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DESIGN OF A NOVEL DEVICE TO REDUCE ENGINE EMISSIONS

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ABSTRACT

Air pollution is a threat in which air has adverse effects on humans and the ecosystem. It is caused by substances which may be solid particles, liquid droplets or gases. Pollutants are classified as primary and secondary. Primary pollutants include carbon monoxide and nitrogen oxides from automobile vehicle exhaust and secondary pollutants includes the Sulphur-dioxide released from factories.

The aim of the present work is to fabricate a novel device to reduce the emission of harmful gases such as carbon monoxide, CO_2, unburnt hydrocarbons, nitrogen oxides (NO_X) which are released from the stationary Engines. Nowadays Diesel particulate filters are used in high-end vehicles to reduce the emission and we are using chemical solutions in our project to reduce the harmful gases released from stationary Engines. The chemical solution used in our project is ammonical cuprous chloride and potassium hydroxide and activated charcoal. Activated charcoal is coated on the baffle plates to absorb the carbon content and the heat generated in the combustion chamber and also filter the harmful nitrous and sulfur content produced by the engine.

Keywords: Emission detection, CO, NOx, Ammonical cuprous chloride

I.INTRODUCTION

Diesel engines have extensive usage compared to gasoline engines. Studies have shown that diesel exhaust gas causes respiratory problems, lung damage and even it may cause cancer. In order to prevent these issues many emission control systems have been introduced in the past[1,2]. Many attempts are being made to reduce the air pollution caused by stationary engines [3-5]. The control systems like diesel oxidation catalyst (DOC), Diesel Particulate Filter (DPF), selective catalytic reduction (SCR), and diesel filters are used to control HC , NOx , CO and PM emissions[6-8]. The present setup will replace conventional silencers and is mainly done to reduce the above-mentioned issues. In the present setup harmful pollutants are reduced by using the chemical solution (ammonical cuprous chloride and potassium hydroxide) which is sprayed using a nozzle.

2. EXPERIMENTAL WORK

The experimental setup is tested at several load conditions at 0%, 25%, 50%, 75%, and 100%, and on average, they show a reduction of harmful gases like CO by 36.66%, NO_X by 37.6% and HC by 37.69%. This setup also eliminates the back pressure completely.

A. Galvanized Iron Sheet:

Galvanized iron is iron that has been coated in a layer of zinc to help the metal resist corrosion. Steel can also be galvanized. When metal is going to be used in an environment where corrosion is likely, it is often galvanized so that it will be able to withstand the conditions. Galvanized iron sheet of 2 mm thickness is used in this process because it is lightweight and easily transportable. It is also used in many areas because of its good mechanical properties like good corrosion-resistant, high thermal resistance and it will not react with the chemical solutions which is used in our project.

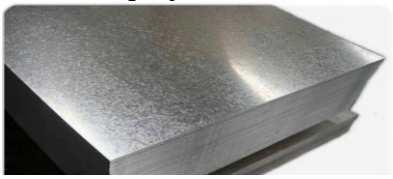

Fig 1: GI Sheet

B. Baffle Plates:
This is installed inside the silencer and is alternately positioned up and down in our setup. When exhaust gas from the engine strikes the plate, it does so at a high speed and a high temperature, which causes the speed and temperature of the exhaust gas to decrease. All of the baffle plates have holes alternately put in them to lessen the back pressure. Additionally, baffle plates are made from 1.5 mm thick GI sheet. A kind of silencer called baffle plate is used to lessen engine noise.

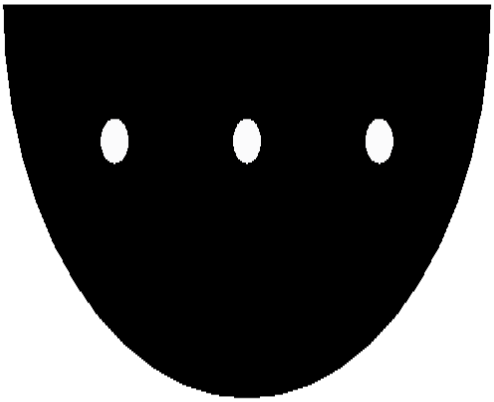

Fig 2: Baffle Plates

C. Spray Nozzle:
A compound nozzle is used here, which means this type of nozzle consists of several individual single or two fluid nozzles incorporated into one nozzle body. The nozzle is used in order to spray the chemical solutions continuously and uniformly in all directions. A spray nozzle is used in this project and is of 1 mm hole diameter. When the pump is switched on the nozzle will start spraying continuously. Nozzles are frequently used to control the rate of flow, speed, direction, mass, and pressure of the stream that emerges from them. The spray nozzle is mainly made up of brass, stainless steel, and nickel alloys.

