International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-7 Issue-3, February 2018

# Hydro Carbon and Carbon Monoxide Reduction from Exhaust of Vehicles

**Rakesh Prajapati, Jigar Patel, Ronak Soni, Saurabh Modi**

***Abstract*: In Present Scenario, Wet scrubbing, a relatively new technology, is used on absorption of pollutants such as carbon dioxide (CO2), unburned hydrocarbons (UHC), oxides of nitrogen (NOX) and lead and other particulate emissions from the engines. Fabrication and falls into the category of automobiles. The total cost of the experimental modal price is 6225 INR. In today's developing world, filtering and cleaning of exhaust gases from automobiles are essential before launching them into the atmosphere. Systems like catalytic converter and scrubber system plays essential role. When the catalytic converter fails to deliver its desired work, Hydrocarbon, Carbon monoxide and NOx directly goes into the atmosphere which is directly impacts on human health and pollutes the environment. To identify the problem, which we have implement to "Advanced Scrubber System". This works on the principle of simple reaction between exhaust gases and scrubbing liquid. It is filtration process which removes the HC and CO from exhaust gases by passing through three different modules.***

***Index Terms*: catalytic converter, Scrubber System, Scrubbing Liquid, Filtration, Exhaust Gases**

## I. INTRODUCTION

Scrubber systems (aka Chemical Scrubbers, Gas Scrubbers) are a differed collection of air pollution controller devices that can be castoff to destroy some particulates and/or gases from industrial drain streams. The essential air scrubber was considered to remove carbon dioxide and the air of an initial submarine, the Ictineo I, a part for which they sustain to be used till today. Conventionally, the word "scrubber" has listed to pollution control maneuvers that practice liquid to wash undesirable pollutants from a gas stream.

Recently, the span has also been used to define systems that insert a dry reagent or slurry into a dull exhaust stream to "wash out" acid gases. Scrubbers are one of the main maneuvers that change gaseous emissions, especially acid gases. Scrubbers are additionally be used for hotness recuperation or hot gases by flue-gas condensation. They are also second hand for the high flows in solar, PV, or LED processes.

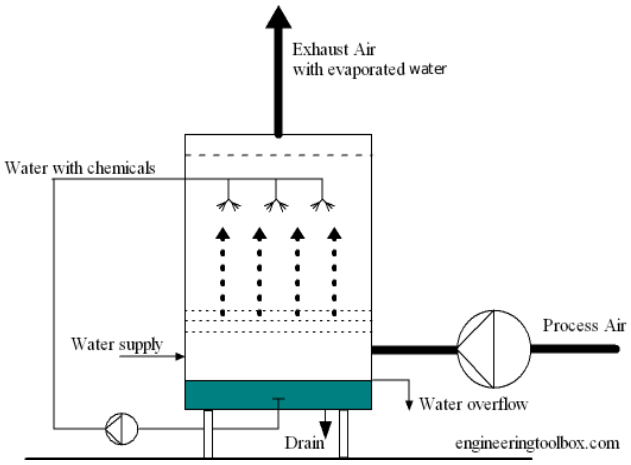


**Fig.1 Basic Principle Scrubbing System**

There are two types of scrubbing system

- Wet scrubbing system
- Dry scrubbing system

### A. Wet Scrubbing System

The expend gases of burning may comprise matters measured damaging to the environment, and the scrubber may confiscate or defuse those. A wet scrubber is used for on slaught air, fuel gas or different gases of various toxins and dust particles. Wet scrubbing is works through the contact of goal combinations and particulate stuff with the scrubbing solution. Solutions may merely be water (for dust) or solutions of reagents that exactly target convinced compounds. Process exhaust gas can also comprise water-soluble noxious or corrosive gases comparable to hydrochloric acid (HCl) or ammonia (NH3). These are or separate very fine by a wet scrubber.

