SUSTAINABLE DEVELOPMENT BY USING AQUA SILENCER WITH GREEN ALGAE

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ABSTRACT

As the industries and vehicles are growing immensely in recent years, the Air pollution and Noise pollution are becoming major problem, cities like Delhi are much affected with this. Power plants are releasing a large number of harmful gases into the atmosphere which is affecting the lives of the people living nearby and also causing pollution. Aqua Silencer with green algae is one of the attempts taken to reduce the air pollution as well as sound pollution also. Aqua silencer deals with control of emission and noise in industries and factories, which is achieved by using activated charcoal, perforated tube, green algae water and outer shell of the aqua silencer fitted to the exhaust pipe of an engine, which produces harmful gases. Activated charcoal layer filters the harmful Nitrous and Sulphur content produced from the engine exhaust. Algae water captures the maximum percentage of Carbon dioxide by photosynthesis process. A Pollution Under Control (P.U.C) test is conducted on a motor vehicle with and without this model and the results will be compared to see how much percentage of harmful emissions that got decreased. As the model is tested on a Silencer of a motor vehicle & water plays a crucial role in this, it is named as Aqua Silencer. Serious attempts must be made to conserve the earth's environment from the degradation. An aqua silencer is an attempt in this direction.

INTRODUCTION

Background

Vehicles & industries are a major source of environmental pollution. Air contamination is serious issue from the public health point of view. Polluted air causes unexpected physical and physiological effects on human health. Air pollution can be defined as addition of unwanted material to our atmosphere, which will have a speedy effect on life of living things upon our planet. The main pollutants contributed by engine exhaust are carbon monoxide (CO), un-burnt hydrocarbon (UBHC), oxides of nitrogen (NOx) and Lead. Fossil fuelled power stations are major emitters of Carbon dioxide (CO_2), a greenhouse gas which is a major contributor to global warming.

Emissions may be divided into two group; 1) Invisible emission and 2) Visible emission. Major emissions in exhaust gas are as follows:

1. Invisible emission.
    a) Un-burned hydro-carbon (HC)
    b) Oxides of carbon (CO_x)
    c) Oxides of sulphur (SO_x)
    d) Oxides of nitrogen (NO_x)
2. Visible emission
    a) Soot and Smoke (carbon particles)
    b) Particulates

It is impossible to conclude simply by saying the only cause of air pollution is automobile specifically. This is because of that, there are other sources such as power plants, electric power generating stations, industrial and domestic fuel consumption, industrial processing etc. also contributes heavily to pollution of our environment, so it is mandatory that serious efforts should be made to conserve of our environment from deprivation. Actually, engines are used for various purposes in power plants, automobiles, locomotives and in various manufacturing. Pollution in a sense not only the air emission part but also the noise produced should be in consideration. Noise created by these engines becomes a vital concern in domestic areas or areas where noisecreates various hazard. Scientifically noise level an average of more than 80 dB is hazardous for human being naturally. The main sources of noise in an engine are the exhaust and that produced due to friction of various parts of the engine.

Even if this study may not deal with noise particularly, it reduces a significant amount of it. Activated charcoal layer is highly porous and possess extra free valences so it has high absorption capacity along with this green algae water absorbs the CO_2 in the exhaust gases by performing Photosynthesis process from the engine and release much less pollution to the environment.

Considering the available fuel resources and the present technological development, fuel is evidently necessary. In general, the consumption of fuel is an index for finding out the economic strength of any country. In spite, we cannot ignore the harmful effects of the large mass of the burnt gases, which erodes the purity of our environment every day. While, constant research is going on to reduce the toxic content of exhaust gases, the power requirement is increasing so as its applications and demand.

The project is an attempt to reduce the toxic content of exhaust gases (especially CO2), before it is emitted to the atmosphere. This system can be safely used in inflammable atmospheres, such as refineries,

chemical processing industries, power plants, open cast mines and other confined areas. For achieving these toxic gases are to be reduced to acceptable limits before they are emitted out to this atmosphere, which otherwise willbe hazardous and prone to accidents.

