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FGD (FLUE GAS DESULPHURIZATION) SYTEM -OVER VIEW

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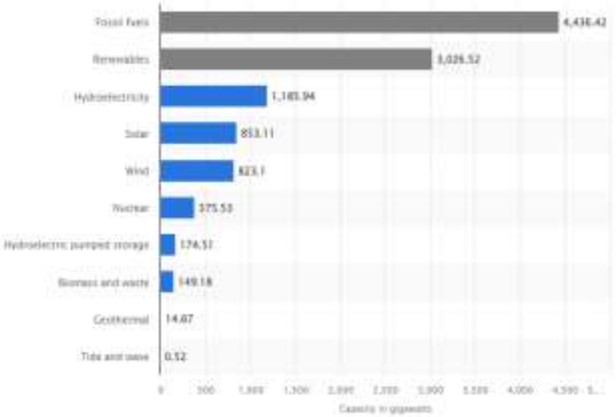
Abstract— **Advantage of using dry FGD (FLUE GAS DESULPHURIZATION) System instead of the WET FGD System in terms of efficiency and cost-effective solution. Though, the high cost of expensive slaked/quick lime required as reagent in dry FGDs, considering the capital cost of the project and considering the Water saving (useful in the water scarcity area) the Dry FGD system shall be recommended.**

I. INTRODUCTION

World's dependency on energy and the same produced through the Coal based power plants has resulted in the generation of huge quantities of SO2, NOx and ash emissions over the years. As of 2021, out of the total installed capacity of over 11 Terawatts of power plants, nearly 40 per cent is coal based. However, this was still significantly lower than the capacity of all fossil-based energy sources these power plants play a major role in worsening air quality. As per the stringent requirement from each countries Emission standards, the new standards aim to drastically cut emissions of particulate matter (PM), Sulphur dioxide (SO2), oxides of nitrogen (NOx) and mercury. The new norms also require power plants to sharply curtail freshwater use and to improve the fly ash utilization. The power production based on each fuel as of 2021 is provided below.



The new standards are aimed at reducing emission of PM10, Sulphur dioxide and oxide of nitrogen, which will improve the ambient air quality in and around thermal power plants. Reducing the usage of water in thermal power plant improve the water conservation as thermal power plant is a water-intensive industry. This will also lead to a reduction in energy requirement. For Example, In India as per the new amendment, the thermal power plants across India from 2017 will have to cut particulate matter emissions by as much as 40 per cent and reduce their water consumption by nearly one third.

For better Understanding, India's Scenario on the restriction on emission level is provided below:
In India, Thermal power plants are categorized into 3 categories, namely those (i) Installed before 31st December 2003 (ii) Installed after 2003 up to 31st December 2016 and (iii) Installed after 31st December 2016.

Pollutant	**Unit**	**Installed before 31st December 2003**	**Installed after 2003 up to 31st December 2016**	**Installed after 31st December 2016.**
Particulate Matter	mg/Nm^3	100	50	30
SOx	mg/Nm^3	600< 500 MW 200> 500 MW	600< 500 MW 200> 500 MW	100

With a view to reduce greenhouse gas emission, harnessing of renewable resources to the extent possible, enhancing efficiency of the existing power plants and introduction of new technologies for power generation for enhancing efficiency and demand side management are being pursued. Since coal will continue to use in power generation, Critical Technology has been introduced for reduction of greenhouse gases.

II. FGD REQUIREMENT

As SO2 is a corrosive gas produced from coal, oil, and natural gas. SO2 emission is a particularly acute problem in the power generation industry. It is derived from the burning of fossil fuels (coal and oil) and the smelting of Sulphur-containing mineral ores (aluminum, copper, zinc, lead and iron). To minimize the adverse effects of Sulphur oxides on the environment, use Flue Gas Desulphurization (FGD) scrubbers/ Absorbers to remove SO2 and SO3 from combustion gases is recommended.

The SO2 emission levels would vary depending on the Sulphur content and the composition of the coal fired. The weighted average of Sulphur content in the coal is varying from 0.28 per cent to 0.5 per cent and therefore, the Sulphur content in the coal of power plant is the main consideration for FGD design.

Flue-gas desulfurization (FGD) is typically used for reducing SO2 emissions from the exhaust gas system of a coal-fired boiler. The physical nature of these materials varies from a wet sludge to a dry, powdered material depending on the process.

There are TWO types of FGD system:

1. Wet FGD system.
2. Dry FGD system.

WET FGD SYSTEM:

The wet sludge from a lime-based reagent wet scrubbing process is predominantly calcium sulfite. The wet product from limestone-based reagent wet scrubbing processes is predominantly calcium sulfate.

The reactions may be stated in an overall expression as:

CaCO3 (limestone)+ SO2 (sulfur dioxide) + 2 H2O (water)+ 1/2 O2 (oxygen) → CaSO4•2H2O (gypsum) + CO2 (carbon dioxide).

