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Emission control using Carbon Silencer

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Abstract: For the purpose of mitigating emission and noise in an automotive exhaust system, a carbon silencer is utilized. It is assembled using a perforated hollow metal tube, external casing, activated charcoal and a solution of limestone. The engine's exhaust pipe is connected to the carbon silencer. The hazardous sulfur oxides and nitrogen oxides elements generated by the engine are filtered by activated charcoal. Compared to sound produced in a traditional silencer, sound produced within limestone water is less audible. This is primarily due to little sprockets in water molecules, which reduces its amplitude and hence the sound level. Due to the presence of activated charcoal which has more surface area than regular charcoal it is known as Carbon Silencer. When tested in a single cylinder 4-stroke petrol engine, the noise and smoke levels are significantly lower compared to a typical silencer. Automobiles contribute the majority of pollutants, which include carbon monoxide (CO), unburned hydrocarbons (HC), nitrogen oxides (NOx), and lead. Other sources include electric power plants, industrial and household fuel usage, trash burning, and industrial processes. Carbon silencers are used to decrease emissions and noise.
Key Word: Carbon Silencer, activated charcoal, Perforated tube, Emission, Noise

1. Introduction

Air pollution is a significant issue nowadays. Automobiles emit nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon monoxide (CO), carbon dioxide (CO2), particulates, sulphur dioxide (SO2), and lead, among other contaminants. Air pollution has a negative physical impact on humans, animals, and the ecosystem. As a result, significant efforts must be made to protect the Earth's environment from degradation. The reason we chose carbon silencer is that pollution nowadays causes physical harm to humans as well as the ecosystem. With its slender structure and lighter weight, the carbon silencer system is intended to replace widely used single unit silencers in engines. It is very essential in controlling engine noise and gas emissions. The primary reason for using a carbon silencer is that air pollution is rapidly growing nowadays. This system reduces the harmful exhaust gases emitted by cars and heavy vehicles. The activated charcoal layer surrounding the perforated tube and lime water regulate these emissions. The charcoal layer has a high ability to collect engine emissions gases. These charcoal layers with lime water respond chemically with emission gases, changing their chemical makeup. The levels of smoke, emission gases, and noise in carbon silencers are significantly lower than in conventionally used silencers.

2. Material and Methods

Materials used:

- Perforated tube
- Activated charcoal layer
- External shell
- Non return valve
- Flange
- Drain plug

Perforated tube: It is a tube with various sized openings. The goal of the holes on the tube is to break down the big mass of gas entering the tube into smaller ones. This perforated tube is connected to the engine's exhaust. The open tube's other end is sealed with a plug.

Activated Charcoal: The charcoal layer is attached to the perforated tube. This charcoal layer is more absorbent due to its larger surface area. It is known as activated charcoal, and it is made by burning charcoal above 1500ºC in a burner for several hours, increasing its surface area.

External shell: The entire setup is retained inside the outer shell. It is primarily composed of steel or iron. The water outlet, inlet, and exhaust conduit were built into the shell of the burner, increasing its surface area.

Non return valve: A non-return valve restricts the flow of a medium to one way. A non-return valve can be installed to guarantee that a medium flows in the correct direction through a pipe when pressure conditions would otherwise cause reversed flow.

Flange: A flange joint is a pipe connection in which the connecting sections have flanges that allow the portions to be bolted together. Although the term flange usually refers to a fitting's raised rim or lip, many flanged plumbing fittings are also known as flange.

Drain plug: A drain plug is a plug that is removed to enable fluid to be drained from a tank and is located at the bottom of the tank.

Procedure methodology

The exhaust gases from the motor enter the carbon silencer through the inlet, and the perforated tube converts the high mass of bubbles to the low mass of bubbles. The vapour is then passed through a charcoal layer, which purifies it once more. This charcoal layer is extremely porous and has a high absorption capacity due to its extra free valence. When gases come into touch with lime water, they chemically react with it. The charcoal layer is surrounded by an outer shell that is filled with water, which lowers emission noise. The amplitude of sound generated in water is less than that of sound produced in the atmosphere. It occurs due to the lower amplitude of water molecules. Some of the gases may be dissolved in the water after traversing over the charcoal layer. Finally, exhaust gases exit into the environment through a vent at the top of the container, reducing noise and pollution.