Statement of the problem

In this project, it is dealt with emission reduction mechanisms due to the environmental pollution what is observed around our living area by introducing the machine component called aqua silencer. Here targeting this study deeply about air emission rather than sound emission. The reason why we go for aqua silencer is, in today life the air pollution causes physical ill effects to the human beings and also to our environment.

The main contributors to air pollution are exhaust gases from automobiles like carbon dioxide, unburnt Hydrocarbon, oxide of nitrogen etc. In order to avoid these types of gases introducing this aqua silencer is very essential at this moment. This aqua silencer system is designed to replace conventional single unit engine silencers on board structures. It is used to control the noise and emission in IC engines. It is fitted to the exhaust pipe of the engine. Sound produced under water is less hearable than produced in atmosphere. This is mainly because of small sprockets in water molecules, which lowers its amplitude thus, lowers the sound level.

The emission can be controlled by using the activated charcoal layer and it is highly porous and possesses an extra free vacancy which renders it high absorption capacity. So,in this project it is tried to minimize the size of silencer as much as possible without affecting the weight of vehicle.

Figure 1.1 Pollution from Power plants (Source: Getty Images Gallery)

AQUA SILENCER

Parts of Aqua Silencer:

- Perforated tube
- Outer shell
- Algae Water
- Wire Mesh
- Charcoal layer

Perforated Tube

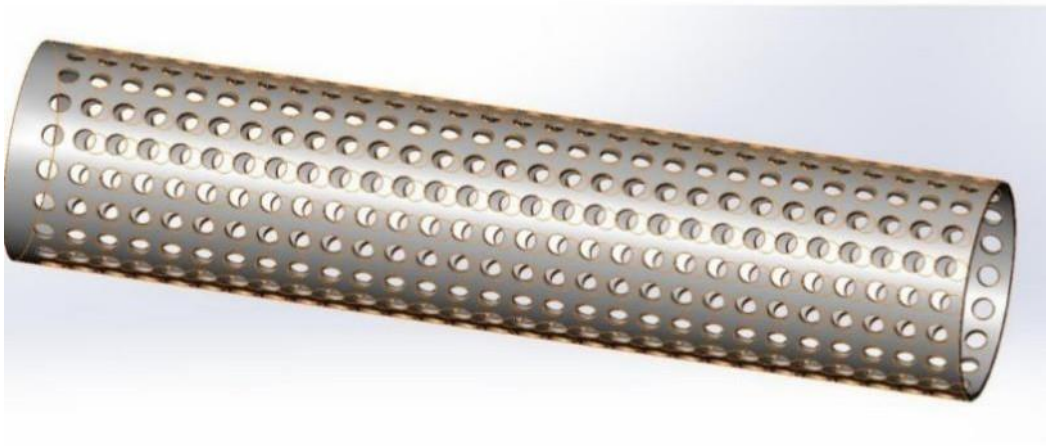

Figure 3.1 Perforated Tube

The perforated tube consists of number of holes of different diameters. It is used toconvert high mass bubbles to low mass bubbles.

The charcoal layer is pasted over the perforated tube. Perforated tube is tube generally made up of stainless steel and have holes punched or drilled around its periphery. These tubes are provided to guide the flow and hence their main function is to reduce the back pressure of the engine. However, with the appropriate design of perforated tube it is possible to increase the transmission loss of the muffler. Back pressure is essential for the performance of a silencer. Pressure drop of exhaust system includes losses due to piping, silencer, and termination. The most critical component regarding back pressure of any commercial muffler is cross flow perforated tube in which the diameter of the perforated tube hole and porosity of the perforations are most critical. If the diameter of the hole increases the back pressure decreases sharply by 40%. The change in diameter of holes has remarkable effect on back pressure.

Perforated Tube Functions

To appreciate where and how perforated tubes are used it helps to understand how they work. Rather obviously, a perforated tube is a tube with holes. These holes let fluids pass through. The size and shape of each hole govern how easily and how quickly the flow takes place. In addition, the total area of holes, referred to as the "open area" controls the overall fluid flow rate. Fluids can be liquids or gases. Liquid applications are often for filtration but can also be to control flow rate. Gas applications are often related more to how the gas transmits sound rather than filtration – acoustics, in other words. Holes can pass more than fluids though. Heat and light are two examples, and then there's also electromagnetic energy – radio waves or microwaves – which holescan filter.

