

Design and Development of Aqua Silencer

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Abstract- Global warming is increasing on our earth due to major increase in the pollution. Air pollution is very serious problem on our earth. The main contribution of the air pollution is automobiles releasing the gases like carbon dioxide, unburned hydrocarbons etc. 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 attempts taken to reduce the air pollution. It is fitted to the exhaust pipe of engine or system. This silencer is used to reduce the noise and control the emission of dangerous gases. The aqua silencer reduces emission of noise because, the sound produced in aqua silencer under water is having less amplitude than the sound produced in open atmosphere.

Keywords- Aqua silencer, Charcoal layer, Perforated tube, Pollution reduction.

I. INTRODUCTION

A lot of effort is being made to reduce the air pollution from petrol and diesel engines and regulations for emission limits are also imposed. In addition to heat and water vapor, the pollutants formed in engine exhaust are Carbon monoxide (CO), Carbon dioxide (CO₂), Oxides of Nitrogen (NO_x), Sulphur dioxide (SO₂), Particulate and Unburned Hydrocarbons (UBHC), Respirable Combustible Dust (RCD). The above polluting contents in the engine exhaust are to be controlled. Furthermore, developments in petrol and diesel engines, combined with improvements in the vehicles, will make fuel consumption reduction of 40% or more in the future cars. One such development is improvement of the silencer unit of an engine. This is where an Aqua Silencer comes into play.

The emission can be controlled by using the activated charcoal layer and amine solution. Activated charcoal layer is highly porous and possesses extra free valences so it has high absorption capacity. Along with this aqueous monoethanolamine (MEA) is used to remove carbon dioxide (CO₂) and H₂S and release much less pollution to the environment. The noise and smoke level is considerable less than the conventional silencer.

II. LITERATURE REVIEW

G. Balasubramanian et.al (2014) had analyzed the contents of the exhaust gas before and after the treatment and it was found that there is a considerable difference in the percentage of harmful products in the emission.

Sarath Raj et.al (March 2016) had found that it is more effective in the reduction of emission gases from the engine exhaust using perforated tube and charcoal, by using perforated tube the backpressure will remain constant and the sound level is reduced. It is smokeless and pollution free emission and also it is very cheap. It can be also used both for two wheelers and four wheelers and also can be used in industries.

Alen M.A. et.al (Aug.2015) had observed that by using perforated tube the back pressure will remain constant and sound level get reduced. The water contamination is found to be negligible in aqua silencer.

Mankhiar Ajay B et.al (May 2014) had concentrates the full paper on the reduction of the air pollution and water pollution along with the elimination of noise. This is based on the effective way of managing the vehicle parameters to fulfill the emission norms.

III. COMPONENTS USED

1) Perforated tube

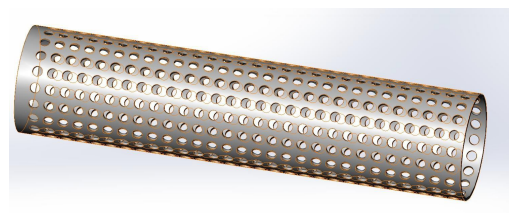


Fig 1 Perforated tube

The main function of the perforated tube is to suppress the sound and increase the performance. Number of holes is provided on the surface of the tube. 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.

2) Charcoal layer



Fig 2 Charcoal layer

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. Charcoal layer is provided on the surface of the perforated tube. Charcoal is highly porous and possesses extra free valences. So the charcoal is a good absorbing medium. Hence the gases may purify. Charcoal may be activated to increase its effectiveness as a filter. In certain industrial processes, such as the purification of sucrose from cane sugar, impurities cause an undesirable colour, which can be removed with activated charcoal.

3) Outer Shell

The whole setup is kept inside the outer shell. It is made up of iron or steel. The inlet, outlet and exhaust ports are provided in the shell itself.

4) Amine solution

Ethanolamine is commonly called monoethanolamine or MEA in order to be distinguished from diethanolamine (DEA) and triethanolamine (TEA). Ethanolamine is a colorless, viscous liquid with an odor reminiscent to that of ammonia. Aqueous solutions of MEA (solutions of MEA in water) are used as a gas stream scrubbing liquid in amine treaters. For example, aqueous MEA is used to remove carbon dioxide (CO₂) and H₂S from various gas streams.

Table 1 Properties of Amine

Chemical formula	C ₂ H ₇ NO
Molar mass	61.08 g•mol ⁻¹
Appearance	Viscous colourless liquid
Odour	Unpleasant ammonia-like odour
Density	1.0117 g/cm ³
Melting point	10.3 °C (50.5 °F; 283.4 K)
Boiling point	170 °C (338 °F; 443 K)
Solubility in water	Miscible
Vapor pressure	64 Pa (20 °C)
Acidity (pKa)	9.50
Refractive index (nD)	1.4539 (20 °C)

III. CONSTRUCTION

Basically an aqua silencer consists of a perforated tube which is installed at the end of the exhaust pipe. The perforated tube may have holes of different diameters. The purpose of providing different diameter holes is to break up large gas molecules to form smaller gas bubbles. Generally 4 sets of holes are drilled on the perforated tube.