Exclusion efficiency of pollutants is enhanced by swelling habitation time in the scrubber or by the rise of surface zone of the scrubber solution by the custom of a spray nozzle, packed or an aspirator. Wet scrubbers may surge the share of water in the gas, subsequent in an obvious stack plume, if the gas is directed to a stack. [1]

Wet scrubbers can also be used for heat retrieval from hot gases by flue-gas condensation. In this mode, called a condensing scrubber, water from the scrubber channel is discrete via a cooler to the nozzles at the spouts of the scrubber. The hot gas arrives the scrubber at the base. If the gas temperature is overhead the water dew point, it is firstly cooled by evaporation of water drops. Additional cooling has done water vapors to consolidate and expansion to the amount of circulating water.

**Manuscript published on 28 February 2018.**
* Correspondence Author (s)
**Rakesh Prajapati***, Mechanical engineering, Parul University / Parul Institute of Technology, Parul University, Vadodara, India, E-mail: rakeshme66@gmail.com
**Jigar Patel** , Mechanical engineering, University of Windsor, Canada, E-mail: Pateljigar3261@gmail.com
**Ronak Soni** , Mechanical engineering, Parul University / Parul Institute of Technology, Parul University, Vadodara, India, E-mail: ronakdsoni2003@gmail.com
**Saurabh Modi** , Mechanical engineering, Parul University / Parul Institute of Technology, Parul University, Vadodara, India, E-mail: smmodi67@yahoo.com

The condensation of water sign important quantities of low temperature heat (more than 2 Giga joules (560 kWh) per ton of water), and case what can be improved by the cooler for e.g. district heating purposes. Surplus condensed water must incessantly be undaunted from the circulating water. The gas verdures the scrubber at its dew point, so even though important amounts of water may have been uninvolved from the cooled gas, it is likely to consent a obvious stack plume of water vapor.

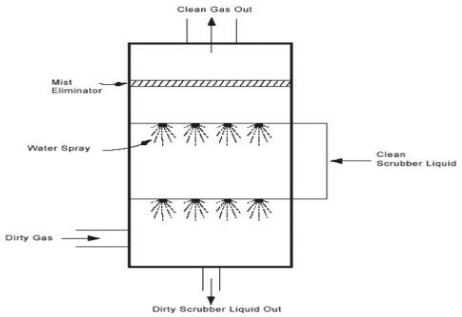


**Fig.2 Wet Scrubber System**

### B. Dry Scrubbing System

A dry or semi-dry scrubbing system, disparate the wet scrubber, does not splash the flue gas stream that is being treated with wetness. Once in a while not at all moisture is added or while in others only the quantity of moisture that can be evaporated in the flue gas deprived of condensing is added. Subsequently, dry scrubbers for the most part don't have a stack steam plume or waste water handling/disposal wants. Dry scrubbing systems are cast-off to eradicate acid gases and (such as $SO_2$ and HCl) mainly from combustion bases.

There are different dry types scrubbing system designs. However, all comprise of two main units or devices: a device to introduce the acid gas sorbent material into the gas stream and a particulate substance direct device to remove response item, additional sorbent material as well as any particulate matter already in the flue gas. Dry scrubbing systems can be considered as dry sorbent injectors (DSIs) or as spray dryer absorbers (SDAs). Spray dryer absorbers are also immersed semi-dry scrubbers or spray dryers. Dry scrubbing systems are frequently utilized for the removal of aromatic and eroding gases from waste water treatment plant operations. The medium utilized is normally a started alumina compound soaked with materials to deal with specific gases such as hydrogen sulfide. Media utilized can be varied together to offer a wide range of deletion for other odorous compounds such as methyl mercaptans, aldehydes, volatile organic compounds, dimethyl sulfide, and dimethyl disulfide.

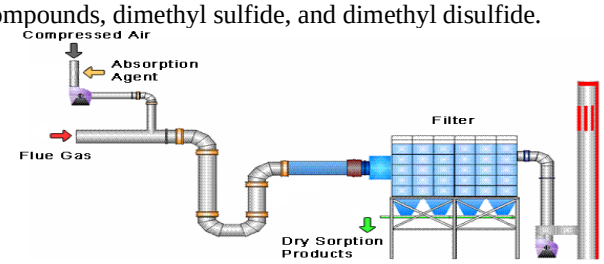


**Fig.3 Dry Scrubber System**

### C. Component of Scrubbing System

- Scrubbing Vessel
- Entrainment Separator or Mist Eliminator
- Pumping
- Spent Scrubbing Liquid treatment
- Exhaust Stack
- Scrubbing Liquid Sprays
- Pipes
- Gases

