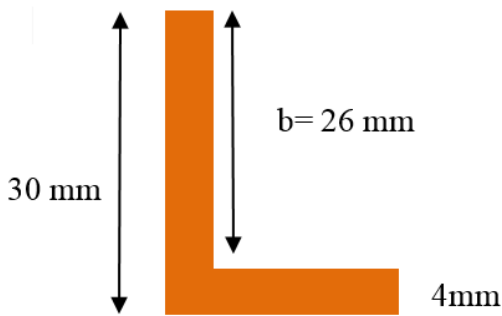


Figure 1: L section

As induced bending stress is less than allowable bending stress i.e. 160 N/mm² design is safe.

1. Design of bolt: -

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-45 steel $f_t = 420 \text{ kg/cm}^2$. STD nominal diameter of bolt is 9.31 mm. From table in design data book, diameter corresponding to M10 bolt is 8 mm

Let us check the strength: -



Figure 2 : Bolts

Also initial tension in the bolt when belt is fully tightened.

P = 981 N is the value of force

P = 981 N

Also, $P = \pi / 4 d c^2 \times \sigma$

981 x 4

$\sigma = 3924 / 201$

$= 19.51 \text{ N / mm}^2$

$3.14 \times (8)^2$

The calculated σ is less than the σ_{tensile} and σ_{shear} hence our design is safe.

2.Design of transverse fillet welded joint.



Figure 3 : Welded joints

selecting weld rod size = 3.2mm

Area of Weld = 0.707 x Weld Size x L

= 0.707 x 3.2 x 25

= 56.56 mm²

Force exerted= ---N

Stress induced = Force Exerted / Area of Weld

$21 = F / 56.56$

$F = 1187.76 \text{ N} = 121.07 \text{ kg}$

Maximum Allowable Stress for Welded Joints = 21 N/mm²

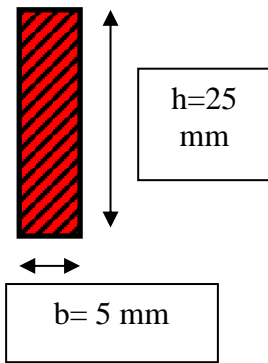


Figure 4 : I section

3.Design of welded joint:-

Checking the strength of the welded joints for safety. The transverse fillet weld welds the side plate and the edge stiffness plates, the maximum load which the plate can carry for transverse fillet weld is

$$P = 0.707 \times S \times L \times f_s$$

Where,

S = size of weld

$$= 3.15$$

L = contact length

$$= 30\text{mm}$$

The load of shear along with the friction is 175 N

$$\text{Hence, } 175 = 0.707 \times 3.15 \times 30 \times f_s$$

Hence let us find the safe value of 'f_s'

$$\text{Therefore } f_s = 175 / (0.707 \times 3.15 \times 30)$$

$$f_s = 2.6 \text{ N/mm}^2$$

Since the calculated value of the tensile load is very smaller than the permissible value as f_s =21 N/mm².

Hence welded joint is safe.

V. RESULT

From the PUC testing of above four stroke petrol engine I find the following result about Carbon dioxide and hydrocarbon

Prescribed Standard	Measured level	Prescribed Standard	Measured level	
CO	CO (ppm)	HC	HC	
Ordinary Silencer	3.50	0.93	6000	269

Aqua silencer	3.50	0.22	6000	212
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Table 1: PUC results

1. Aqua Silencer

For testing of aqua silencer, I used four stroke petrol engine of Jupiter ZX. PUC Certificate Design and Development of Aqua Silencer For Four Stroke Petrol



Figure 5 (a): PUC certificate without aqua silencer

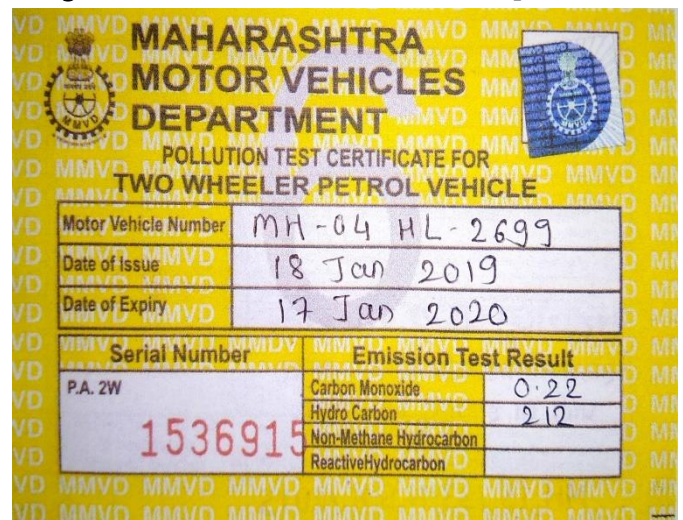


Figure 5 (b) : PUC certificate with aqua silencer

1. Sound Characteristics

Load	Sound Level without Silencer	Sound Level with Aqua Silencer
Without any load	104.5 dB	75 dB
50% load	106.5 dB	76.5 dB
100% load	107 dB	77.8dB

Table 2 : Sound Characteristics of Aqua Silencer



Figure 6 : Testing of aqua silencer.

3. Advantages

The advantages of the Aqua Silencer are as follows: -

- Control air pollution.
- Sound is reduced
- CO is reduced 60 to 70 % compared to ordinary silencer.
- Low cost.
- Reusable
- Maintenance cost is less.
- Operating cost is less.
- Compact in size.

Same concept can be used for heavy vehicle.

2. Disadvantages

- Aqua silencer is big in size.
- More space is required.

Water refilling and flushing is required periodically.

VI. CONCLUSION

- 1) As the Aqua Silencer is more suitable for stationary IC engine. The design is at the research stage hence the dimensions are little bulkier compared to conventional engine silencers.
- 2) The arc welding is used for the aqua silencer fabrication. However, the advanced fabrication can be used in mass production.
- 3) The aqua silencer is more effective in the reduction of emission gases from the engine

reduction of emission gases from the engine. By using perforated tube, the backpressure will remain constant and the sound level is reduced. By using perforated tube, the fuel remains same as conventional system. By using water as a medium the sound can be lowered and also by using activated charcoal in water we can control the exhaust emission to a greater level. It is smokeless and pollution free emission and also it is very cheap. This aqua silencer's performance is almost equivalent to the conventional silencer. It can be also used both for two wheelers and four wheelers and also can be used in industries.

- 4) From the PUC testing we get the following results:

Prescribed Standard	CO	Measured level (ppm)	Prescribed Standard HC	Measured level HC
Ordinary Silencer	3.50	0.93	6000	269
Aqua silencer	3.50	0.22	6001	213

Hence the CO reduced from 0.93 to 0.22 this reduced shows the benefit of Aqua Silencer.

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Cite this article as :

Namrata Agrawal, Arun Kulkarni, "Design, Development and Fabrication of Automobile Silencer for Exhaust Flow", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), ISSN : 2456-3307, Volume 6 Issue 1, pp. 367-379, January-February 2019. Available at doi : <https://doi.org/10.32628/IJSRSET196171>
Journal URL : <http://ijsrset.com/IJSRSET196171>