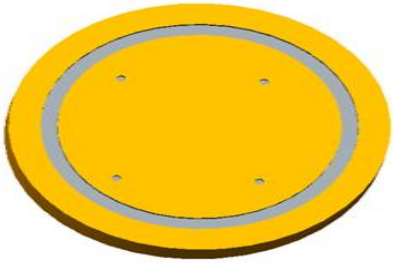

Fig 3: Spray Nozzle

D. Submersible Pump:
Submersible pump which means the whole pump assembly is submerged in the fluid to be pumped. The main advantage of this pump is that it prevents pump cavitation, a problem associated with a high elevation difference between the pump and the fluid surface. A submersible pump of type AM1 is used in this experiment and it works on 220/240V AC supply. This pump is used to pump the chemical solution from the container to the spray nozzle. Submersible pumps push fluid to the surface as opposed to jet pumps having to pull fluids. Submersible pumps are more efficient than jet pumps.

Fig 4: Submersible Pump

E. Drain:
The drain area is situated at the bottom of the nozzle to store the reacted chemical solution. The reacted solutions are further transferred to another container which can also be recirculated after adding certain additives. The drain portion is also made up of Galvanized Iron of thickness 1.5 mm.

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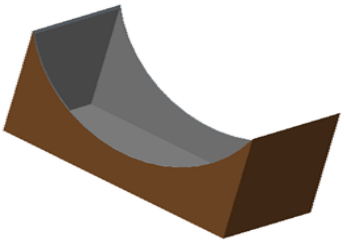


Fig 5: Drain

3. MATERIALS

A. Activated Charcoal:

Activated carbon also called activated charcoal, is a form of carbon processed to have, low-volume pores that increase the surface area available for absorption or chemical reaction. It is highly porous and possesses extra free valences so it has a high absorption capacity and when ammonical cuprous chloride solution and potassium hydroxide solution chemically reacts with the exhaust gases from the engine and releases much less polluted gases to the environment. It is coated at the surfaces of the baffle plates when it hits the area the carbon contents present in the pollutants will get absorbed by the activated charcoal. Activated charcoal is also used in the absorption of the heat generated during combustion which reduces the generation of NOx emission. The activated charcoal layer filters the harmful nitrous and Sulphur content produced by the Engine.

Fig 6: Activated Charcoal

B. Chemical Solution:

Ammonical cuprous chloride and potassium Hydroxide are the two chemicals used for reducing harmful gases. The solution we obtained is a mixture of ammonical cuprous chloride and potassium Hydroxide in the ratio of 1:2 which is black in color. Copper (I) chloride is also called cuprous chloride, is a lower chloride of copper of the chemical formula CuCl. The substance is a white solid sparingly soluble in water but readily soluble in concentrated Hydrochloric acid. Impure samples appear green due to copper (II) chloride and then the cuprous chloride solution is mixed with liquid ammonia to obtain Ammonical cuprous chloride. Potassium Hydroxide is also called as Caustic Potash, which is an odorless white solid substance. Its density is 2.04g/cm3 at room temperature. It has a very high melting and boiling point of 360^0C and 1327^0C respectively. It is soluble in water and also in alcohol but insoluble in ether. Potassium Hydroxide (KOH) is a non-flammable solution.

4. WORKING

In this silencer, the emission of harmful gases is reduced by spraying the chemical solutions and the noise level gets reduced by the help of baffle plates. The working is of 3 stages.

The first one is allowing the exhaust gas to expand. This is done by using sudden expansion of the pipes (diffuser). The second one is applying the activated charcoal on the surface of the baffle plates. Activated charcoal is in the form of powder and it is made into a paste form and then coated on the surface of the baffle plate. The purpose of activated charcoal is to reduce the carbon contents present in the pollutants by absorbing them. The third stage is by spraying the chemical solutions (Ammonical cuprous chloride and potassium hydroxide) using a spray nozzle. When the exhaust gas reacts with the chemical solutions the harmful gas and particulates will get reduced and the reacted chemicals will get deposits on the drain portion after adding certain additives these reacted chemicals can be again used. The particulates in the drain surface will be removed by using filters. At last, the exhaust entering the atmosphere will be less harmful.