The role of the perforated tube is to support the filtration media, holding it in place and letting fluid flow. Hole size and open area are important in managing the fluid, particularly to ensure even distribution across the filter material. The holes themselves though are too big to filter any but the largest particles.

Outer Shell

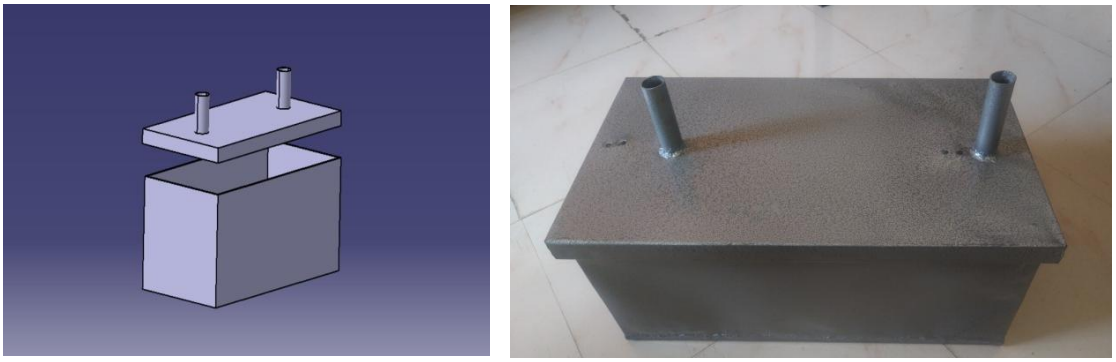

Figure 3.2 Outer Shell

The whole setup was kept inside the outer shell. It is made up of iron or steel. The waterinlet, outlet and

exhaust tube were provided in the shell itself. Material selection of the outer shell is the crucial parameter because of the consideration of heat conductivity, corrosiveness and cost.

Requirement of good shell material selection:

1. Its thermal conductivity.
2. The thermal conductivity of material must not be high enough so that it will liberateall of its heat and will cause less effective temperature for necessary reactions.
3. The material should have good resistance to corrosiveness and erosion.

Algae Water

Figure 3.3 Green Algae

Algae can be effective and economical in dealing with industries effluents. One acre of algae can absorb up to 2.7 tons per day of Carbon dioxide (CO_2). Algae consumes more CO_2 than tress because it can cover more surface area and also grow faster.

Wire Mesh

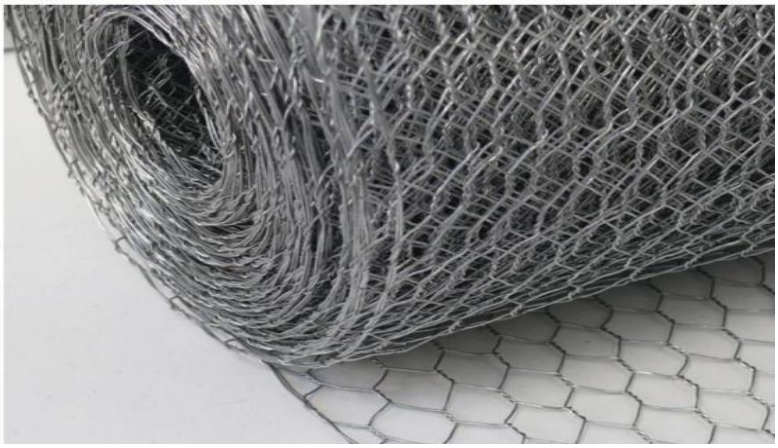

Figure 3.4 Wire Mesh

Dimensions & Calculations

Table 3.1 Dimensions & Calculations

• Outer Shell	• 20×10×10 inches
• Volume of Algae Water	• 508mm(length)× 70mm (height of algae water) × 254mm (breadth) = (0.009m3)
• Perforated tube length	• 0.3m
• Perforated tube diameter	• 0.03m
• Weight of Charcoal	• 0.5 Kg
• Thickness of charcoal layer	• 0.015m
• Inlet & Outlet pipe diameter	• 0.015m
• Ratio of Algae & water	• 1:2
• Weight of the Container	• 3 Kgs
• Velocity of exhaust gases	• 47 m/s (Approx.)
• Volume Flow Rate ofexhaust gases (V_{eg})	• 0.033 m^3/s ($7\times10^{-4}\times47m^2$)

- 1 acre of algae absorbs 225 kg CO_2 per hour.
- Power plants produce 400kg CO_2 per hour if 1 MW power isproduced per hour.
- So, algae will remove approximately 50-55% CO_2 if 1 acre of algae is circulated.

