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Design and Development of Aqua Silencer using Zeolite Material

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Abstract: The main purpose of designing Aqua Silencer is to deal with the daily increase in air pollution as well as noise pollution which mainly caused due to automobile. These harmful exhaust gases are emitted from silencer/exhaust system of an automobile. Aqua Silencer is an attempt to reduce such pollution. Aqua Silencer is made by using a perforated tube, zeolite, outer cover, non return valve and lime water. This Aqua Silencer is attached at the exhaust pipe of an automobile. The main harmful gases/pollutant which Aqua Silencer deals with are Unburned hydrocarbon(UBHC), Carbon Monoxide(CO), Oxides of Nitrogen(NO_x), Lead Sulphur, Carbon dioxide(CO₂) etc. The zeolite is turned into sheet and rolled on perforated tube which absorbs and filters the pollutants which reduces air pollution and since the exhaust gas is passed through lime water solution it decreases the noise than compared to noise with respect to atmosphere thus also reduces noise pollution. Since water is needed for silencer, it is named as AQUA SILENCER. Thus Aqua Silencer is an updated version of conventional silencer.

Keywords: Pollutants, Exhaust gases, aqua silencer, zeolite, air pollution, noise pollution, CO, UBHC, NO_x, Sulphur, CO₂.

I. INTRODUCTION

The main sources of air pollution in India are Industries, power plants, automobiles etc. In which automobile is the second major reason. The heavy use of automobiles causes pollution and smog. All sound are not noise, any sound which crosses the hearing limit above 80 decibels (dB) causes noise pollution. The main reasons of noise pollution are automobile, railway, machines, aeroplanes etc. Thus rise in pollution leads to global warming and causes dexterous effect on human life on earth. While constant research is going on to reduce the toxic content from exhaust, this project is an attempt to reduce this toxic pollutants of exhaust before it is emitted into the atmosphere. Inorder to reduce these noise pollution and air pollution Aqua Silencer is used. The system can be safely used for diesel engines for industrial purpose and also for automobiles. Aqua Silencer replaces the conventional silencer and is placed in place of conventional silencer. It is attached to the exhaust of an automobile.

Aqua silencer absorbs and filters the main pollutant which causes pollution such as carbon dioxide (CO₂), unburned hydrocarbon (UBHC), sulphur, oxides of nitrogen (NO_x), carbon monoxide (CO), hydrocarbons (HC). As we know that sound is less audible in water than compared to atmosphere so the exhaust gas is passed through water in order to reduce noise pollution. But water will get polluted when exhaust gases are passed through it thus to overcome the water pollution in aqua silencer lime water is used instead of normal water. Zeolites are highly porous and they have extra valences which gives them high adsorption property thus it can filter more amount of exhaust gases than activated carbon. Hence there is no need of installing catalytic converter and it is quite cost efficient and very easy to install.

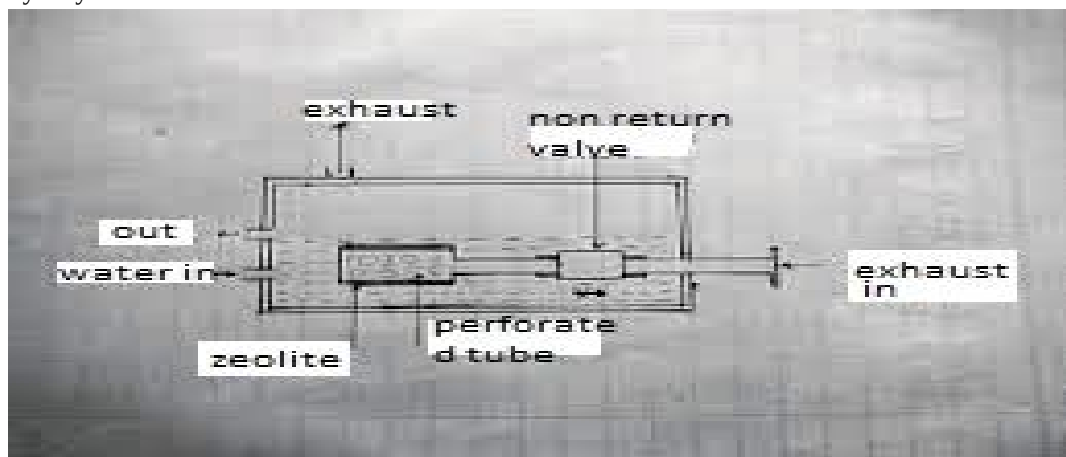


Fig.1. Block diagram of Aqua Silencer

II. COMPONENTS

A. Zeolite

These are hydrated aluminosilicate material made from interlinked tetrahedral of alumina (AlO_4), silica (SiO_4). High temperature does not bother them since they have relatively high melting point. They also resist high pressure, doesn't dissolve in water or inorganic solvent and don't oxidize in the air. They are usually used for purifying purpose and do not cause any health problem.