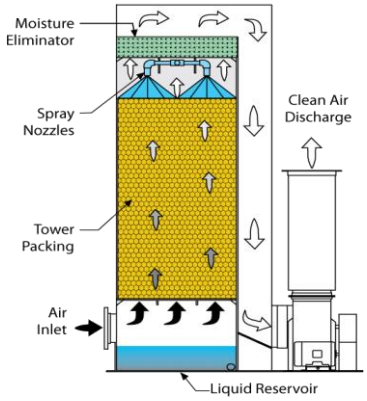


**Fig.4 Components**

## II. LITERATURE REVIEW

***"Performance of Wet Scrubbers on Liquid and Solid Particulate Matter", John S. Eckert & Ralph F. Strigle Jr. 2012***

Stuffed wet scrubbers are actual decent devices for the economical elimination of particulates down to a nominal size of 5 jumps. Less than 5 Mm size the removal efficiency of these devices will either initiate to fall off or it will be essential to operate them at higher than normal pressure drops or something over 0.25 inch of water head per foot of packed depth. It is conceivable to preserve a great efficiency scrubbing action down to about 3 / inch particle size, however at this time the pressure drop will be up to 0.75 to 1.0 in. water/ft and severe misting of the irrigation liquid will set in. This is about the upper limit at which a pressed wet scrubber can be worked in countercurrent flow (Figure 1). Efficient evacuation of any smaller particulates will require a dissimilar operating technique because this is the limit of loading capability for the countercurrent flow operated stuffed bed. [3]

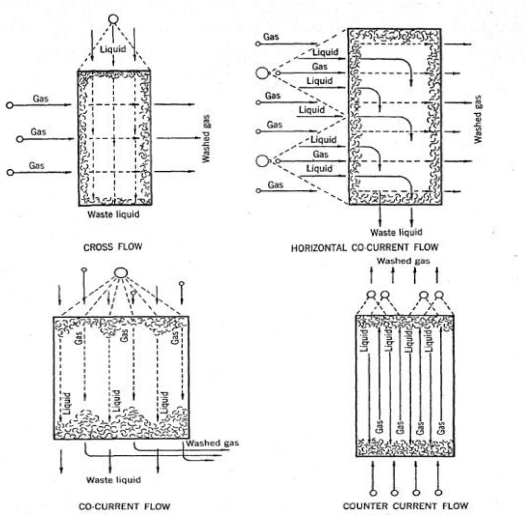


**Fig.5 Method of Operating Packed Beds**


*Published By:*
*Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)*

It may be said that wet packed scrubbers are very effective in the rejection of particulate stuff from an air stream in molecule sizes up to 0.01 jum and then in particle sizes from 0.5 /xm up to whatever size of particulate can be approved in the/gas stream. They are generally worked at a temperature under the breaking point of water and are best functional when the material to be removed is of an odorous, corrosive, or moist nature.

***"Fine Particulate Removal and S02 Absorption with a Two Stage Wet Scrubber", J. I. Accortt, A. L Plumley and J. R. Martin***

This research contains results from pilot plant studies and introductory field protest units and a conversation of the application of the limestone wet scrubbing process to a low sulfur sub-bituminous coal. The latter application mandatory the development of a hybrid two stage scrubber to enable collection of the fine particulate matter as well as deletion of a major amount of the sulfur dioxide.

If the will deal precisely with that part of C-E's wet scrubbing development program relating to the collection of fly ash. Comprised are results from pilot plant studies and early field demonstration units built in 1968; a review of the measurement techniques engaged by C-E in obtaining the mass dust loadings and particulate matter sizing information; and a discussion of the application of the limestone wet scrubbing process on a low sulfur sub-bituminous coal. [6] This application is imperative the development of the fine particulate matter as well as removal of a weighty amount of the sulfur dioxide. These particulate and $SO_2$ conclusion systems are called Air Quality Control Systems (AQCS) at C-E.

