

# Design, Fabrication and Testing of Aqua Silencer with twin filters

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**Abstract :** Air pollution is most important from the public health of view, because every individual person breaths approximately 22000 time 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 automobile are carbon monoxide (CO), unburned hydrocarbon (UBHC), oxides of nitrogen (NOx) and Lead. 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.

**Key Words:** Aqua silencer, air pollution, charcoal, Lime water, perforated tube, fiber glasses, etc.

## 1. INTRODUCTION

Aqua silencer system is design for replace commonly used single unit silencers in engine with its slender structure and less weight. It plays an important role in control the noise and emission of gases from engines. Air pollution causes dangerous physical effect on the human body, animal and environment. The main reason to use aqua silencer is because now a day's air pollution is increasing rapidly. This system reduces the dangerous exhaust gases from the engine. In these, the emission is controlled by the activated charcoal layer around perforated tube and lime water with the sound absorbing material like fiber glass. The charcoal layer having high capacity to absorb emission gases from engine. The charcoal layer and the lime water reacts with the emission gases from the engine and change the chemical structure of emission gases. The smoke or emission gases and noise level in aqua silencer is very less than the commonly used silencers.

### 1.1 Types of silencers

There are some important types of silencers which we have studied,

1. Baffle type
2. Wave cancellation type
3. Resonance type
4. Absorber type
5. Combined resonance & absorber type.

#### 1.1.1 Baffle Type:

It is generally cylindrical in shape with a number of baffles spot welded inside. There are many designs of baffles, but the principle in all cases is the same that is, closing in any direct passage for the gas. Major drawback of the muffler is their Low efficiency. Because of the restrictions provided to the flow by the baffles, the back pressure is increased, thus causing loss in engine power.

#### 1.1.2 Wave Cancellation Type:

In this type, exhaust gases are divided into two parts. The lengths of these paths are so adjusted that after they come out of the muffler, the crests of one wave coincide with the troughs of the second wave, thus the cancelling each other and reducing the noise to zero theoretically. This is achieved if the lengths of the two passages differ by half the wave length.

In practice this type of muffler does not eliminate noise completely, because this is possible only at one frequency for Which muffler is designed, whereas the noise is a combination of different frequencies However, appreciable noise reduction is achieved. In this the resistance to the main gas flow is very small as compared to the baffle type.

#### 1.1.3 Resonance Type:

These are also called Helmholtz type, after the person who originated the idea. It consists of a number of Helmholtz resonators in series, in which a pipe containing access ports passes. The exhaust gases flow through this type and thus experience no resistance. Series of resonators eliminate the fundamental and higher harmonics of the engine noise.

#### 1.1.4 Absorber Type:

The sound absorbing material, usually fiber glasses, is placed in this case around the perforated tube through which the exhaust gases pass. The sound is reduced by conversion into heat by the sound absorbing material. Such mufflers are commonly known as glass-packs and are quite common in performance and raising cars due to their little resistance to flow. These essentially attenuate at higher frequency sounds and produce the deep, throaty sound usually associated with a high performance engine. A common design is a cylindrical can with a perforated tube which is surrounded by packing material.

### 1.1.5 Combined Resonance and Absorber type:

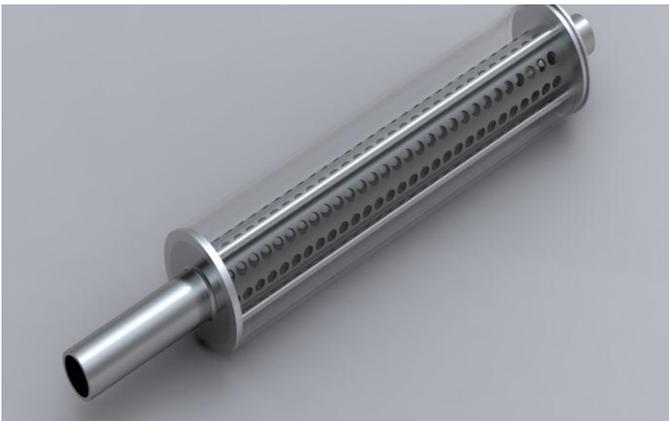
It is seen that the absorber type muffler, has a drawback in that it is not efficient in reducing noise of low frequency. To obviate this defect, this is combined with a resonant chamber. It has been found that this type is more efficient than either the simple resonance or the absorber types.

After the study of these types we combine the design and properties of aqua silencer with resonance and absorber type silencer.

## 2. COMPONENTS AND EXPLANATION

1. Perforated Tube.
2. Charcoal Layer.
3. Lime water.
4. The sound absorbing material- fiber glasses.
5. Outer Shell.

### 2.1 Perforated tube



**Fig-1:** Perforated tube

The main function of the perforated tube is to suppress the sound and increase the performance. Number of egg shape holes is provided on the surface of the tube. Also called as Helmholtz resonators in series, through which a pipe containing access ports passes. The exhaust gases flow through this type and thus experience no resistance. Series of resonators eliminate the fundamental and higher harmonics of the engine noise. It is used to convert high mass bubbles to low mass bubbles. 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. Perforated tube is an essential part of twin filter silencer.

### 2.2 Charcoal layer



**Fig-2:** Activated charcoal

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 at 1500° in a burner. Charcoal layer is provided on the surface of the perforated tube. It is highly porous and possesses extra free valences. Activated charcoal readily adsorbs a wide range of organic compounds dissolved or suspended in gases and liquids.