Fig.2. Zeolite

B. Perforated Tube

It is tube of different diameter holes i.e. it has various number of holes drilled on the tube which helps to convert high mass gases or bubbles into low mass.



Perforated tube

Fig.3. Perforated tube

III. LITERATURE SURVEY

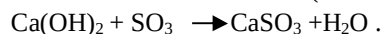
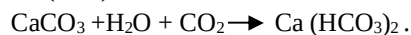
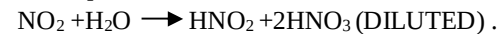
Alen M, Akshay M, Prem Sankar, Mohammed Shafeeq [1] proposed a research paper on Fabrication and testing of aqua silencer. An aqua silencer is more effective in the reduction of emission of harmful gases and pollutants from engine exhaust using perforated tube, lime water solution and activated charcoal. By using perforated tube the back pressure will remain constant and the sound level is reduced. Also by using the perforated tube the fuel consumption remains same as that of 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 gases emission to a greater level. The water contamination is found to be negligible in aqua silencer. It has smokeless and pollution free emission equivalent to conventional silencer.

Shaikh L T, Raut A V, Sake S H, V Elapure S P [2] proposed a research paper on Design manufacturing and testing of aqua silencer. An aqua silencer system is designed in such a way as to substitute for conventional single unit engine unit silencers installed on industrial engines and automobiles. Its construction is simple and has slender design. Aqua silencer basically consists of a perforated tube and charcoal layer on it with a lime water solution placed inside closed container. The perforated tube is installed at the exit of the exhaust from the engine, which has holes of various diameters. Since there are small holes of different diameter the large molecule which forms gas are converted into smaller portion. The main difference is that there are two container chambers which contain lime water solution and they are connected with each other with the help of U-bend tube with non return valve with helps to reduce the back pressure.

Akhil Chowdary Belam, Meka Raghunandh, Akhil Chirra, S Ravi Krishnamoorthy [3] proposed research paper on fabrication and testing of aqua silencer. Various tests were carried out on aqua silencer in order to find out the performance of aqua silencer. The smoke test analyser test was carried out along with gas analyser and noise test. The smoke emission of aqua silencer is analysed with the help of gas analyser which finds the amount of CO and HC content. The reduction of pollutant in exhaust gas is due to the activated charcoal which absorbs about 74% of gases. In this aqua silencer there is a container which contains water and lime stones

in it. The exhaust pipe is connected to the bell mouth which is connected to the tank. This tank is partially immersed in the lime water solution and the remaining exhaust gas goes out from the other end where outlet is given.

Shaikh Hannan, Kale Ajinkya, Patel Shubham, Adekar Joitram, Jadhav Nikhil [4] proposed a research paper on emission control using aqua silencer. Not only the fabrication and design is necessary but also the chemical reactions are important. Hence the chemical reactions are explained using petrol emission analysis through which they came to a conclusion. The water in the scrubber tank itself plays an important role in absorbing the obnoxious products of combustion like the oxides of nitrogen. It serves to dissolve the unburned hydrocarbon (UBHC) which is present in petrol emission, thereby serves to suppress the spark before it is emitted to the surrounding environment. In case of water a weak lime water solution can be used which allow the chemical reaction to take place at faster rates. Reactions of various pollutants are



Some of the reactions were explained in the paper.

Steffin John Eapen, Dilson B Samuel, Manikanand P.M [5] proposed a research paper on overview of activated carbon and zeolite on water treatment. They did a research on activated charcoal which are very well known adsorbent due to highly developed porosity, large surface, variable characteristic of surface chemistry and high degree of surface reactivity. Whereas zeolite is used to remove the most common cations in water affecting human and animal health is NH_4^+ . It can be removed by exchanging with biologically acceptable cations such as Na^+ , K^+ , Mg^{2+} , Ca^{2+} or H^+ residing on the exchanging side of zeolite. They conducted same test for both activated charcoal as well as zeolite and found out that they both has their own advantages and disadvantages.

