International Journal of Research in Engineering, Science and Management
Volume-1, Issue-11, November-2018
www.ijresm.com | ISSN (Online): 2581-5792

Combined System for Reduction of Oxides of Sulphur, Nitrogen and Particulate Matters

Shahrukh Saiyad[1], Patel Rutul[2], Jayesh Prajapati[3], Salim Memon[4]
[1,2,3,4]*BE Student, Department of Environmental Science & Technology, Shroff S. R. Rotary Institute of Chemical Technology, Vataria, India*

***Abstract*: Combined system for the reduction of oxides of Sulphur, oxides of Nitrogen and Particulate matter is the confederate system for the Reduction of the above air pollutants. SO_X, NO_X and PM are the pollutants which are being exhaust from the various sources like vehicles, industries, ships, Diesel generator sets etc. But we are focusing more on the Diesel generator sets as it is mostly the stationary air pollution sources. We would like to reduce the NO_X by the Copper tubes, SO_X by the use of scrubber and Particulate matters with the help of the Filter beds. We are also interested to find out the various scrubbing liquid for the reduction of the oxides of sulphur as we want to keep it as cheap as possible and as efficient as possible and we also finding the different types of the filter beds for the reduction of the particulate matters. Finally, we would be reducing the oxides of Sulphur, oxides of Nitrogen and Particulate matter with respect to the concentration and the efficiency of the system from the Diesel Generator set.**

***Keywords*: Oxides of Sulphur (SO_X), Oxides of Nitrogen (NO_X), Particulate Matter (PM), Scrubber, Scrubbing Liquid, Isokinetic Condition, Filter media.**

1. Introduction

A. Particulate matter (PM)

Particulate matter (PM) consists of majorly solids and liquids such as smoke, dust, aerosols, mists, fumes and condensed vapors that are suspended in the air for longer period of time. An important share of PM sources is from human (anthropogenic) activities and small share of natural activities. Human (anthropogenic) activities include Industrial pollution, Agriculture, combustion of fuel and wood, construction etc. Natural activities includes windblown and wildfires.PM10 is associated with dust as it has larger suspended particles and PM2.5 is associated with fuel burning, combustion processes and vehicle emissions as it has smaller suspended particle size. Particulate air pollution originates from different sources. One major source of primary particle emissions is fuel combustion, including mobile sources such as diesel and gasoline-powered vehicles. They are subdivided according to diameter: coarse particles >2.5 μm, fine particles <2.5 μm. A further it is to classify particles as primary or secondary, according to their origin. Particles that are emitted directly into the atmosphere are termed primary particles, whereas secondary particles form during atmospheric reactions. The primary particles contain dust and other solid materials, which are primarily formed during combustion processes. The increasing awareness about particulate matters monitoring is mainly due to its effects on human health as well as environment. It is part of air quality monitoring which include process of monitoring harmful gases, Wind speed and its Direction etc. Particulate matter affects respiratory and cardiovascular systems. Because of smallest size of fine particles it can go deep down in lungs and access gas exchange regions of the lungs through the dispersion. Particulate Matters can affect environment, such as change in the radiation balance of the planet, change in process of cloud formation, reduced visibility and global warming. It is necessity to monitor fine particulate matter at industrial sites as dust and air monitoring is becoming regular.

B. SO_X and NO_X

The emission of NOx and SOx has different consequences for the atmosphere: The primary air pollutants sulphur dioxide and nitrogen oxides undergo chemical transformations as they are dispersed in the atmosphere, forming sulphuric acid and nitric acid respectively, which may be deposited downwind as acid rain.

C. SO_X

The main sources are the combustion of fuel containing sulphur mostly coal and oil. It is also produced during metal smelting and other industrial processes. SO2 is oxidized to SO3 and at last forms sulphuric acid, which contributes to acid rain and provides cloud condensation nuclei by forming secondary particles.

D. NO_X

Nitrogen oxides (NOx) are a very interesting and important family of air polluting chemical compounds. NOx is involved in production of ground level ozone but it also reacts with tropospheric ozone thus help in the depletion of the ozone layer. Nitrogen dioxide (NO2) is not usually released directly into the air. Nitrogen dioxide forms when nitrogen oxide (NO) and other nitrogen oxides (NOx) react with other chemicals in the air to form nitrogen dioxide. The main source of nitrogen dioxide resulting from human activities is the combustion of coal, gas and oil especially fuel used in the cars. It is also produced from making nitric acid, welding and using explosives, refining of petrol and metals, commercial manufacturing, and food manufacturing. Natural sources of other nitrogen oxides include volcanoes and bacteria.

2. Problem summary

Before the introduction of air quality regulations the use of air pollution control technology is to satisfy the demands of good engineering practice. At present the purpose of applying or developing a control technology is to meet the ambient air quality standards and other source related to regulations. A control technology can only be applied to a controllable source. So, it will be difficult to think of controlling emissions. The cost of removing or reducing pollutants from the source is generally increases gradually with the percentage of control efficiency. Application of control system requires the knowledge of source of air pollution regulations and waste generated from the system. Sometimes it is possible to develop a successful air pollution control system which tends to the problem of disposing the waste generated after using it. There are mainly two methods for controlling air pollution can be either without an air pollution control device or with air pollution control equipment. The general methods for without an air pollution control device include process change, change in fuel, improve dispersion, good operating practices, and plant shutdown or relocation. Control equipment removes the pollutant, convert to less harmful contaminant or recover a valuable material for further use from it.