Working of Aqua Silencer

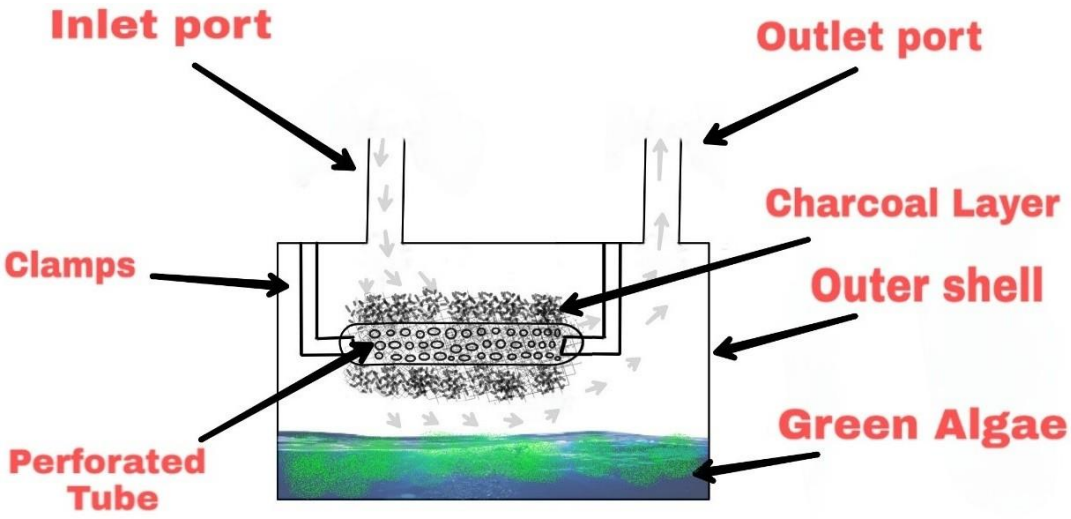

Figure 3.8 Working of Aqua Silencer

As the exhaust gases enter into the aqua silencer, they pass through the charcoal layer which purify the gases and it also absorb large quantity of Nitrous oxides, as it is highly porous and possess free valences it possess high absorption capacity. A wire mesh is used to hold the charcoal around the perforated tube. The perforated tube converts high mass bubbles into low mass bubbles, after that they come into contact with green algae water, they react with it through Photosynthesis process. The gases like HC, CO, CO2 are absorbed from the emission. The purified gases are then released into atmosphere. The grown up and used algae can then be removed and it can be used as fish food & bio energy production. Algae serves as the basis for many aquatic food webs, fueling the growth of fish, insects, snails and other organisms.

Wire mesh is used to hold the charcoal layer around the perforated tube. Wire mesh is made in such a way that it has so much of gap in it, which helps the gases to pass through it at the same time can hold the charcoal. Mild steel wire mesh is generally preferred due to its strength. The gaps in the mesh should not be more than the size of the charcoal otherwise the charcoal will fall from the mesh easily. 10mm gap wire meshis used in the model.

Charcoal Layer

Figure 3.5 Charcoal

Charcoal is a form of carbon processed to have small, low volume pores that increase the surface area presented for adsorption or chemical reactions. It has high degree of micro porosity naturally. An activation level sufficient for useful application may be attained solely from the high surface area; however, further chemical action often enhances adsorption properties. Activated carbon is usually derived from charcoal andis sometimes utilized as bio char. Generally activated carbon is material of very high surface area made up of millions of pores and is well known as “molecular sponge” by microscopic view.

P.U.C (Pollution Under Control) Test

P.U.C Vehicle:

Figure 6.1 P.U.C Vehicle

What is P.U.C

This is a certificate that states that your vehicle is emitting controlled smoke as per the set standards i.e., less polluting. For this, certificates are issued only after checking the vehicles at the Pollution Test Centre, its full name is **Pollution Under Control Certificate**.

