

EFFECT OF FLUE GASES WITH WET SCRUBBER IN 4-STROKE C.I ENGINE

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ABSTRACT

There are wide varieties of system being used to control air pollution and scrubber system is one of those which are being used to control the emissions out of the exhaust of the diesel vehicles. Fuel burns in combustion chamber to give hazardous particulate emission out of the exhaust manifold. The objective of this experiment is to control the emission out of the exhaust by means of scrubber system used with water with different components in order to minimize the emission to maximum level. The basic principle behind this technique is absorption or particle wetting in which the solid particle is brought in contact of the liquid and the solid particle get absorbed in the colloidal form and get dissolved in the water or get settled down in the of colloidal form. The experiment was done on the Indian emission standards of hartridge smoke unit (65 HSU) used by "Pollution Under Control" Test van (PUC) used for diesel vehicles. The experiment was performed with a model which was connected at the rear of the exhaust of Chevrolet Tavera NEO 3 LS and 4-stroke diesel engine and then the readings were taken from the wet scrubber and the results were positive and again it was done by mixing calcium carbonate (lime stone) and the emission was minimized to too much extent. This technique is quite helpful in control of pollution from diesel vehicles or any 4-stroke C.I engine as these emit a lot of pollution out of the exhaust in the environment.

Key words: Pollution, scrubber, hartridge smoke unit, Bharat emission standards.

1. INTRODUCTION

To stay alive on this earth we need to breathe similarly every living being either plants or animals everyone needs air to maintain their life by a chemical process which can only take place due the presence of air. Also air is not the main thing but the air should be clean to breathe and for running the metabolism of the other living beings. First, the question arise that what is clean air and what are the measures through which we can achieve our required goal? Simply clean air means the presence of the pollutants should not be there. Clean air is good to for every living being on the earth to run their metabolism and is also good to breathe for the humans.

1.1 Air Pollutant:

An air pollutant in the nature has adverse effect on both human and the nature. It can be solid, water droplets and gases. The pollutant can also be manmade. There are mainly two types of pollutants in the air primary and the secondary air pollutant. Primary air pollutants are formed during a process like carbon monoxide formed out of the burning of fuel in the vehicle, sulfur dioxide released from the factories and ashes from the volcanic eruption. Secondary air pollutants are formed due to reaction in between two primary

air pollutants. We are here mainly concerned with the primary pollutant released from the diesel engine vehicles.

1.2 Types of air pollutants:

Now we should also what are the main air pollutants in the air and what are the adverse effects of these. These are as follows:

Carbon monoxide (CO): It is the primary air pollutant being released out of the exhaust of the vehicle. Carbon monoxide obstructs the oxygen heart, brain and many more important organs when it is being inhaled.

1.3 Air pollution in India:

India has been ranked 155 out of 172 in 2013 as per "Environmental Performance Index". Air pollution is quite a serious concern in INDIA. The major sources of air pollution in India due to vehicle emission, burning of wood as fuel, traffic jam, fuel defilement. After China and United States, India is the largest producer in per capita emission of green house gases. Consumption of fuel wood in India is in largest amount around the world. In India cowdungs, logs and agricultural wastes are still used as cooking fuels. The burning of these types of fuel leads to the formation of heavy amount of smoke, nitrogen oxides, sulfur oxides, hydrocarbons (HC), carbon monoxides are released in environment. These are the hazardous gases being emitted and having adverse effect on the life of living beings. There are many vehicles on the roads of India emitting a lot of pollution as India is following Bharat Stage IV emission norms for vehicles in 2005 which is equivalent to Euro IV European norms for the vehicle emission. However, there are many vehicles running on the streets which are based on early norms of year before 2005 and even earlier before 1992. Some of the taxis and auto-rickshaws running in India run on tainted fuel blends. Diesel and gasoline is being adulterated to make a low price fuel. These are the reason for high price rise in fuel resulting of cheaper fuel blending which is not suitable for the vehicle. The blending of fuel leads to the saving of money but on the contrary it has many adverse effects on the environment and the living beings too. This lead to the emission of many harmful

Sulfur Oxides (SO_x): When sulfur containing fuel especially diesel is being burnt in the motor vehicles and the factories it produces sulfur dioxide. Sulfur dioxide oxidizes in the presence of nitrogen dioxide to form sulfuric acid and acid rain in nature. It leads to asthmatics problems in the children of the younger ages.