IV. PROBLEM DEFINITION

In today's generation, there has been increasing concern about enormously increase in pollution due to industries and automobiles. These pollutants are very harmful and toxic for human life and nature. Some of these pollutants are CO, UBHC, NO_x , HC etc. Hence removal of such pollutants is the primary concern. There are many ways through which we can reduce pollution but most of them are quite expensive. Thus we need a cost effective and efficient way through which pollutants are reduced and here aqua silencer comes in light. The main problem faced is the water pollution due to exhaust gases passes through water and other is the back pressure created due to flow of gases in reverse direction of flow. One of the major problems faced is the reduction of performance of vehicle due to high backpressure.

V. EXPERIMENTAL PROCEDURE

Methodology is the backbone of any project and it is quite important and necessary. Methodology includes some steps like abstract, introduction, selection of project, literature review, design calculation and part fabrication.

This Aqua silencer helps to reduce the air and noise pollution. We could not only use it on stationary diesel engines but also on daily used automobile. This is an attempt to do so. The solution in silencer reduces noise and converts bad odour and the zeolite helps to adsorb the harmful gases and eventually reduce pollution.

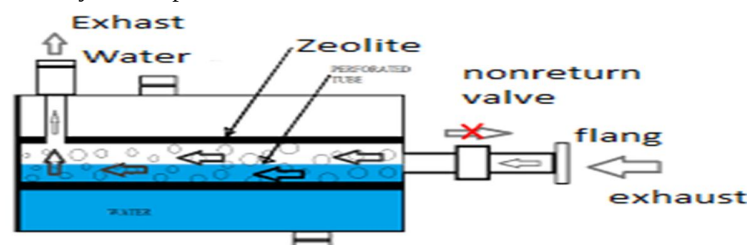


Fig.4. Aqua Silencer

When the exhaust from the engine enters the aqua silencer, gas molecules of larger proportions are converted into molecules of smaller proportion diameter in perforated tube and also reacted with lime water solution and ultimately passes through the layer covered on perforated tube by zeolite which again purifies the exhaust gases.

There are various effects of gases when dissolved in water:

A. Action of Dissolved SO_2

When SO_2 is mixed in water it forms sulphuric acid (H_2SO_3). It forms hydrogen sulphide which causes foul rotten egg smell and corrodes the metal.

B. Action of Dissolved CO_2

When CO_2 is dissolved it forms bicarbonate when pH is low and carbonate when pH is high. Due to which a scale is formed on the pipe. This carbonic acid causes the green house gases and they are highly corrosive in nature.

C. Action of Dissolved NO_x

When NO_x is dissolved in water it starts to oxidize and forms ammonia and nitride and nitric acid.

VI. DESIGN MODEL

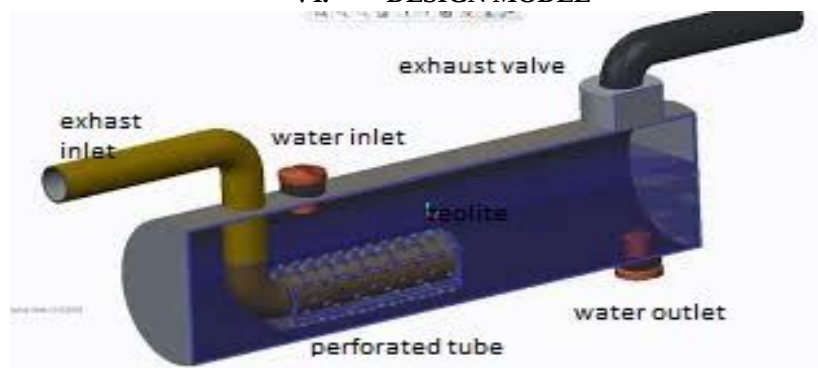


Fig.5. Cad model of Aqua silencer

VII. CONCLUSION

Hence we can easily conclude that by using Aqua silencer the air and noise pollution is reduced as compared to the normal conventional silencer. The emission of CO and HC have been reduced also the noise test shows decrease in sound level than conventional silencer. Aqua silencer have more efficiency to reduce the emission gasses from engine using lime water, zeolite and perforated tube, it also helped in reducing the back pressure and kept it constant. These can be used for both 4-wheeler and 2-wheeler and is also very cheap and play a vital role in industries.