P.U.C Test Method

How much pollution is coming out of the vehicle in the form of smoke? To test this, a gas analyser is put in the silencer. During this, the vehicle is kept running. With the help of the analyser, all the data store in the computer, while during this time the photo of the number plate of the vehicle is also taken. If all goes well, the certificate is issued.

For petrol vehicles – When the gas analyser is inserted in the silencer of petrol vehicles, then only the vehicle is kept on starting.

For diesel vehicles – When the analyser is inserted into the silencer of diesel vehicles, the accelerator is pressed four to six times after starting the vehicle, then its average reading is considered final.

Figure 6.2 P.U.C Machine Airvisor Setup (Gas Analyser)

Line Diagram for the P.U.C Test

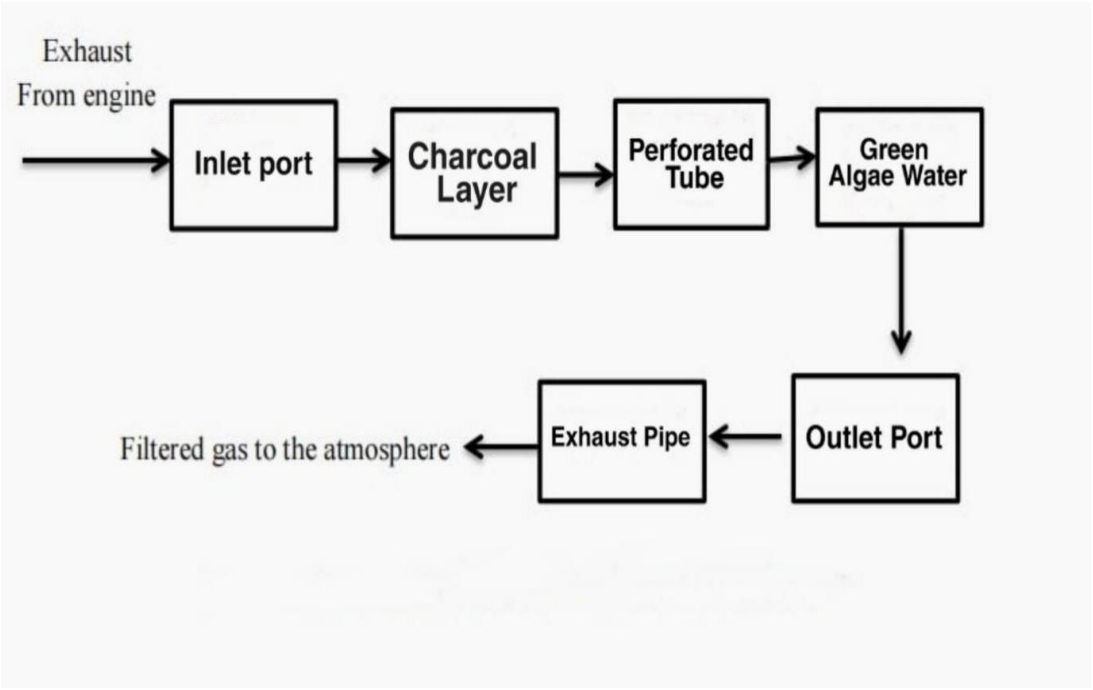

Figure 6.3 Line diagram of Aqua Silencer for the P.U.C Test

Important things about P.U.C Test

All two-wheeler and three-wheeler or four-wheeler of any type require a PUCcertificate. Provided that it is not a battery-operated or electrical vehicle.

1. PUC issued from one state is recognized in another state, so there is no need to get anew PUC certificate while moving to another state.
2. PUC can be checked only by a person who has a degree in Motor Mechanic or Automobile Engineer.
3. The PUC has a serial number.
4. The photo of the number plate of the vehicle for which PUC has been done is on thePUC.
5. The validity of the PUC i.e., the day on which it has been issued and for how long itwill be valid is written on it.