Carbon silencer has two methods for controlling water pollution. The water is contaminated by the dissolved pollutants. When these gases react with water, they create acids such as carbonic acid, sulfuric acid, and nitrogenic acid, among others. Petroleum goods contain phenols, which emit a suffocating odour. Sulphur gas reacts with water to produce hydrogen sulphide, which has a rotten egg odour. To minimise water pollution, these gases must be managed. We took the strategy of washing with lime water. The assimilation procedure (using charcoal) In our project, we used the absorption process technique (activated charcoal) to control water pollution. Activated charcoal is available in granular or powdery form. It has permeable walls and open valences

Chemical reactions:

$$Ca(OH)_2 + 2HNO_2 \rightarrow Ca(NO_2)_2 + 2H_2O$$

$$Ca(OH)_2 + 2HNO_3\ Ca(NO_3)_2 \rightarrow 2H_2O$$

Calcium carbonate will precipitate when the carbon dioxide in the exhaust gas gets into contact with the limewater. When calcium carbonate is subjected to carbon dioxide, calcium-bicarbonate is precipitated. The chemical process is as follows:

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

Carbon sulphite will separate from calcium carbonate, and CO_2 will be produced as a by-product. Carbon dioxide liberation is very low due to the low percentage and abundance of SO_2. However, the released CO_2 will recombine with $CaCO_3$ to create calcium bicarbonate.

3. Result

Water can be used as a medium to reduce noise, and activated charcoal in water can be used to control exhaust emissions to a greater degree. Carbon Silencer was found to be capable of reducing carbon footprints by up to 40%. It has been found to be more suitable. It creates no pollution and emits no smoke, and it is also relatively inexpensive. Carbon silencers successfully reduce sound by using water as a medium. The noise level is decreased by 20% compared to a traditional suppressor because sound is less audible in water.

Table no 1: Pollution test without Carbon Silencer

Sr. No.	Pollutant (as applicable)	Units (as applicable)	Emission limits	Measured value (upto 2 decimal places)
1	2	3	4	5
Idling Emissions	Carbon Monoxide (CO)	Percentage(%)	3.0	0.26
	Hydrocarbon (THC/HC)	ppm	3000.0	139.0
High Idling Emissions	CO	Percentage(%)	0.0	0.0
	RPM	RPM	2500±100	0.0
	Lambda	-	1±0.03	0.0

Smoke Density	Light absorption coefficient	1/metre		

Table no 2: Pollution test with Carbon Silencer

Sr. No.	Pollutant (as applicable)	Units (as applicable)	Emission limits	Measured value (upto 2 decimal places)
1	2	3	4	5
Idling Emissions	Carbon Monoxide (CO)	Percentage(%)	3.0	0.16
	Hydrocarbon (THC/HC)	ppm	3000.0	118.0
High Idling Emissions	CO	Percentage(%)	0.0	0.0
	RPM	RPM	2500±100	0.0
	Lambda	-	1±0.03	0.0
Smoke Density	Light absorption coefficient	1/metre		

4. Discussion

Using a perforated tube, lime water, and charcoal, the carbon silencer is more effective in reducing emissions gases from vehicle exhaust. The use of perforated tube maintains consistent back pressure while lowering the sound level. By using a perforated tube, the fuel consumption stays the same as in a conventional system. By using water as a medium, the sound can be reduced, and we can control the exhaust emission to a greater extent by using activated charcoal in water. Because water is used as a medium for sound, these systems emit no emissions and produce no smoke. These systems are very inexpensive. These systems are used on both four and two wheelers. It is very essential in industries.

5. Conclusion

Naturally, there has been an increase in recent years in concern about the rising rate of mobility and the release of modern waste waters into the environment, as well as the arrival of toxic outflow into the climate from vehicle and mechanical motors. The new silencer, for example, could be a reaction to the decrease in deadly engine outflows into nature. Currently, the new silencer is appropriate for use in mechanical motors and heavy-duty vehicles. In any case, R&D offices have taken the problem into consideration and are working on developing and updating the silencer so that it can be installed in vehicles while keeping its streamlined qualities and supporting or increasing its capability.

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