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 container. A small opening is provided at the top of the container to flow the exhaust gases to the next container. Another container which is filled by amine solution is used. Amine solution reacts with the treated gas and the gas is removed from the container with the help of outlet port.

A non return valve is provided at the start of silencer to prevent the back flow of exhaust gases. A filler plug and drain plug is provided to change the solution periodically.

IV. WORKING

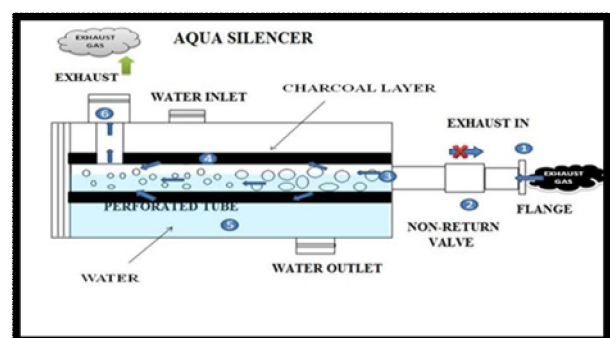


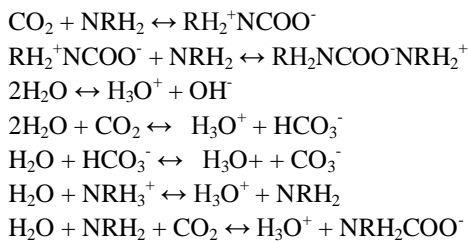
Fig 3 Working principle

As the exhaust gases enter in to the aqua silencer, the perforated tube converts high mass bubbles into low mass bubbles after that they come in to contact with charcoal layer

which purify the gases. It is highly porous and posses extra free valences so it has high absorption capacity.

Since the charcoal layer is covered with outer shell which is filled with water. Sound produced under water is less hearable than it produced in atmosphere. This is mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level hence aqua silencer reduces noise and pollution.

Following are some of the reactions normally assumed to take place when CO₂ reacts in a primary amine like MEA in an aqueous solution.



V. ANALYSIS OF EXHAUST EMISSION

Emissions from diesel engines can be classified in same categories as those from the gasoline engines but the level of emission in these categories varies considerably. A sample of diesel exhaust may be free from smoke, odorless, and have no unburned hydrocarbons (UBHC) or it may be heavily smoke laden, highly mal-odorous and can have heavy concentration of UBHC. It shows the approximately the possible variations in concentration of different constituents of diesel exhaust. The concentration is deceptively low in diesel engines, as compared to petrol engines. However, as the specific air consumption in diesel engines is always high due to excess air, the total amount of pollutants is nearly same in diesel and petrol engine exhaust. Hence, diesel exhaust emissions are as great concern as of petrol engines. Engine type and the mode of operation are two main factors, which influence the exhaust emissions from a diesel engine.

Table shows the range of concentration of different constituents of diesel exhaust:

Table 2 Range of concentration of different constituents of diesel exhaust

Sr. No.	Constituent	Minimum	Maximum
1	Hydrocarbons (HC)	A few ppm	1000 ppm
2	NO _x	100 ppm	2000 ppm
3	RCD	Few	100 ppm
4	CO	Zero	2 percent

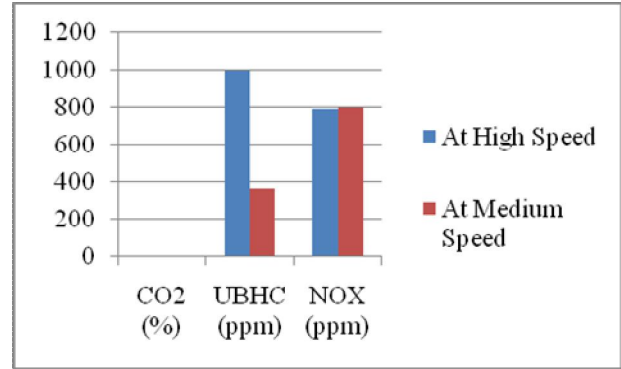


Chart 1 Emission levels of 4-stroke normally aspirated engine

Table 3 Emission characteristics of 4-stroke normally aspirated engine

Sr. No.	Emission	At Medium Speed	At High Speed
1	Hydrocarbon (HC)	Low	High
2	NO _x	Low	Low
3	RCD	Low	High
4	Smoke	High	High

Idle, full load at rated speed and acceleration at full rack are the three modes of operation which have been found to significantly affect the emission levels in diesel exhaust. During the idle mode the concentration of HC, NO_x and aldehyde emissions are lower than other modes the emissions. The acceleration mode has profound influence on odor. Highest odor occurred when full rack acceleration was encountered. Smoke levels are also high during acceleration. Four-stroke normally aspirated engines smoke very much at rated full load.

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