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STUDY ON DEVELOPMENT OF AQUA SILENCER

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ABSTRACT:

Aqua Silencer is a improved variant 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 lime water solution and hence its name is Aqua silencer. The objective of this project is to design & fabricate a simple system, where the toxic levels are controlled through chemical reaction to the more agreeable level. An Aqua Silencer is fitted to the exhaust pipe of engine and perforated plates used for maintain the constant flow of exhaust of the engine towards the outlet of aqua silencer, Hence reduce the noise and controls the emissions. Aqua silencer is cheaper, effective and easy to install and maintain.

KEYWORDS: Aqua Silencer; Pollutant; Air Pollution; Emission; Noise.

INTRODUCTION:

Nowadays the pollution causes physical unwell effects to the mortals and additionally the environment. Automobile gases like carbon dioxide and un burnt hydrocarbons contributes majority of air pollution. Other pollutant gases like oxides of nitrogen, oxides of sulphur and lead are also present in exhaust gases of automobiles. Aqua silencer is used to reduce these gases. Aqua silencer is easy to install and there is no need of catalytic converter. Aqua silencer is one of the important methods for effective reduction of toxic gases and noise.

Aqua Silencer

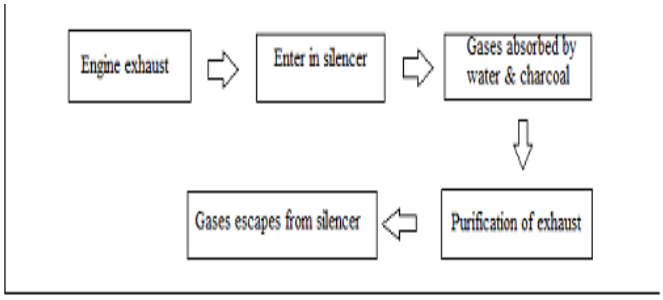

Fig. 1 Block diagram of Aqua Silence

1) PARTS OF AQUA SILENCER:

- Mountings
- Scrubber
- Perforated plate
- Drain plug Charcoal
- Glass wool filter

a) PERFORATED PLATE:

The perforated plate used for convert the high mass bubbles into low mass bubbles, when exhaust gases enters the Aqua silencer. After that they pass through activated charcoals which purify again the gases, so it has high adsorption capacity. Some of the gases may dissolve in to the water and remains passes through the activated charcoals and finally opening it exhaust gases escape

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throughout the atmosphere. Hence aqua silencer reduces large amount of toxic gases and noise.

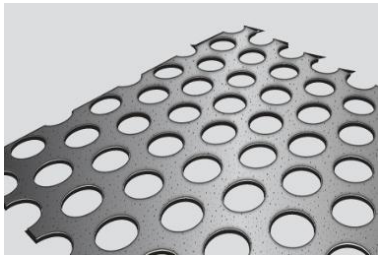

Fig. 2 Perforated Plate

b) CHARCOAL LAYER:

Because of its more surface area charcoal has more adsorbing capacity. Its surface area gets increases when it is produced by heating the charcoal above 1500 ^{0}c for several hours in a burner. It is also known as activated charcoal.

Fig. 3 Charcoal Layer

c) LIME POWDER:

Lime water it is the saturated solution of calcium hydroxide Some amount of Calcium hydroxide $Ca(OH)_2$ is soluble in water (1.5 g/L at 25 °C). Pure limewater is crystalline, odorless and colorless. Limewater is prepared by stirring allowable calcium hydroxide in pure water, and filtering off the allowable insoluble $Ca(OH)_2$. When calcium hydroxide particles dissolve in pure water then it looks like milky color, hence its name known as milk of lime. It is an alkaline solution.