VIII. ACKNOWLEDGEMENT

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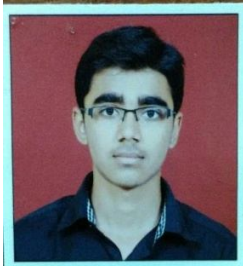
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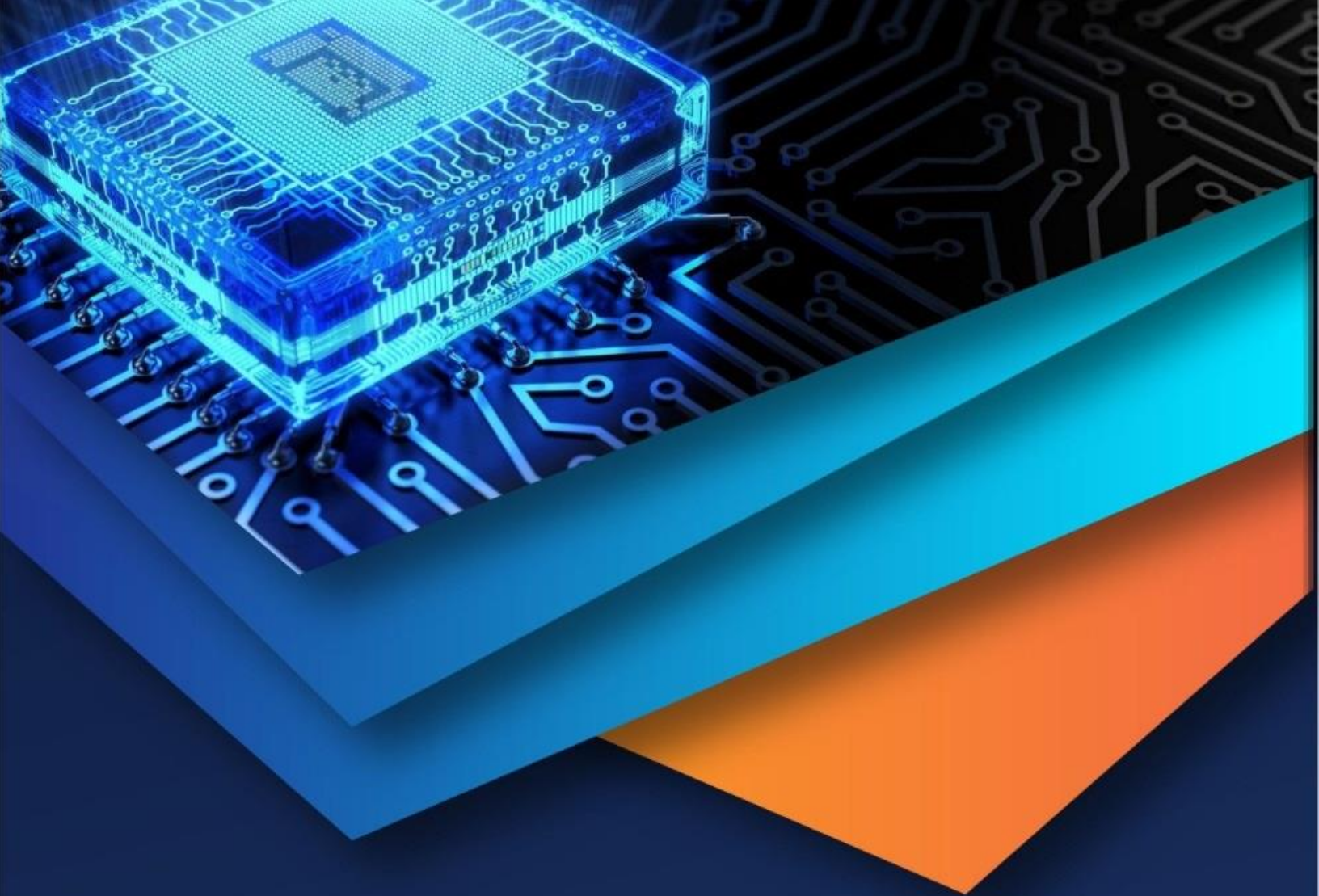
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