### 2.3 Lime water



**Fig-3:** Limestone powder

Lime water is the common name for a saturated solution of calcium hydroxide. Calcium hydroxide, traditionally called slaked lime, is an inorganic compound with the chemical formula  $\text{Ca}(\text{OH})_2$ . It is a colorless 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.

## 2.4 The sound absorbing material- fiber glasses.

The sound absorbing material, usually fiber glasses, is placed in this case around the perforated tube through which the exhaust gases pass. The sound is reduced by conversion into heat by the sound absorbing material.

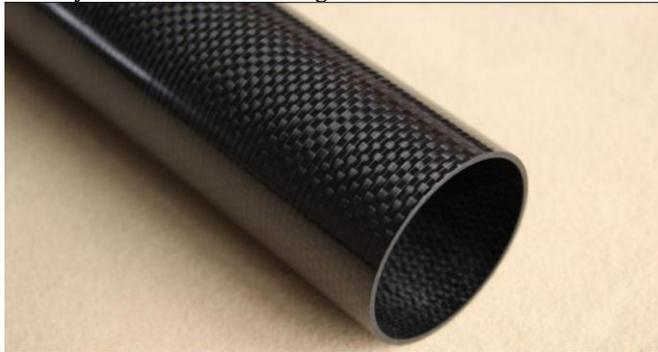


Fig-4: Fiber glass

## 2.5 Outer shell



Fig-5: 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. The shape of the outer shell has a cylindrical shape that is formed by a three roll bending mill.

## 3. PROPOSED SOLUTION

The exhaust gas from the engine cylinder is enters in to the twin filter aqua silencer through perforated tube. Through the perforated tube gas first enters in to the primary filter of the silencer. Perforated tube is a special tube having different diameter sections. So the perforated tube converts high mass bubbles in to low mass bubbles. A primary filter consist sound absorbing material like fiber glass absorbs the sound and converts it in to the heat. After that they pass to the secondary filter consist of charcoal which again purify the gases. Finally the exhaust gases escape through the opening in to the atmosphere. The twin filter 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 twin filter silencer, because the amount of acidity level in twin filter silencer is expected to be below the dangerous acidity. It is smokeless and pollution free emission and also very cheap. Hence twin filter aqua silencer reduces both noise and pollution. The twin filter aqua silencer's performance is almost equivalent to the conventional silencer.

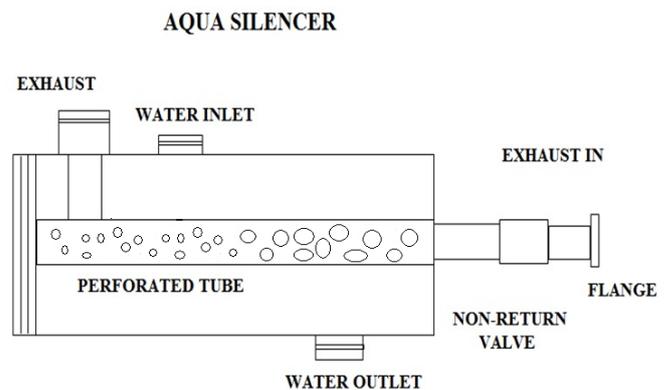


Fig-6: Working principle

Following chemical reactions takes place in aqua silencer:

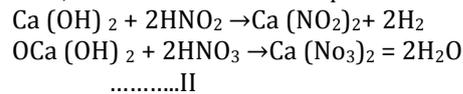
### Chemical Reaction 1

The obnoxious product of combustion is NO<sub>x</sub>-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.



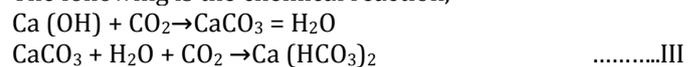
### Chemical Reaction 2

If a small amount of limewater is added to scrubber tank, further reaction takes place as below.



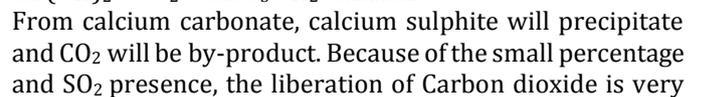
### Chemical Reaction 3

When the carbon-di-oxide present in the exhaust gas comes in contact with the limewater, calcium carbonate will precipitate. The calcium carbonate when further exposed to carbon-di-oxide, calcium-bi-carbonate will be precipitated. The following is the chemical reaction,



### Chemical Reaction 4

The sulphur-di-oxide present in the Diesel Exhaust also reacts with the limewater. But the small trace of sulphur-di-oxide makes it little difficult to measure the magnitude of the chemical reaction, accurately. The following equation gives the chemical reaction and calcium sulphite will precipitate.



less. But the liberated CO<sub>2</sub> will again combine with CaCO<sub>3</sub> to form calcium bicarbonate.

#### 4. CONCLUSIONS

The twin filter aqua silencer is very effective in the reduction of emission gases from the engine exhaust using perforated tube and charcoal layer, by using perforated tube the backpressure will be remain constant and the sound level is reduced. By using perforated tube the fuel consumption remains same as conventional system. By using sound absorbing material like fiber glasses sound energy is converted in to heat. 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. The water contamination is found to be negligible in aqua silencer. It is smokeless and pollution free emission and also it is very cheap. This twin filter silencer 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.

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