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EXPERIMENTAL INVESTIGATION ON AN AQUA SILENCER

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Abstract *—Air pollution is an important public health problem in most cities of the developing world. Pollution levels in megacities such as Bangkok, Cairo, Delhi and Mexico City exceed those in any city in the industrialized countries. Epidemiological studies show that air pollution in developing countries accounts for tens of thousands of excess deaths and billions of dollars in medical costs and lost productivity every year. These losses, and the associated degradation in quality of life, impose a significant burden on people in all sectors of society, but especially the poor.*

Industries is major source of noice and air pollution then after second major source is Automobiles. The internal combustion engine is the key to the current society. Without the transportation performed by the millions of vehicles on road and at sea we would not have continue to today's living standard. The internal combustion (IC) engine is known to be one of the extreme sources of air pollution in the environment. The fuel oxidation process in the engine generates not totally useful power, but also a considerable amount of pollutant emissions including Carbon Dioxide (CO_2), Carbon Monoxide (CO), Nitrogen Oxides (NOx),Unburned Hydrocarbon (HC) and Particulate Matter (PM). CO_2 is essentially responsible for the global warming issue as it creates a reflective layer in the atmosphere that reflects heat from the earth back to the earth surface, increasing the earth's normal temperature over time. CO is a very dangerous substance, since it reduces the oxygen-carrying capacity of the blood stream. An aqua silencer is an attempt in this direction to reduce air and noise pollution by the automobile vehicle with the help of aqua silencer sound produce is very less because , the sound produced in under water having less amplitude than in open atmosphere and with the help of the perforeted tube gases high mass bubble transformed into low mass bubble which has low amplitude and lower sound level. The charcoal layer which is pasted over perforated tube. The emission of polluted gases can be controlled by using the activated charcoal and highly porous extra free valences due to have high absorption capacity of this layer.

Keywords-Charcoal layer, Perforated tube, Aqua silencer, Air pollution, Noise pollution.

I. INTRODUCTION

Now-a-days the automobiles are very essential needs of human beings. The world without automobiles is unimaginable at today. But the major problem corresponding to the automobiles are undesirable emissions from the engine exhaust. The unwanted emission contains CO, CO_2, HC, SO_X, NO_X, etc. Control of these gases is very needful now, because it leads to harmful injuries to environment and also living beings. So, we are going to introduce one methods to reduce these exhaust emissions in the silencer part.

Composition of the normal petrol engine exhaust is as follows:

A) Nitrogen (71% of vol.)
B) Hydrocarbons (<0.25% of vol.)
C) Oxides of sulphur (<0.03% of vol.)
D) Carbon dioxide (14% of vol.)
E) Water vapour (12% of vol.)
F) Oxides of nitrogen (<0.25% of vol.)
G) Carbon monoxide (1-2% of vol.)

Approximately, noise level of more than 80-90 dB is harmful for human being. The main primary source of noise in an engine are divided in two parts, first is the exhaust noise and second is the noise produced due to friction of various parts of the engine. The engine exhaust noise is the ultimate dominant. To reduce this noise, the best effective way to use a muffler in the engines. The level of noise reduction depends upon the design, construction and the working procedure of muffler. If a car running without a muffler then the noise level is intolerable. The most of the advances in the exhaust mufflers and acoustic filters came out in last four decades. Hence good design of the muffler should give the best noise reduction and offer excellent back pressure for the engine. Back pressure is the extra static pressure exerted by muffler on the engine direct the restriction in the flow of exhaust gases. The insertion loss is defined as the difference in the acoustic power radiated with and without the muffler fitted.

Sarath Raj et. al. [1] discussed about silencer types in that the combined resonance and absorber type is the more effective type. In that project they made model and carried out the analysis.Alen.M.A et. al. [7] investigated that emission can be controlled by the activated charcoal and lime water. They compared the results between simple silencer and silencer with lime water and activated charcoal layer. Keval Patel et. al. [3] Bead activated carbon is made from petroleum pitch and supplied in diameters from approximately 0.35 to 0.80 mm. It is also noted for its low pressure drop,

high mechanical strength and low dust content, but with a smaller grain size. P.Balashunmugam et. al. [4] carried out the analysis in which the lime stones are originally intended to reduce the toxic ingredients of the exhaust, gas through chemical reaction. NO is converted into NO2 after emission which highly toxic is mainly absorbed in the water scrubber. Rahul.s.padval et. al. [5] found in their experiment of an aqua silencer that water in a silencer reduces the sound. The system is very cheap and is use for four and two wheelers. The performance of twin silencer is almost equivalent to the conventional silencer. Rishikesh Acharekar1 at ai.[11] During the experiment observed that the emission of ordinary silencer for HC and CO are 1836 and 1.64 respectively whereas the emissions of aqua-silencer are 1701 and 1.35 respectively which proves that the emissions are reduced by using an aqua-silencer. J.Soundhar at al.[12]The aqua silencer's performance is almost equivalent to the conventional silencer.