A. Aim of the study

To remove/reduce the concentration of oxides of Sulphur, oxides of Nitrogen & Particulate matter using combined system.

B. Objectives of the study

- To study the effect of combined system on emission characteristics (PM, SOx & NOx) and conclude its effectiveness.
- The reading will be taken on Diesel engine with and without combined system and study the result obtained.
- To find out the different scrubbing liquids.
- To study the analysis of emission properties of combined system with standard emission norms.

3. Methodology

Fig. 1. Diesel generator set

Firstly, we have selected a specified source for our system as the Diesel Generator set. Our system first contains the Filter bed for the reduction/removal of the particulate matter after the exhaust gas from DG set. After filter bed there is a Bunch of Copper tubes through which gas is passed & the Oxides of Nitrogen is reduced/removed & then there is Cellular media on which there is a glass wool through which scrubbing liquid is passed. Passing the gas through this unit can reduce/remove the oxides of Sulphur. There are so many scrubbing liquids, Filter Medias, they can be used as per the economy & as per the efficiency we want to have in our system.

4. Calculation

NOx Calculation:

$$\mu g/m3\ NO2 = \frac{OD\ *\ F*\ F.V.*\ 10^3}{AV(m3)*\ ml\ sample\ taken*\ 0.82}$$

Without attached system:

$$NO2 = \frac{0.035*1.1*50*10^3}{30*1\ *\ 0.82\ *\ 10}$$

$$NO2 = 7.8\ \mu g/m3$$

With attached system:

$$NO2 = \frac{0.030*1.1*50*10^3}{30*1\ *\ 0.82\ *\ 10}$$

$$NO2 = \ 6.7\ \mu g/m3$$

SOx Calculation:

Without attached system:

$$ppm\ SO2 = \frac{(S-B)*final\ volume*24.25}{ml\ of\ sample*AV}$$

$$ppm\ SO2 = \frac{(28-0.5)*50*24.25}{10*30*1}$$

$$ppm\ SO2 = 112.06$$

Where,
AV = LPM * time (min.)
S = B.R. of sample
B = B.R. of blank
With Attached system:

$$ppm\ SO2 = \frac{(S-B)*final\ volume*24.25}{ml\ of\ sample*AV}$$

$$ppm\ SO2 = \frac{(21.4-0.5)*50*24.25}{10*30*1}$$

$$ppm\ SO2 = 81.16$$

SPM (Suspended Particulate Matter) Calculation:

$$SPM\ (\mu g/m^3) = \frac{(W_t - W_i)*10^6}{AV}$$

Where,
V = volume of air sampled (m3)
AV = Flow rate * time
W_t = weight of exposed filter (gm)
W_i = tare weight of filter (gm)

Without attached system:

$$SPM = \frac{(1.325-1.236)*10^6}{30*20}$$

$$SPM = 148.33\ \mu g/m^3$$

With Attached system:

$$SPM = \frac{(1.296 - 1.237) * 10^6}{30 * 20}$$

$$SPM = 98.33\ \mu g/\ m^3$$

5. Summary of result and conclusion

Table 1
Result

S. No.	Pollutant	Initial concentration	Final Concentration	Efficiency of system (%)
1	SO_X	112.06 ppm	81.16 ppm	27.58%
2	NO_X	7.8 µg/m^3	6.7 µg/m^3	14.10%
3	SPM	148.33 µg/m^3	98.33 µg/m^3	33.71%

The study of the many research papers and literature survey the combined system for the reduction of the SO_X and NO_X has been made. After taking the samples and performing the practical in laboratory, initial and final reading of the exhaust gases without attaching combined system and with attaching combined system has been taken and after doing the calculation, the result has been achieved near to the expected efficiency of the reduction of SO_X & NO_X.

References

[1] Eco-friendly selection of ship emissions reduction strategies with emphasis on SOx and NOx emissions
[2] NOx removal from simulated marine exhaust gas by Wet Scrubbing using NaClO solution New Technologies for Marine Diesel Engine Emission Control
[3] The pollutant emissions from diesel-engine vehicles and exhaust after treatment systems
[4] The control of nitrogen oxides from motor vehicle exhaust for improved indoor air quality
[5] Simultaneous Removal of SO_2 and NO from Flue Gas with Calcium-Based Sorbent at Low Temperature
[6] Simultaneous Removal of SOx and NOx Using Slaked Lime at Low Temperature
[7] Pilot-scale NOx and SOx removal from boiler emission using radical injection and chemical hybrid process
[8] Removal of SO2 and NO from flue gas by wet scrubbing using an aqueous NaClO2 solution
[9] Reducing NO_X and SO_X: A Summary of option
[10] Exhaust Gas Emission Control Today and Tomorrow
[11] http://www.marineinsight.com/tech/10-technologiesmethods-for controlling-nox-sox-emissions-from-ships/