P.U.C Test on Vehicle

Figure 6.4 P.U.C Test on Vehicle

Figure 6.5 P.U.C Test on Vehicle with Aqua Silencer Setup & Normal Water

Figure 6.6 Aqua Silencer Setup with Green Algae Water

Figure 6.7 P.U.C Test on vehicle with Aqua Silencer Setup and Green Algae Water

P.U.C Test Certificates

CASE 1: P.U.C Test on Normal Vehicle

Figure 7.1 (CASE 1) P.U.C Test on normal vehicle

COMPUTERISED POLLUTION UNDER CONTROL CERTIFICATE

Serial No. 281321

Rule 115(2) Of C.M.V.Rules 1989

AUTHORISED BY

Transport Department, Govt. of A.P.

Type of Vehicle : 2 WHEELER

Type of Engine : 4 Stroke

Fuel : CNG/LPG/PETROL

Catalyst :

Make : HERO

Model : PASSION PRO

Date : No 19 Apr 2022

Time : 16:04:02

PTS Licence No. :

Vehicle Registration No. : 0000871

Year of Registration : AP04BM3566

Odometer Reading : Feb 2017

Photograph of the Vehicle

2 and 3 Wheelers (4 Stroke) Mrf after 31/3/2000

Test Result : ALL INDIA VALID

	Regulation (%)	Actual Reading
CO	3.5	1.55 % Vol:
HC	4500	0468 PPM

Certified that this Vehicle Co Emission level confirms to the Standards prescribed under Rule 115(2) of CMV Rules 1989

Validity : 6 Months

Valid Upto : 18 Oct 2022

Seal of Test Station :

Authorised Signature :

STOP POLLUTION SAVE LIFE

Printed by : Manas Graphics for Association of Pollution Testing Station

When the P.U.C Test is conducted on normal 2-wheeler vehicle i.e., HERO passion probike in this case, it is observed that CO is 1.55% and HC is 0468 ppm.

The photograph of the vehicle is placed at the bottom right of the P.U.C Certificate, itshows the number plate of the vehicle along with the silencer outlet.

Also, it is noted that the certificate only shows the CO and HC emissions, but the testgives other emission results also like CO_2, O_2, NO_x

CASE 2: P.U.C Test on vehicle with Aqua Silencer but with normal water

Figure 7.2 (CASE 2) P.U.C Test on vehicle withAqua Silencer but with normal water.

In the second case, the P.U.C test is done on the vehicle with normal water & thereadings are taken. It shows that CO is 0.89% and HC is 0292 ppm.

A decrease of 42% in CO and 37.1% in HC emissions.

The photograph of the vehicle now shows the Aqua Silencer setup i.e., the readings arenow taken from outlet port of the Aqua silencer setup

CASE 3: P.U.C Test with Aqua Silencer and Green Algae Water

Figure 7.3 (CASE 3) P.U.C Test withAqua Silencer & Green Algae Water

In the third case, the P.U.C test is done on the vehicle with proper Aqua Silencer setup i.e., with green algae, perforated tube with charcoal layer & the readings are taken. It shows that CO is 0.32% and HC is 0169 ppm.

A decrease of 72% in CO and 42.8% in HC. Also, it is observed that not only emissions got reduced but oxygen level also increased 53.8%.

Test Results Comparison

Test Results Comparison in table

Emissions		Case 1	Case 2	Case 3	% change in case 2	% change in case 3
	Regulation(%)	Actual Reading (%)				
CO	3.5	1.55	0.89	0.32	42	75
$C0_2$	2.5	2.1	1.9	1.2	19.4	42.8
O_2	...	1.3	1.4	2.0	7.6	53.8

Table 7.1: Comparison of emissions CO, CO_2, O_2

Emissions		Case 1	Case 2	Case 3	% change in case 2	% change in case 3
	Regulation(PPM)	Actual Reading (PPM)				
HC	4500	0468	0292	0169	37.1	63.2
NO_x	600	510	480	416	5	18.43

Table 7.2: Comparison of emissions HC, NO_x

Case 1: P.U.C Test on normal vehicle i.e., without any project setup. Case 2: P.U.C Test on vehicle with Aqua Silencer but with normal water.Case 3: P.U.C Test with Aqua Silencer & Green Algae