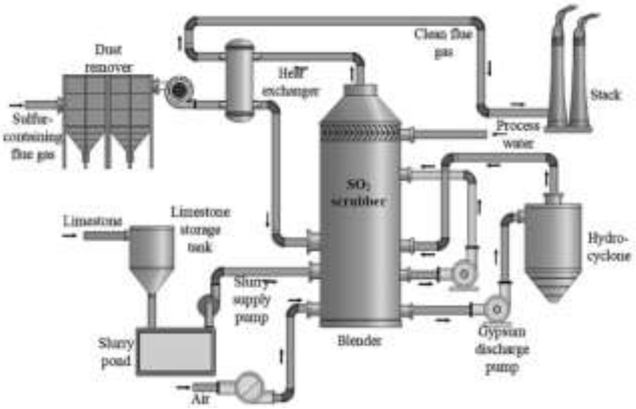
The basic system of Wet FGD system consists of:

Scrubber/ Absorber

Limestone slurry make up system (Storage, miiling, Slurry preparation system)

By product-Gypsum handling system

Typical scheme for the Wet FGD system is provided below for understanding:

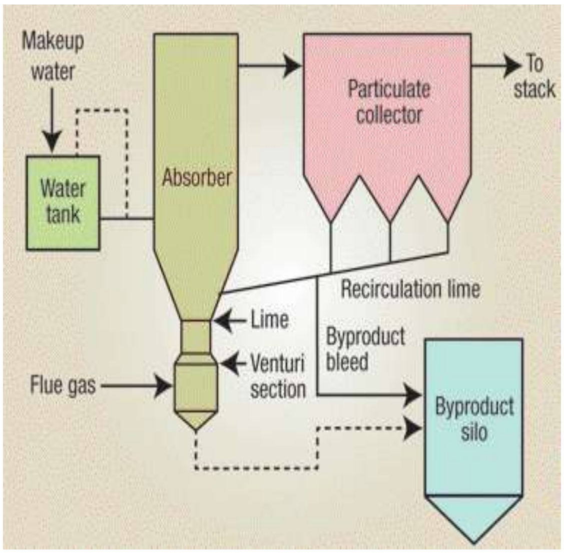


DRY FGD SYSTEM:

This type of FGD use lime slurry as reagent. The main components in this process are dry Absorber, ESP/fabric filter, reagent slurry preparation system, by-product collection and recirculation system and by-product handling system. The limestone is mixed with water at a controlled rate to maintain a high slaking temperature that helps to generate fine hydrates of lime with high surface area. Process makeup water is added to the slacker to produce solid slurry. The slurry is fed to the absorber by reagent feed pump. The reagent slurry is atomised through rotary cup spray atomisers or through dual fluid nozzles. The flue gas post air preheater enters the spray dryer absorber where gas stream is cooled by the regent slurry spray. The mixture then passes through the fabric filter for removal of particulate before entering the ID fan. A portion un-reacted lime, gypsum and the other reaction products collected in the fabric filter is mixed with water and returned to the process as high solid slurry. The remaining solids are directed to a storage silo for by-product. The by-product is semi-dry/dry in nature and flue gas leaving the absorber is not saturated with moisture. This technology of desulphurization requires less capital cost for smaller capacity units. It has lower water consumption and auxiliary power consumption. There is no visible moisture plume in stack, as the flue gas leaving absorber is not saturated with moisture.

Beside the advantages, cost of lime storage is higher. The technology is limited to low sulphur fuel because of high reagent cost. It has limited reagent utilisation.

Calcium sulfite FGD material can be used as an embankment and road base material. Calcium sulfate FGD material, once it has been dewatered, can be used in wallboard manufacturing and in place of gypsum for the production of cement. The largest single market for FGD material is in wallboard manufacturing.



- The flue gas with fly ash enters the bottom of the absorber, flowing upwards through Venturi to accelerate the gas causing turbulent flow.
- The solids, reagent, and water mix with the turbulent flue gas makes the gas cooling, reactivation of ash and capture of pollutants.
- The cooled gas enters the particulate collector (Baghouse) where solids are captured and recycled back to the absorber to capture more pollutants.
- Reactive absorbent like sodium carbonates, hydrated lime, activated carbon or others can be added to mix with the specific pollutant (Sulphur). The final product is stored in the Product Silo.

The reactions may be stated in an overall expression as:
$SO2+Ca(OH)2 \rightarrow CaSO3 + H2O$
$SO2+Ca(OH)2 +1/2O2 \rightarrow CaSO4 + H2O$
$SO3+Ca(OH)2 \rightarrow CaSO4 + H2O$
The reaction takes place in the dry Desulphurization process in between the temperature 75°C -145°C

III. COMPARISION OF DRYFGD WITH WETFGD

The test set for this evaluation experiment watermark image randomly selected from the internet. Matlab 7.0 software platform is use to perform the experiment. The PC for experiment is equipped with an Intel P4 2.4GHz Personal laptop and 2GB memory.
The proposed scheme is tested using ordinarily image processing. From the simulation of the experiment results, we can draw to the conclusion that this method is robust to many kinds of watermark images.

Description	**Dry FGD System**	**Wet FGD System**
Absorber	Absorber	Spray Tower
Capital cost	Low	High
Size of plant	Small	Large
Reagent	Lime	Limestone
By-product	Landfill	Marketable gypsum or landfill
Removal Efficiency	-98 %	-99 %
Capital Cost	0.6- 0.7 X	X
Power Consumption (inc. booster fans)	1%	2%
Absorbent Cost	3 – 4 X	X
Water consumption	Less	More

IV.CONCLUSION

With regulatory changes and technology developments, SO_2 emission management has evolved significantly over the years and continues to improve. FGD technologies such as dry type and wet type systems improve the overall efficiency of plants and provide monetary benefits to operators. They also help operators conform to emission regulations and standards. Based on the Indian coal quality generally available for thermal power Electrical India | April 2020 31 stations and bring down the SO2 emission level less than the norms, Dry type FGD and Wet limestone type FGD could be feasible. Through, the capital cost of dry FGDs is lower when compared to wet limestone FGD, based on the lifecycle cost comparison, the wet limestone FGD has lesser operating cost. The dry type FGD systems have a lesser water requirement in the absorber as compared to wet limestone FGD. Though, the high cost of expensive slaked/quick lime required as reagent in dry FGDs, considering the capital cost of the project and considering the Water saving (useful in the water scarcity area) the Dry FGD system shall be recommended.

V. REFERENCE

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