Nitrogen Oxides (NO_x): These are produced as a result of combustion at high temperatures. Lung irritation, respiratory infections are more prominent like influenza and pneumonia.

Particulate Matter (PM): These are the suspended particles of the solid or liquid particles present in the air. The main sources of the particulate matter are from volcanoes, forests, from vehicles and many more. The presence of particulate matter in the air leads to lung cancer, heart disease.

pollutants likes hydrocarbons, carbon monoxide, oxides of nitrogen and particulate matters also. Kerosene being blended in the fuel is quiet uneasy to burn which lead to emission of these hazardous gases even in more amount. Sulfur content in the Indian fuel was 0.25 percent by weight while 0.10 percent for gasoline. More the sulfur in the fuel more is the release of oxides of sulfur from the exhaust and the presence of adulterated fuel blend enhances this result to much extent. Another reason for more emission in India is due to more traffic jams. Scientific results show that when vehicles are at low speeds, the fuel burns inadequately and emission is even more per trip. Traffic congestion is more common in the metro cities of India. Results show that children of Bangalore around 50% suffer from asthma. These are some of the reasons why air pollution is more prominent in India.

1.4 Hartridge Smoke Unit:

Hartridge smoke unit is generally referred as HSU, is used to measure the opacity of the exhaust gases of engines, particularly diesel engine. It is expressed in terms of integers ranging from 0-100 followed by HSU as its dimensional quantity. In India "65 HSU" is being given as the standard quantity to measure the pollution from the exhaust of the diesel vehicle. The vehicle exceeding 65 HSU is not fit for running on the roads of India. The unit of hartridge smoke unit is "K m⁻¹" which is termed as "Light Absorption Coefficient".

1.5 Bharat Stage emission standards:

Bharat stage emission standards are being introduced by the Government of India to standardize the pollutants being emitted from the internal combustion engine equipments also from the vehicles. Central Pollution Control Board controlled by the Ministry of Environment and forest execute the standards for these. These

standards are based on the European convention which was first introduced in the year 2000. Moreover these standards are being changed with due respect of time. Now a day the norms this is active from April 2010 is Bharat stage IV imposed in 13 major cities of India. Mainly we are here concerned with the emission norms related to the diesel vehicles.

Table 1

Emission Standards for Light-Duty Diesel Vehicles, g/km

Year	Reference	CO	HC	HC+NOx	NOx	PM
1992	-	17.3-32.6	2.7-3.7	-	-	-
1996	-	5.0-9.0	-	2.0-4.0	-	-
2000	Euro 1	2.72-6.90	-	0.97-1.70	-	0.14-0.25
2005+	Euro 2	1.0-1.5	-	0.7-1.2	-	0.08-0.17
2010+	Euro 3	0.64	-	0.56	0.50	0.05
		0.80		0.72	0.65	0.65
		0.95		0.86	0.78	0.78
2010++	Euro 4	0.50	-	0.30	0.25	0.025
		0.63		0.39	0.33	0.04
		0.74		0.46	0.39	0.06

From "Diesel Net" Emission standards of India, car and light trucks
<https://www.dieselnet.com/standards/in/ld.php>)

+ is for earlier introduction in selected regions.
 ++ is for only in selected regions.

Here,
 g/km= gram/kilo meter.
 Euro 1 is for India 2000 standard.
 Euro 2 is for Bharat Stage II.
 Euro 3 is for Bharat Stage III.
 Euro 4 is for Bharat Stage IV.

The selected regions are:
 Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur, Lucknow, Sholapur, Jamshedpur and Agra.