Test Results Comparison in graph

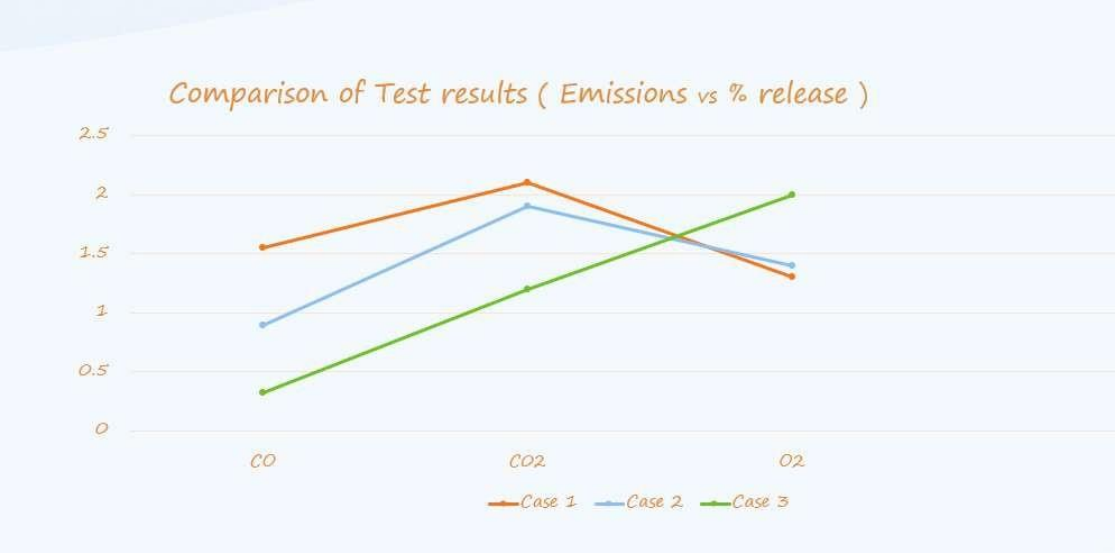

Figure 7.4 Comparison of emissions CO, CO_2, O_2

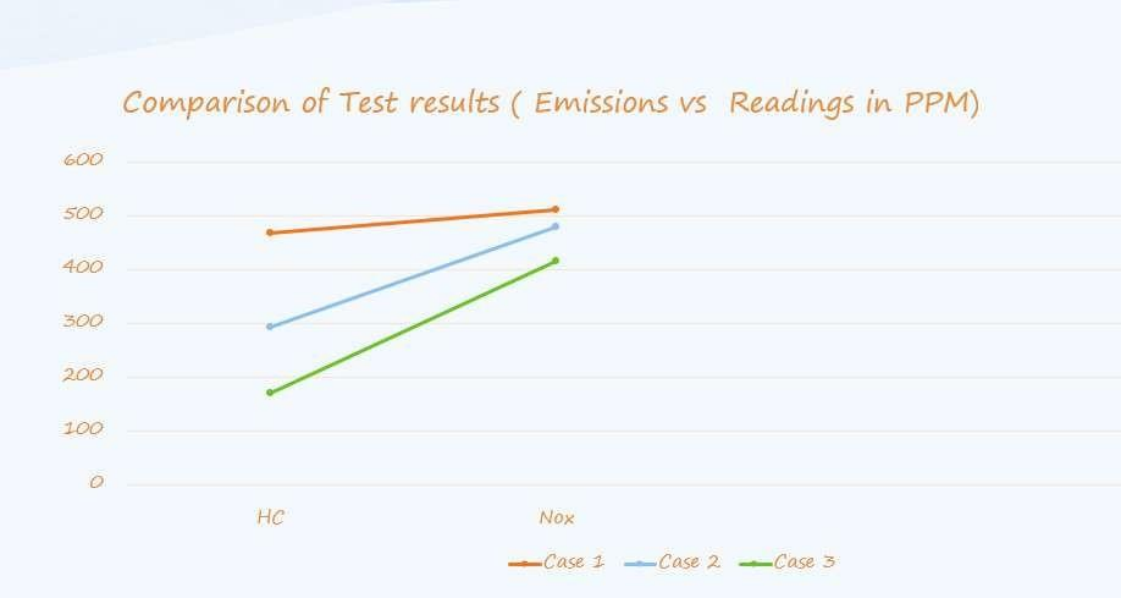

Figure 7.5 Comparison of emissions HC, NO_x

Case 1: P.U.C Test on normal vehicle i.e., without any project setup. Case 2: P.U.C Test on vehicle with Aqua Silencer but with normal water.Case 3: P.U.C Test with Aqua Silencer & Green Algae