2.1. Types of silencer

Silencer is device in which reduce the loudness of the sound pressure produce by the engine. Silencers are mostly instlied in the i.c. engine exhaust outlet system. An unavoidable side effect of silencer is it increases the back pressure and due to increase back pressure the efficiency and performance of engine is decreases.

Types of silencer are as below:

A)Baffle type.
B)Wave cancellation type.
C)Resonance type.
D)Absorber type .
E)Combined resonance & absorber type.

A)Baffle type

It is mostly cylindrical shape type in construction. Inner side of it the no of baffle spot welded inside. The design of baffle many types is available nowday but the working principle in every baffle cases is similar.

B)Wave cancellation type :-

In wave cancellation type exhaust gases devided into two or more then two parts. The length of silencer are adjust in such a way that reduce the noice theoritically zero. The silencer does not eliminate noise completely because in this type of silencer have less resistance gas flow compare to the baffle type. major diaadvantage of the muffler is their low efficiency.

C)Resonance type :-

In this type of silencer inner side tube surface haveing four set of different hole due to this hole high mass bubble is converted into low mass bubble. It is also called as a Helmhotlz type silencer.

D)Absorber type :-

In this type of silencer absorption materials are use around the perforated tube. By using the absorbing material sound intencity is reduced by converting into heat by sound absorbing material. This type of silencer is used for the high frequency and high perfomance engine. A simple design is a cylindrical can with a perforated tube which is covered by packing material.The sound absorbing material, usually fiber glasses, is used in this case around the perforated tube through which the exhaust gases pass

E)Combined resonance & absorber type:-

In this type silencer the resonance type silencer advantages as well as the absorber type advantantages are occpuancy.

II. CONSTRUCTION

Basically an aqua silencer consist of a perforated tube which is installed at the end of the exhaust pipe. The perforated tube may have holes of different diameters. The main purpose of providing different diameters hole is to break up gas mass to form smaller gas bubble. The perforated tube of different diameters. Generally 3 or 4 sets of holes are drilled on the perforated tube. 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. The whole unit is then placed in a water container. A small opening is provided at the Top of the container to remove the exhaust gases and a drain plug is provided at the bottom of the container for periodically cleaning of the container. Also a filler plug is mounted at the top of the container. At the inlet of the exhaust pipe a non-return valve is provided which prevents the back flow of gases and water as well.

III. COMPONENTS

PERFORATED TUBE :-

FIGURE -1 :- PERFORATED TUBE

The major function of the perforated tube is to suppress the sound and increase the performance. The perforated tube be contained in number of holes of different diameters. It is used to transform high mass bubble to low mass bubble. The charcoal layer is pasted over the perforated tube. The exhaust gas from the engine cylinder is passed through these holes so large gas bubbles are converted to smaller gas bubbles. Hence the noise is reduced . It is an essential part of an aqua silencer.

B)OUTER SHELL:-

FIGURE-2:- OUTER SHELL

The whole setup was kept inside the outer shell. It is made up of steel. The water inlet, outlet and exhaust tube was provided in the shell itself. The first process deals with manufacturing the outer shell of the silencer. First the metal sheets are cut using the electric hand cutter.Thus the manufacturing process must be extremely flexible. The shape of the outer shell has a cylindrical shape that is formed by the roll bending mill. The rolling process is efficient in creating this cylindrical shaped shell which takes approximately three passes to obtain the final shape. The rolling process requires high skill persons because the material properties of the sheets changes from sheet to sheet, and pass to pass. The operator must take these into account to produce a well-shaped shell. Once the shell has taken its shape welding the seam is required. At this seam there is an overlap, where a consumable electrode welding procedure known as submerged arc welding takes place. The welding is done by hand . It is also requires a qualified and experienced welder.

C)CHARCOAL LAYER :-

FIGURE-3:- ACTIVATED CHARCOAL

Charcoal layer is pested on the surface of the perforated tube. Charcoal has highly porous and possesses extra free valances.The charcoal layer has more absorbing capacity because it has more surface area. This charcoal is called as activated charcoal. It is produced by heating the charcoal for several hours in a burner. Its surface area gets increased. the charcoal is a good absorbing medium. Hence the gases may purify. Different types of charcoal are available. But activated carbon charcoal is commonly used in aqua silencer. In certain industrial processes, such as the impurities cause an undesirable colour, purification of sucrose from cane sugar, which can be removed with activated charcoal. It is also used to absorb odors and toxins in gases, such as air. Charcoal filters are also used in some types of gas mask.

D)LIME POWDER:-

Lime water is the common name for a saturated solution of calcium hydroxide. Calcium hydroxide, $Ca(OH)_2$ is sparsely soluble in water (1.5 g/L at 25 °C). The pure limewater is colour less and clear, with a slight earthy smell and an alkaline bitter taste of calcium hydroxide. The term lime refers to the alkaline mineral, and is unrelated to the acidic fruit.