2. Methodologies:

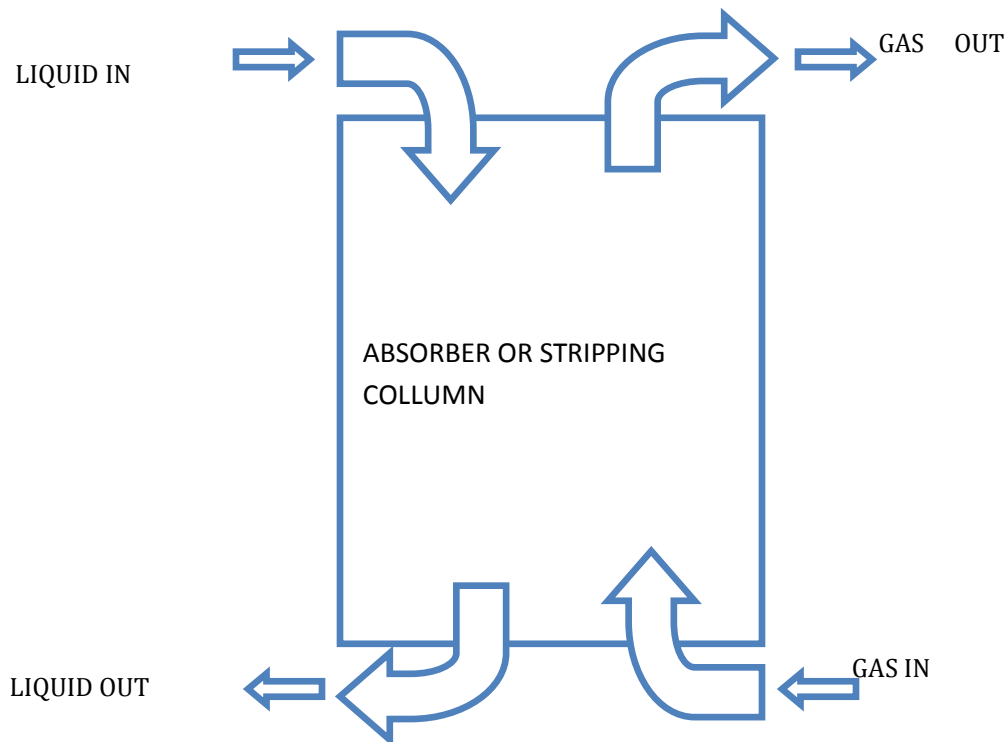
2.1 Scrubber:

There are wide varieties of air pollution control device being incorporated and scrubber is one of those. It is used to remove particulate matter or gases from the industrial exhaust. Conventionally, the pollution control device which uses water/liquid to remove the superfluous materials from exhaust is known as scrubber. These are the primary devices which are used to remove the unwanted pollutants out of gaseous stream. Mainly there are two types of scrubbing process i.e. dry scrubbing and the wet scrubbing, but we are mainly concerned with wet scrubbing process.

2.2 Wet Scrubber:

The gases from the exhaust of the vehicle or factories are being removed by means of wet scrubber. It is used to absorb many harmful pollutants out of the flue gases; it also used to remove dust particles. A scrubbing solution is brought in contact of the targeted compound so as to remove it. Solution can simply be water or any another reagent is prepared for other types of compound. The basic principle involved in this process absorption. In this gaseous pollutant is dissolved in the liquid. The gas stream is allowed to pass through the liquid, the liquid absorbs the gas and fresh gas is being released which is less toxic as compared to the earlier one. Usually, the removal efficiency of the scrubber is more than 95%. But there is a problem behind this is the removal of contaminated waste water. If this problem of scrubber is managed then it is the best way of scrubbing pollution.

Figure 1: Absorption process involved in scrubbing



2.2 Model description:

The model of scrubber which was prepared for measuring the pollution was made of a cylindrical box of 20 liters having cross section of 10", in which a pipe was welded of 3.25" in cross section for inlet of exhaust gas as intake port from one end and it was dipped into the box full of water with the help of elbow connected to it with another pipe of 3.25" at the other end of the box. A pipe with 0.25" in cross section was welded below the intake port for over flow tank and to rescue the muffler of car by not allowing the water to come in its level. A pipe of 0.25" in cross section was welded to allow the waste water to flow out of the tank from the bottom. Another pipe with cross section of 1.25" with a disc to cover it from the top and to allow the exhaust gas passing through the water should move from this pipe.

" is for inches.