Fig. 4 Lime powder

- **Properties of lime**:

Molecular Formula - $Ca(OH)_2$
Molar mass -74.093 g/mole
Appearance- White power
Odor - Odorless
Density - 2.211 g/cm^3, solid
Melting point - 580^{0}C (loses water)
Solubility in water - 0.189 g/100mL (0^{0}C),
0.173 g/100mL (20^{0}C),
0.066g/100mL (100^{0}C)
Acidity (pKa) - 12.4
Basicity (pKb) - 2.37
Refractive index (nD) - 1.574

2) Methods to Avoid Water Pollution in Aqua Silencer:
   a Lime Water Wash Method
   b Adsorption process

CHEMICAL REACTIONS:

(1) **Reaction First**

The NO_X is obnoxious product of combustion – the oxides of Nitrogen. Nitrogen will be absorbed to a larger extent by water.

$$NO_2 + 2H_2O \rightarrow 2\,HNO_2 + 2HNO_3 \text{ (Diluted)}$$

(2) **Reaction second**

In scrubber tank a small amount of limewater is added, this reaction will takes place.

$$Ca(OH)_2 + 2HNO3 \rightarrow Ca(No_3)_2 = 2H_2O$$
$$Ca(OH)_2 + 2HNO2 \rightarrow Ca(NO_2)_2 + 2H_2O$$

(3) **Reaction third**

Calcium carbonate will precipitate, when the carbon-di-oxide present in the exhaust gas and comes in contact with the limewater. The calcium carbonate when further exposed to carbon-di-oxide, calcium-bi-carbonate will be precipitated.

$$Ca(OH) + CO_2 \rightarrow CaCO_3 = H_2O$$

$$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$$

(4) **Reaction four**

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. This equation gives the chemical reaction and calcium sulphite will precipitate.

$$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$$

(5) **Reaction fifth**

From calcium carbonate, calcium sulphite will precipitate and CO_2 will be by-product. Because of the small percentage and SO_2 presence, the

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liberation of Carbon dioxide is very less. But the liberated CO_2 will again combine with $CaCO_3$ to form calcium bicarbonate.

$$CaCO_3 + SO_2 + H_2O \longrightarrow CaSO_3 + CO_2 + H_2O$$

a) ADSORPTION PROCESS:

Activated charcoal possesses high adsorption capacity because of its granular or powdered form. As it is highly porous and possess free valances. Activated carbon is mainly used for the removal of taste and odorous from the public water supplies. Because it has excellent properties of attracting toxic gases, finely divided solid particles and phenol type impurities, the activated carbon, usually in the powdered form is added to the water either before or after the coagulation with sedimentation.[7]

REVIEW:

A Keval I. Patel et al [1]:

The researcher made a whole study of aqua silencer on actual conditions and made conclusions accordingly. The use of aqua silencer in reduction of noise and toxic gases and the benefits that this silencer can give are explained in this extract.

1) Analysis of the toxic gases and noise reduction system of aqua silencer: In this first experimental study considerations was only the toxic gases and noise reduction system

a) System Description: The system under study consists of three units

- a charcoal layer
- a perforated tube
- water

b) Experimental Procedure:

- First a perforated tube which is installed at the end of the exhaust pipe. The perforated tube consists of number of holes of different diameters 8mm, 4mm, 2mm. It is used to convert high mass bubbles to low mass bubbles.
- The charcoal layer is pasted over the perforated tube.
- Bead Activated carbon is used as a charcoal layer.
- 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.
- The water inlet, outlet and exhaust tube was provided in the shell.

c) Method:

- Absorption method

d) Result:

- Sound is reduced
- CO is reduced 60 to 70 % compared to ordinary silencer
- Engine efficiency increases with increase in flow rate of fluid
- It has Low cost

e) Conclusion:

- Using perforated tube and charcoal layer there is reduction of emissions from the exhaust.
- The activated charcoal increases efficiency and water lowers the noise levels.
- Energy efficiency increases with increase in flow rate of back pressure (engine exhaust in the experiment under consideration).
- It gives smokeless and pollution free emission.