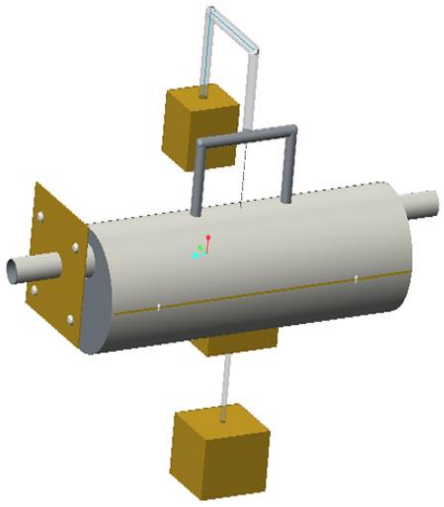


Fig 8: Final Setup

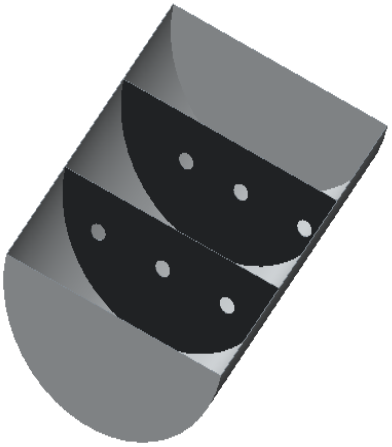


Fig 9: Cross-sectional View

5 . TESTING RESULTS

*NS-NORMAL SILENCER.
*CUS-CHEMICAL USED SILENCER

1. Load at 0% (No Load):

	NS	CUS
CO	0.04	0.02
CO_2	1.90	1.6
NO	178	173
O_2	18.32	18.52
HC	11	4
LAMDA	0	0

2. Load at 25%:

	NS	CUS
CO	0.03	0.02
CO_2	3.10	2.1
NO	473	258
O_2	16.57	17.78
HC	13	8
LAMDA	6.273	9.35

3.Load at 50%:

	NS	CUS
CO	0.02	0.02
CO_2	4.20	2.5
NO	819	443
O_2	15.18	17.19
HC	12	6
LAMDA	4.586	7.8

4. Load at 75%:

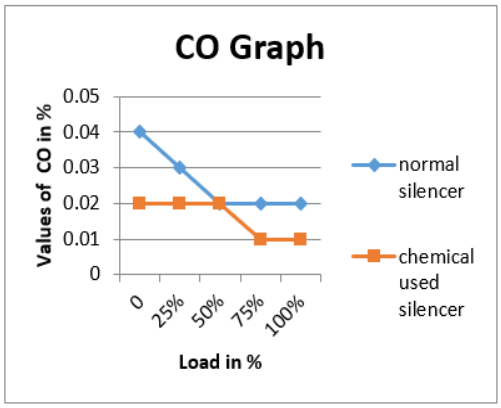
	NS	CUS
CO	0.02	0.01
CO_2	5.30	3.1
NO	1182	580
O_2	13.54	16.2
HC	11	7
LAMDA	3.538	6.19

5. Load at 100% (Full Load):

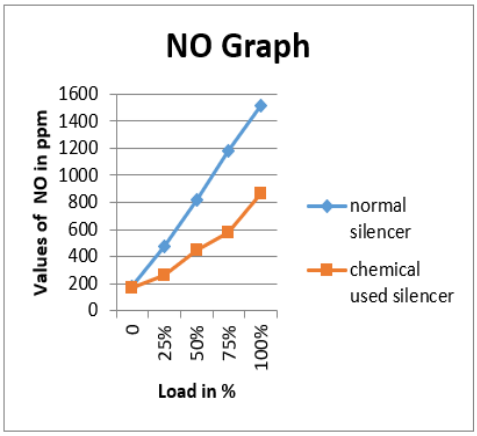
	NS	CUS
CO	0.02	0.01
CO_2	7.30	4.1
NO	1516	865
O_2	10.93	14.58
HC	10	10
LAMDA	2.489	4.54

VI. GRAPHS

1. Load vs CO:



2. Load vs NO:



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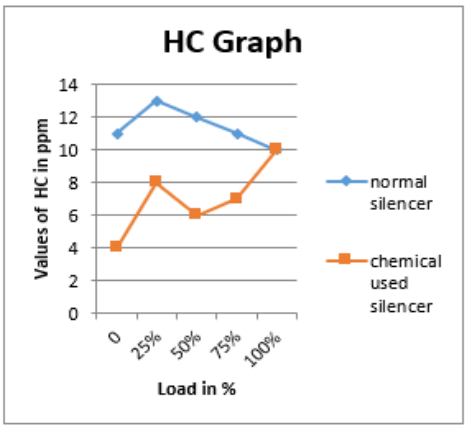
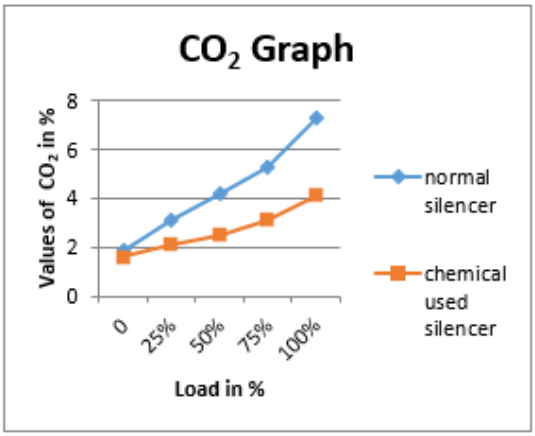
3. Load vs HC:



4. Load vs CO_2:



6. CONCLUSION:

Gases such as CO and HC are emitted because of incomplete combustion and unburnt fuel while NOx emissions are caused because of high combustion temperatures above 1350^0C, PM emissions are caused by very small particles of partly burned fuel, partly burned lube oil.

Our test results show that our device by us will reduce the major pollutants like carbon monoxide, NOx, and unburnt-Hydro carbons in the exhaust gas released from stationary engines and even in automobile vehicles with some modifications. The cost is less compared to the catalytic convertor and the installation process is also easy. This setup can also act as a silencer by reducing the noise generated during combustion.

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