Figure 2: Model used for experiment



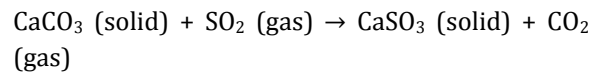
Figure 3: Upper view of the box



Figure 4: Pipes used for over flow tank and waste water disposal



The model was attached to the exhaust of the car and three different readings were taken by PUC van. The first reading was with normal condition, no scrubber was attached to it. After that the scrubber was attached to the cars exhaust with water filled in it and then the reading was taken. In third time the scrubber was filled with water and lime stone was added to it so that desulfurization should take place.



Limestone (CaCO_3) is being added in the water to react with the sulfur dioxide (an acid gas) reacts to form calcium sulfite (CaSO_3) and carbon dioxide (CO_2) in the air.

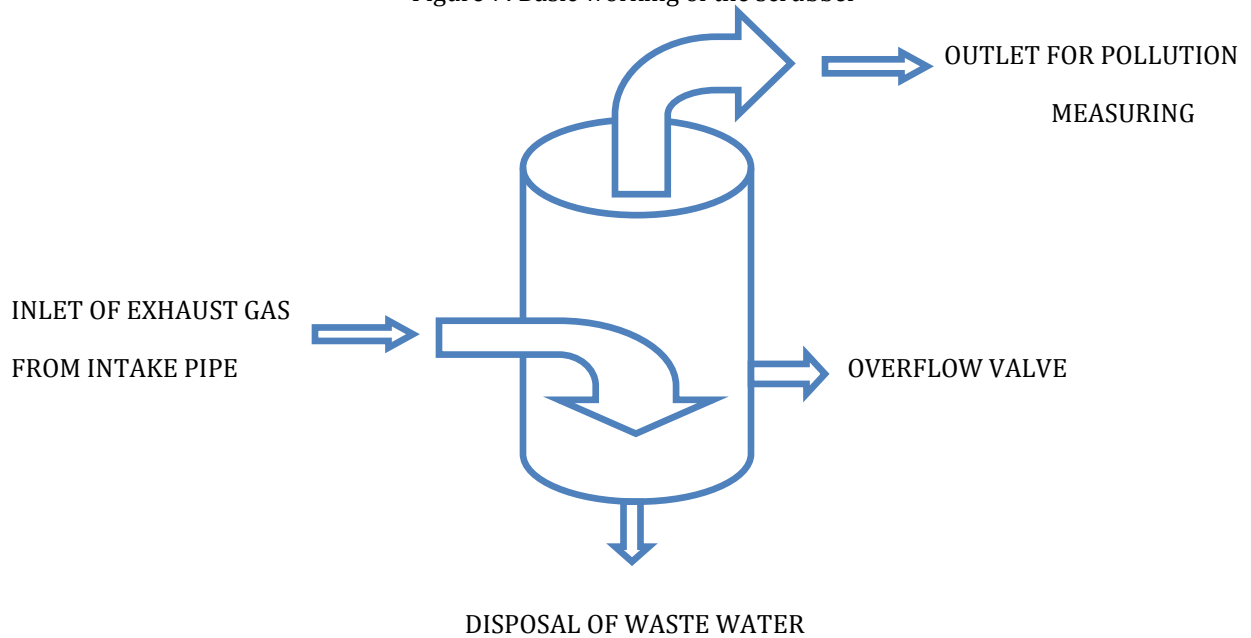
Figure 5: Pollution test without scrubber



Figure 6: Pollution test with scrubber



Figure 7: Basic working of the scrubber



3. Result and discussion:

Different readings were taken with different attachments. These readings are as follows:

Table 3-1: Pollution reading in normal condition

Sl.No.	HSU%	$K m^{-1}$
1.	14.0	0.352
2.	56.4	1.938
3.	08.7	0.212
4.	27.8	0.760

5.	21.2	0.556
Mean	28.5	0.866k

Table 3-2: Pollution reading with scrubber filled with water

Sl.No.	HSU%	K m ⁻¹
1.	36.1	1.045
2.	03.1	0.073
3.	42.3	0.1284
4.	03.8	0.090
5.	37.0	1.078
Mean	21.5	0.637k

Table 3-3: pollution reading with scrubber filled with lime stone in water

Sl.No.	HSU%	K m ⁻¹
1.	03.5	0.083
2.	04.5	0.107
3.	03.7	0.088
4.	04.0	0.095
5.	30.4	0.846
Mean	10.6	0.284k

From the above results we can see that there is a lot of difference in the emission from the exhaust. Rather the normal reading is much less as compared to that of 65HSU which can be said that the vehicle is not emitting much pollution. Thus by following these steps the pollution can be minimized too much extent.