| | In | | | Out | | |
|---|---|---|---|---|---|---|
| Particle Size | Wt., g | No. of particles[a] | Sample Wt.,[b] g | Actual Wt.,[b] g | No. of particles | % of Particles removed |
| 10 μ and over | 0.07 | $2.8 \times 10^7$ | .00 | 0.00 | 0 | 100. |
| 5–10 μ | 0.03 | $2.8 \times 10^7$ | .00 | 0.00 | 0 | 100. |
| 2–5 μ | 0.09 | $8.4 \times 10^8$ | .03 | 0.0006 | $5.6 \times 10^6$ | 99.3 |
| 1–2 μ | 0.22 | $2.6 \times 10^{10}$ | .14 | 0.0028 | $3.3 \times 10^8$ | 98.7 |
| 0.5–1 μ | 0.26 | $2.46 \times 10^{11}$ | .40 | 0.0080 | $7.58 \times 10^9$ | 97.0 |
| 0.25–0.5 μ | 0.18 | $1.37 \times 10^{12}$ | .28 | 0.0056 | $4.31 \times 10^{10}$ | 96.9 |
| 0.10–0.25 μ | 0.15 | $1.12 \times 10^{13}$ | .15 | 0.0030 | $2.24 \times 10^{11}$ | 98.0 |
| | 1.00 | | | 0.02 | | |

[a] Number of Particles = [Wt. %/25 = Vol.]/Particle Size³; 1 g Sample Assumed Spg. = 2.5.
[b] Overall Wt. %, Removal Was 98 ∴ Wt. Out = (Wt. % OUT) (1.00 — 0.98).

**Fig; 6 Performances**

***"Valuation of possible impacts of scrubber water discharges on the marine environment", Jesper Kjølholt, Stian Aakre, Carsten Jorgensen, Jørn Lauridsen.***

The isolates of intentionally tumbling air pollution from ships, the utilization of low Sulphure fuel will be required internationally within few years. A thinkable substitute to this amount is housework of the exhaust gases in scrubbers but the likely marine environmental penalties arising from the use of scrubbers has not before been calculated in detail this study was carried out in order to achieve a more detailed assessment, which can add to the ongoing international evaluation of criteria for wash water from scrubbers It was discovered that connected to current environmental acceptability levels the releases from scrubbers can be projected to be significantly underneath the heights of ecological concern. However, a risk calculation for any specific area must also take existing contamination levels and issues from different sources. [4]

Based on the literature review, exhaust gas scrubbers for ships (wet scrubbers) seem to be able to effectually ruse SOX and also the majority of soot and different particles. In the scrubber SOX is changed to sulphuric acid. Additionally various different pollutants (e.g. metals and PAH) occurring in the exhaust gas are entombed in the scrubber wash water, moreover additionally changing degrees.

***"Wet Scrubbers for Particulate Matter", Daniel Mussatti, Paula Hemmer, 2002.***

A wet scrubber is an air pollution controller device that removes PM and acid vapors from left-finished gas streams of motionless point bases. The pollutants are uninvolved primarily through the impaction, dispersal, interception and/or captivation of the pollutant onto beads of fluid. The fluid covering the contaminant is before composed for removal. There are frequent types of wet scrubbers which confiscate both acid gas and PM. This episode words the project and price of wet scrubbers for director of PM10 and PM2.5. [5]

## III. METHODOLOGY

- Exhaust coming out of the vehicle goes into the circuit 1. Liquid NaOH is being sprayed on the exhaust from top. As it pass from the baffles $SO_2$ and HC reacts with NaOH.
- It removes the Sox and HC impurities up to some extent.
- Then it passes from the circuit 2, where cotton is fitted on the baffles with the help of aluminum net. Carbon Particles traps into it and removes the carbon.
- Then it passes from the NaOH reservoir where Sox impurities are removed.
- There are drainage pipes provided at the bottom of the circuit 1. They are connected to reservoir for continuous circulation of liquid NaOH.
- Simultaneously heat carrying gas heat up the TEG also called a See beck generator, is a solid state device that converts heat flux (temperature differences) directly into electrical energy through a phenomenon called the See beck effect (a form of thermoelectric effect).