B Akhil Anil Kumar et al[2]:The researchers did a complete investigation of how AQUA SILENCER can affect the toxic emission and noise reducing capacity of an engines and explained the applications of engines with aqua silencer. A complete study of aqua silencer was made which included analysis of their work, structure and also their toxic emission and noise reduction capacities. Performance comparison of simple silencer, silencer with activated charcoal and silencer with activated charcoal and lime water was made. Aqua silencer is thermally effective and technically feasible but certain improvements were made in the working of aqua silencer to fit in the application with the engine exhausting unit is essential. The study was done in research methodology which includes the study of methods, performance simulation and cost evaluation.

a) Method:

- Lime water

b) Material Specification**:**

- Perforated tube with activated charcoal.
- Aqua silencer (box type).
- Engine exhaust first with aqua silencer and second without aqua silencer.

c) Conclusion:

- Increase in less toxic emission and noise reduction capacity and efficiency by the use of aqua silencer.
- More improvements can be done in aqua silencer for lowering noise levels and reducing emissions.

C Sarath Raj et al [3]: In this extract the researcher has given special attention towards performance and the cost analysis of aqua silencer. Different engines are tested on aqua silencer. General study

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is made on aqua silencer irrespective of them being used with engine or any other noise and toxic emission reducing devices. The effect of aqua silencer with different engine (petrol, diesel) on the engine efficiency and the cost of the overall work are properly analyzed. Perforated tube with activated charcoal layer for absorbs toxic gases and dissolve into water is the experimental setup for this study. Engine's exhaust toxic gases reduction rate is calculated for this value of engine efficiency gain. On the basis of the value of different results of toxic gases reduction rates and the noise reduction rate, the final conclusions are drawn.

a) Methods:
- Adsorption method.

b) Material specification**:**
- Toxic gas reduces in aqua silencer with normal water.
- Aqua silencer designed to reduce toxic gases and noise for almost working Hrs.
- Aqua silencer's components (price equal to 8579 Rs).

c) Result:

Share of different factors in the total life cycle cost
- Average lost energy price- 29.45%
- Aqua silencer price - 0.06%
- The CO and HC values are reduce 33% and 48% with twin filter aqua silencer.

d) Conclusion:
- For having an optimum design work of the system should be considered as it has an important and major Share in the total work cost.
- A successful attempt of reducing the noise is made.

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D Parikshit K. Patel et al [4]: Nowadays different types of silencers are used for noise controlling and to reduce toxic emissions. In this study we have been given complete information about CFD analysis and how the use of perforated tube has enhanced the thermal efficiency of an engine with water. All this experimental setup and study was been carried out in order to check the systems performance with the use of perforated tube in aqua silencer. The study aimed at bringing in ideas to reduce toxic emission and noise. The experimenter integrated an aqua silencer directly exhaust of engine and studied the effect of such an alignment of aqua silencer on this operating constant exhaust system. For this study charcoal layer which was directly wrapped around the perforated tube were selected and tested. The effects of the charcoal layer for absorbing toxic gases and dissolving in water were checked. Also description about the mesh characteristics of this type of applications with the use of perforated tube in aqua silencer is given. The aqua silencer's perforated tube with charcoal layer and water are used in this study.

a) Methods:
- Adsorption method.

b) Material specifications:
- Integrated charcoal layer.
- perforated tube.

c) Result:
- Use of perforated tube's enhanced the systems performance.
- More the perforated tube diameters lesser the turbulence and contour.
- Study on the aqua silencer's shows that the use of perforated tube with charcoal layer proved to be more beneficial.

d) Conclusion
- A successful attempt of reducing the sound is made.
- Use of perforated tube in aqua silencer has a great affect on the system.
- Perforated tube reduces the sound and kept the constant back pressure.

CONCLUSION

1. In this review paper complete focus was given on the study about the use of aqua silencer enhances the reduction of noise and toxic emission and all the various applications.
2. Use of water as a medium lowers the noise levels and activated charcoal in water control the exhaust emission to a greater level and increases its efficiency.
3. Energy efficiency increases with increase in flow rate of back pressure (engine exhaust in the experiment under consideration).
4. It gives smokeless and pollution free emissions.

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