Readings were also taken on single cylinder four stroke diesel engine with the scrubber system to test the emission of flue gases. The readings were in three steps without the scrubber system, with scrubber system with water in ii and third with scrubber system with water and lime stone in it.

Figure 8: Single cylinder four stroke diesel engine



Figure 9: Gas analyzer at the exhaust of the scrubber system



Chart 1: Graphical presentation of CO & HC without scrubber system

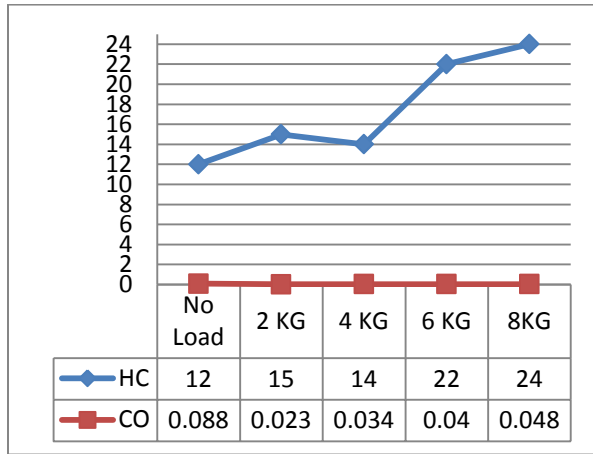


Chart 2: Graphical presentation of CO & HC with scrubber filled with water

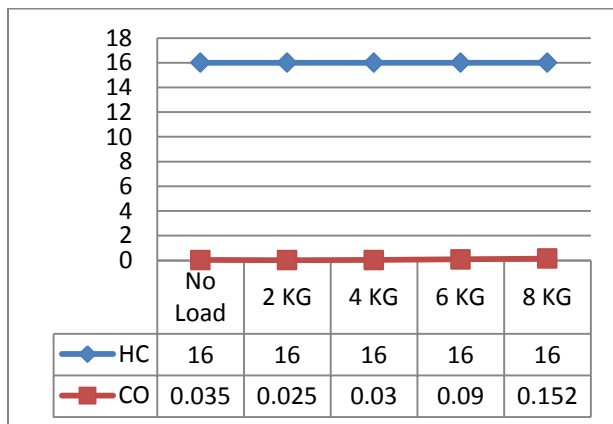
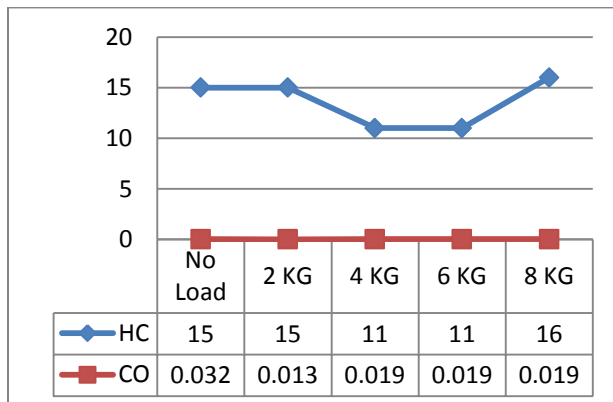


Chart 3: Graphical presentation of CO & HC with scrubber filled with water and lime stone



Here, HC is in ppm i.e. parts per million

& CO is in % i.e. percentage

4. CONCLUSION:

From the above result it is obvious that the pollution can be controlled too much level. In India the emission norms which we are following now a day is Bharat Stage IV and this vehicle is as per this norm, but what about the vehicles which were based on previous norms are still running on the roads of India. We can say that these old vehicles of year before 2005 are not fit for environment but still these are active. Measures should be taken to control the contamination of water.

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