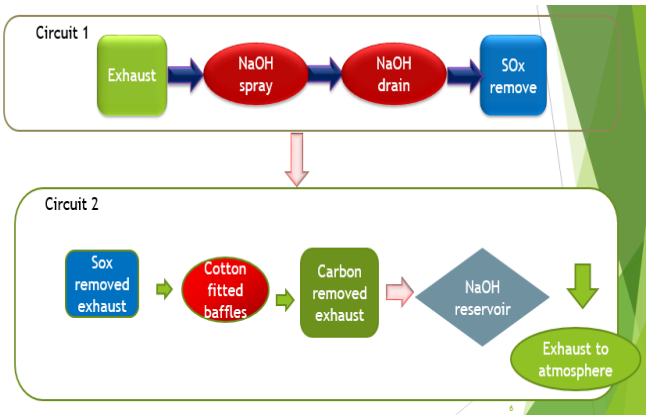


**Fig.7 Working Methodology**

- This electricity is stored in 12 volt, 1 Amp battery. Electricity produced is in the D.C. form which is converted to A.C. via DC to AC circuit. By this small power rating equipment can be run.
- Fluid pressure is 1.2 Kgf/cm2 and flow rate is 150ml/10 sec which is produced by the pump used.


Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

### A. Chemical Process

***(a)*** When the alkali (NaOH) solution is exceptionally weaken (pH < 8), carbon dioxide first reacts with water to form carbonic acid (H2CO3) slowly. The acid thus formed then reacts with the alkali to give sodium hydrogen carbonate (NaHCO3).

$CO_2$ (g) + $H_2O$ (l) ⇔ $H_2CO_3$ (aq)

$H_2CO_3$ (aq) + NaOH (aq) → $NaCO_3$ (aq) + $H_2O$ (l)

***(b)*** When the alkali solution is a genuinely thought one (pH > 10), carbon dioxide directly reacts with it to shape the bicarbonate, which additionally responds with the alkali to form sodium carbonate (Na2CO3) as the main product by complete neutralization.

NaOH + CO2 = NaHCO3

NaHCO3 + NaOH = Na2CO3 + H2O

Thus, only when the concentration of the alkali solution is very low, the reaction proceeds via the formation of carbonic acid. But the acidic oxide is not completely neutralized in this case.

## II. MATERIAL SELECTION

**TABLE I. MATERIAL & DIMENSION**

| Sr. No. | Component | Material (Dimension) |
|---|---|---|
| 1 | Filter 1 | Acrylic (25*15*15 cm) |
| 2 | Filter 1 | Acrylic (25*15*15 cm) |
| 3 | NaOH Reservoir | Acrylic (15*10*10 cm) |
| 4 | SS Pipes<br>PVC Pipes / PVC Elbow | 1.5 (30 cm) |
| 5 | Pump | Automotive material |
| 6 | Cotton | Surgical |
| 7 | Net | Aluminum |
| 8 | Battery | 12 volt |
| 9 | Flexible rubber pipes | 1 meter |
| 10 | TEG-1 12706 module | 2 units |
| 11 | Heat sink | 2 units |
| 12 | wires | Copper |