Limewater is prepared by stirring excess calcium hydroxide in pure water, and filtering off the excess insoluble $Ca(OH)_2$. When excess calcium hydroxide is added to limewater, a suspension of calcium hydroxide particles remains, giving it a milky aspect, in which case it has the common name of milk of lime. Milk of lime is an alkaline solution with a pH of 12.3.

Carbon dioxide passes through limewater, giving a milky solution. This is due to the insoluble suspension of calcium carbonate formed:

$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$ If excess CO_2 is added, the following reaction takes place:

$CaCO_3(s) + H_2O(l) + CO_2(g) \rightarrow Ca(HCO_3)_2(aq)$ When heated to 512 °C, the partial pressure of water in equilibrium with calcium hydroxide reaches 101 KPa, which decomposes calcium hydroxide into calcium oxide and water.

$Ca(OH)_2 \rightarrow CaO + H_2O$ Limewater turns milky in the presence of carbon dioxide due to formation of calcium carbonate, a process called carbonizations.

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2$

Calcium hydroxide, traditionally called slaked lime, is an inorganic compound with the chemical formula $Ca(OH)_2$. It is a colour less crystal or white powder and is obtained when calcium oxide (called lime or quicklime) is mixed, or slaked with water. It has many names including hydrated lime, caustic lime, builder's lime, slack lime, or pickling lime. Calcium hydroxide is used in many applications, including food preparation. Limewater is the common name for a saturated solution of calcium hydroxide. A suspension of fine calcium hydroxide particles in water is called milk of lime. The solution is called limewater and is a medium strength base that reacts with acids and attacks many metals. .

Table 1.

Molecular formula	$Ca(OH)^2$
Molar mass	74.093 g/mole
Density	2.211 g/cm^3, solid
Melting point	5800C (loses water)
Solubility product, Ksp	4.68×10-6
Solubility in water	0.189 g/100mL (00C) 0.173 g/100mL (200C) 0.066 g/100mL (1000C)
Solubility	Soluble in glycerol and acids Insoluble in alcohol
Appearance	White power
Odour	Odourless
Acidity (pKa)	12.4
Basicity (pKb)	2.37
Refractive index (nD)	1.574

"Table . Properties of lime"

E) NON RETURN VALVE :-

FIGURE-4:- NON RETURN VALVE

The non return valve is a mechanical device which normally allows fluid to flow through it in only one direction. Check valve are two-ports valves, meaning they have two openings in the body, one fluid enter and another for fluid to leave.An important concept in check valves is the cracking pressure which is the minimum up stream pressure at which the valve will operate. Typically the check valves designed for and can therefore be specified for a specific cracking pressure.The Aqua silencer was filled with water and it is directly connected to the exhaust pipe of the engine. There is a chance for the water to get enter into the engine cylinder. To avoid this, Non Return valves are used. It allows the flow of fluid in one direction.

IV. *WORKING*

The exhaust gas from the engine cylinder are received into the aqua silencer Through the perforated tube. Perforated tube is a special tube having different diameter sections. So the perforated tube converts high mass bubbles in to low mass bubbles. At the primary filter calcium hydroxide reacts with toxic gases & reduces its concentration. After that they pass to the charcoal layer which again purify the gases. A charcoal is highly porous and possesses extra free valances. So charcoal has high adsorption capacity. Finally the exhaust gases escape through the opening in to the atmosphere. The aqua silencer is more effective in the reduction of emission gases from the engine exhaust gas using water and lime stone mixture. By using water and lime stone mixture the back pressure will remain constant and the sound level is reduced. By using water as a medium the sound can be lowered and also by using limestone in water we can control the exhaust emission to a greater level. The water contamination is found to be negligible in aqua silencer, because the amount of acidity renge in aqua silencer is expected to be below the dangerous acidity. It is very cheap and pollution free emission and also smokeless.The aqua silencer's performance is almost equivalent to the conventional silencer. Hence aqua silencer reduces both noise and pollution.

V. RESULT

5.1 Test-1: Pollution testing on conventional silencer .

FIGURE-5 :- puc certificate with conventional silencer.

5.2 Test-1: Pollution testing on Aqua Silencer .

FIGURE-6:- puc certificate with aqua silencer.

In test-1, 4- stroke petrol engine is used. The CO & HC values, without the aqua silencer are 4.365 & 412 respectively.
In test-2, 4- stroke petrol engine is used. The CO & HC values, with the aqua silencer are 0.068 & 745 respectively.

VI. CONCLUSION

According to our results an aqua silencer is more effective in the reduction of emission gases from the engine exhaust using perforated tube and charcoal. Using water as a medium the sound can be lowered and also by using activated charcoal in water exhaust emissions can be controlled to a greater level. The water contamination is found to be negligible in an aqua silencer. It is smokeless and pollution free emission, eco-friendly and also it is economical. It can be also used both for two wheelers and four wheelers and also can be used in industries.

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