CHAPTER-8 COST ANALYSIS

S.NO.	Particulars	Quantity	Total Cost
1	Stainless Steel Sheet	3 Kg	900
2	Sheet Metal Works	-	650
3	Perforated Tube	1	50
4	Charcoal	0.5 Kg	80
5	Wire Mesh	1	70
6	Pipe Fittings	2	50
7	Clamps	2	50
8	Green Algae	2 Litres	50
9	P.U.C Test	-	600
10	Transportation and Miscellaneous	-	500
Total			3000

Table 8.1: Cost Analysis

CONCLUSON

The test results show how the emissions changed in different cases.

In Case 1 when the test was done on normal vehicle the emissions were at certain level under regulation.

In Case 2 when the test was done with Aqua Silencer setup but with normal water, it is observed that little decrease in the emissions occurred.

When in Case 3 i.e., with proper Aqua Silencer setup with charcoal layer, perforated tube and green algae water the emissions showed a drastic decrease, not only the emissions reduced but also the Oxygen levels were also increased.

FUTURE SCOPE

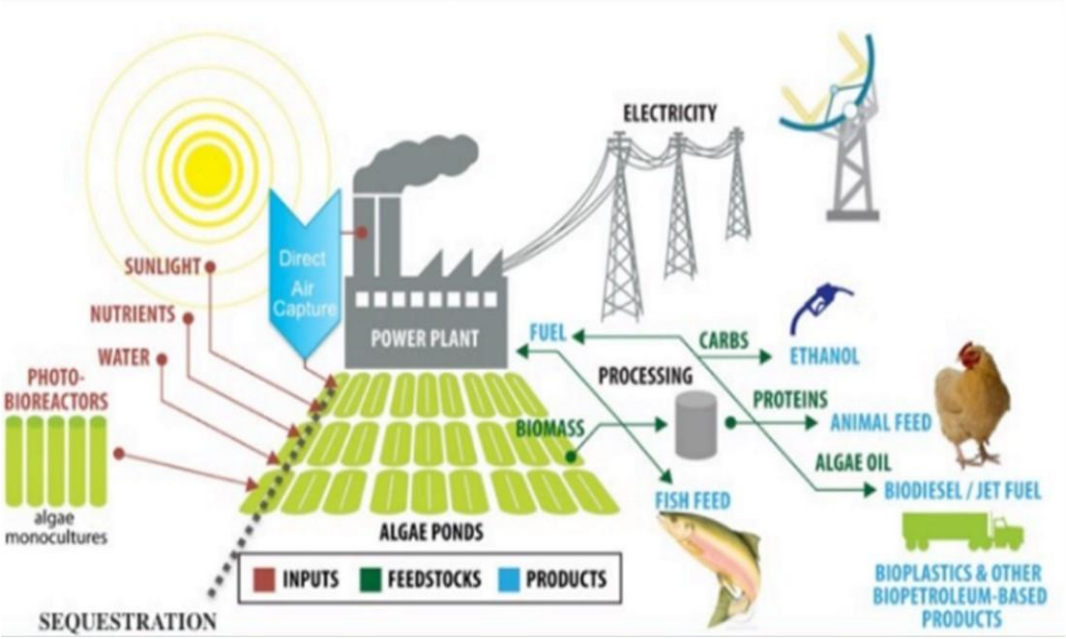

Figure 10.1: Algae Culture in Power plants

The Aqua Silencer model can be used in small industries or power plants where huge amount of exhaust gases are released into the atmosphere. Algae can be grown near by power plants in a pond. The grown-up algae can be used as fish feed, animal feed etc.

Like this we can achieve sustainable development i.e., without causing much change to the existing models and damaging environment we can control the pollution emissions.

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