## III. MODELING

Part modeling in CRE-O software

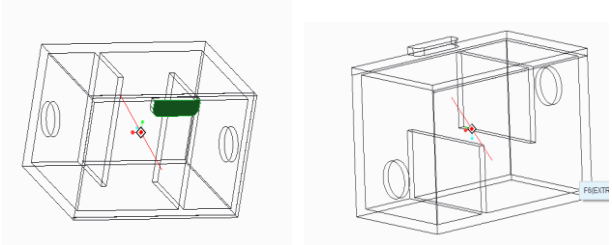

**Fig.8 Filter 1& 2**

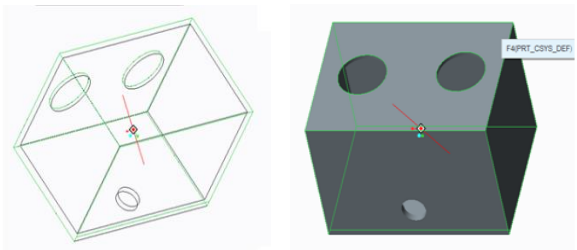

**Fig.9 NaOH Reservoir Modeling in CRE-O Software**

## IV. EXPERIMENTAL SET-UP

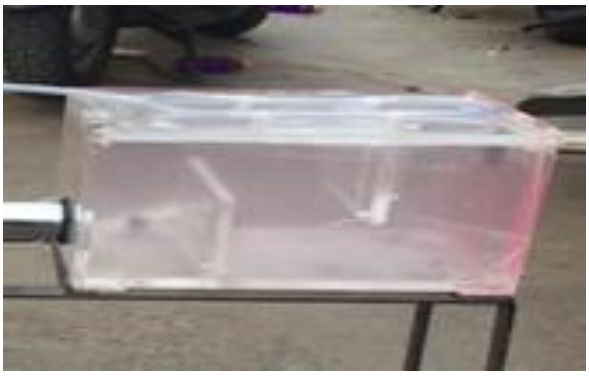

**Fig.10 Actual Model Filter 1**

**Fig.11 Actual Model Filter 2**


**Fig.12 Actual Model NaOH Reservoir**

**Fig.13 Assembled to all parts**


*Published By:*
*Blue Eyes Intelligence Engineering*
*and Sciences Publication (BEIESP)*

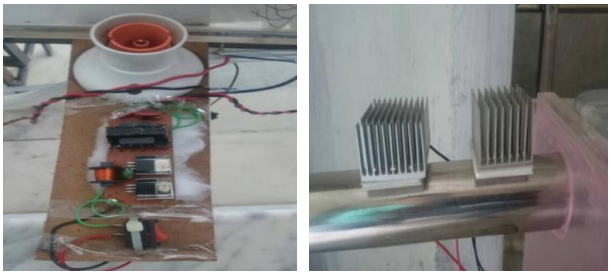

**Fig.14 Heat Sink and DC to AC Circuit**

## V. COST ANALYSIS

**TABLE II. MATERIAL COST ANALYSIS**

| Sr. No. | Component | Material (Dimension) |
|---|---|---|
| 1 | Acrylic box all | 2200 |
| 2 | TEC1-12706 module | 1200 |
| 3 | Pump | 400 |
| 4 | SS Pipe | 330 |
| 5 | Flexible pipes & Nozzle | 400 |
| 6 | PVC pipe & elbow | 130 |
| 7 | DC to AC converter | 300 |
| 8 | Battery | 450 |
| 9 | Heat absorber | 75 |
| 10 | CFL | 50 |
| 11 | Cotton | 30 |
| 12 | Aluminum net | 40 |
| 13 | Adhesives | 100 |
| 14 | Frame | 500 |
| 15 | Wires | 20 |
| ***Total Cost*** | | ***6225/-*** |

## IV. RESULT AND DISCUSSION

Here are the results obtained from the experiments:


**Fig.15 PUC Testing of HONDA STUNNER (2 Wheeler)**


**Fig.16 Result after Passing from Model**


**Fig.17 PUC Testing of CHEVROLET SPARK (4 Wheeler)**


**Fig.18 Result after Passing from Model**

**TABLE III. CO & HC LEVEL (% VOLUME – PPM )**

| Name | | Before | After | | Before | After |
|---|---|---|---|---|---|---|
| Petrol | Standards CO Value | Measured CO Value | Reduced CO with our unit | Standard HC Value | Measured CO Value | Reduced CO with our unit |
| Honda Stunner | 3.5 | 0.15 | 0.06 | 4500 | 460 | 342 |
| Cheverlot Spark | 0.5 | 0.04 | 0.024 | 750 | 148 | 101 |
| Honda Activa | 3.5 | 0.12 | 0.07 | 4500 | 430 | 360 |

## V. CONCLUSION

These measurements taken from STUNNER, as shown from figures CO% reduces from **0.15 to 0.06** and hydrocarbons fall from **460 to 342**.

These measurements taken from CHEVERLOT SPARK, as shown from figures CO% reduces from **0.04 to 0.024** and hydrocarbons fall from **148 to 101**.

These measurements taken from ACTIVA, as shown from figures CO% reduces from **0.12 to 0.07** and hydrocarbons fall from **430 to 360.**

Electricity up to ***3 volt*** can be produced by our unit. As one TEG produces 1.5 volt, we have used two TEGs.


*Published By:*
*Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)*

## ACKNOWLEDGMENT

It is indeed a great pleasure and gratified honor for the group members to present the final year project. The purpose of the project was to showcase the talent among the students studying in fourth year of Mechanical Engineering to know the practical applications and solve the various problems occurring in the mechanical engineering.

Group associates pay their deep thankfulness and express their indebtedness to the academic guide Prof. Rakesh Prajapati for their support and guidance to successfully complete the project within the time duration.

Lastly, we would thank God and our parents for their support without which it would not be possible to complete our project.

## REFERENCES

1. Lapple, C.E. and H.J. Kamack, “Performance of Wet Dust Scrubbers”, Chemical Engineering Progress, vol. 51, March 1955.
2. San Diego, “Scrubber Selection Guide”, Calvert Environmental Equipment, , 1988.
3. John S. Eckert & Ralph F. Strigle Jr. “Performance of Wet Scrubbers on Liquid and Solid Particulate Matter”, 2012.
4. Jesper Kjølholt, Stian Aakre, Carsten Jorgensen, Jørn Lauridsen. “Valuation of possible impacts of scrubber water discharges on the marine environment”,
5. Daniel Mussatti, Paula Hemmer, “Wet Scrubbers for Particulate Matter”, 2002.
6. J. I. Accortt, A. L Plumley and J. R. Martin , “Fine Particulate Removal and S02 Absorption with a Two Stage Wet Scrubber”.
7. Calvert, S., How to choose a particulate scrubber, Chem. Eng., 54-68, August 29, 1977.
8. Calvert, S., J. Goldsmith, G. Leith, and D. Metha, “Scrubber Handbook”, NTIS, Springfield, VA, 1972.
9. H. P. Munger, "Present status of air pollution research," Mech. Eng. 73: 405(1951).
10. Schifftner, K.C. and H.E. Hesketh, Wet Scrubbers (2nd Edition), Technomic Publishing, Lancaster, PA, 1996.
11. Advanced Air Technologies, Inc., technical information on scrubbers, www.aatinc.com/scrubbing_zone.htm, 2002.
12. Semrau, K.T., “Dust Scrubber Design - A Critique on the State of the Art,”” Journalof Air Pollution Control Association, vol.13, December 1963.

### AUTHOR PROFILE

**Rakesh Prajapati** received Diploma degree in Mechanical Engineering, B&B institute of Technology, v.v.nagar under Technical Education Board. B.Tech degree in Mechanical Engineering from Gurukul Institute of Engineering & Technology, Kota under Rajasthan Technical University, in 2011, and M.Tech (CAD/CAM) Degree in Mechanical Engineering from CHARUSAT University, Changa in 2013. Rakesh Prajapati has total 4.9 years of experience. Recently, I have recently published a research book in Germany, I am working as an Assistant Professor, with Department of Mechanical Engineering, in Parul Institute of Technology, Parul University, Vadodara.

**Jigar Patel** received his Graduate degree in Mechanical Engineering, from Parul Institute of technology, Vadodara under Gujarat Technical University.2017, and MS (Master of Mechanical - Auto) Degree in Mechanical Engineering from University of Windsor, Canada

**Ronak Soni** received his Graduate degree in Mechanical Engineering, from Sardar Vallabhbhai Patel Institute of Technology, Vasad under Gujarat University.2011, and M.E (CAD/CAM) Degree in Mechanical Engineering from Sardar Vallabhbhai Patel Institute of Technology, Vasad under Gujarat Technical University.2011. Ronak Soni has total 4 years of experience. He is working as an Assistant Professor, with Department of Mechanical Engineering, in Parul Institute of Technology, Parul University, Vadodara.

**Saurabh Modi** received his Diploma degree in Mechanical Engineering, under M.S. University in 2007, Vadodara. B.Tech degree in Mechanical Engineering from Deokar college of Engineering, Jalgaon, under North Maharashtra University, in 2011, and M.Tech (Design Engineering) Degree in Mechanical Engineering from Nirma University, Ahmedabad in 2013. Saurabh Modi has total 4.5 years of experience. Recently, He is working as an Assistant Professor, with Department of Mechanical Engineering, in Parul Institute of Technology, Parul University, Vadodara.



*Published By:*
*Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)*