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RECOVERY OF POLLUTANTS FROM THERMAL POWER PLANT TUTICORIN

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Abstract — Emissions standards are becoming more stringer, as a result new technique are being applied in the existing Tuticorin Thermal Power Plant (TTPS) by using Imported and Indian Coal. Electrostatic Precipitators (ESP) are used to control fly ash. The Indian coal burned in TTPS is having low calorific value 3300 Kcal/kg., and high ash content 42.5%. Thus compared to Imported coal, Indian coal generates about 8 to 10 times more ash for collection for similar electricity generation. Thus ESPs in India is having lower collection efficiencies than the ESPs in other Developed Countries

In this paper we discuss Ammonia Injection method which are being applied in different power plants in India to improve the collection efficiencies of ESP. Blending of coal is done and Ammonia is injected in different concentration there by reducing the SPM ranges from 900 to 120 mg/Nm^3. The paper describes the experiments and analysis. The results obtained by SPM range is brought below 150 mg/Nm^3 as prescribed by Pollution Control Board and in turn reduces pollution.

Keywords — ESP, Ammonia Injection, Stack Emission, Stimulation.

1. INTRODUCTION

Fossil fuel will maintain a fundamental role in electricity generation in coming decades. The country has abundant reserves of coal, which are estimated to be 50 billion tonnes, and depends on coal as the cheap source of energy and heat. Atmospheric Particulate Matter is fine solid matter or liquid matter floating in atmospheric air. Of the particle, environment standards specify particulate having a diameter lower than 10 µm, which is considered to affect health. The main objective of this thesis is to find the possible physical and chemical process to control Particulate Matter emission from flue gas by changing the blending ratio of Imported coal and Indian coal in Thermal Power Plant Tuticorin . ESP efficiency can be improved. Then Cost Vs Benefit

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Analysis is done. Thus it optimizes operation and maintenance costs. InA Tuticorin Thermal Power Plant the designed ESP was having Stack emission of 250 mg/Nm^3 at 1979 and Ambient of 500 mg/Nm^3 at Present Prescribed limit for TTPS is 150 mg/Nm^3. And the limits have to be brought under control from 250 mg/Nm^3 to 150 mg/Nm^3. So methods are to be implemented for reducing the Stack emission thereby cost of coal used by TTPS can be reduced. Ammonia is being injected in ESP there by reduces the stack emission and at present prescribed standard limit 150 mg/Nm^3 can be maintained.

2. AIR POLLUTION CONTROL EQUIPMENTS & SYSTEM

- ✓ Bag Filters.
- ✓ Hybrid filters.
- ✓ Electrostatic precipitator.

3. MATERIALS AND METHODS

3.1 Electrostatic Precipitator

The most widely used high efficiency dust collector today is electrostatic precipitator based on the simple principle that a charged body extracts one oppositely charged ion. High voltage direct current corona method is adopted universally for electrostatic precipitating. This is achieved by maintaining a large potential difference between the electrodes. When the voltage is sufficiently high, electrons and ions are accelerated to such a high speed that they ionize the gas molecules by collision. The collision ionizing around the emitting electrodes is called the "corona discharge". As positive corona discharge likely to create localized flares, which is undesirable in ESP's the negative ion discharge is used universally.

The dust collection efficiency of ESP can be estimated by the "Deutsch – Anderson Formula"

$$n = 1 - e^{\left(\frac{-WA}{Q}\right)}$$

Where,

N - Efficiency
A - Collecting area
Q - Gas flow in m^3/s
W - Migration velocity in m/s

The electrically charged dust is collected on the collection plate, which is dusted by the periodic hammering of the plates. The hammering of the plates is conducted at periodic interval in cyclic order. The dust collected in a hopper (valley at 55 degree) and which is removed by dry and wet methods.

Advantages:

- ✓ *High collection efficiency for smaller size (0.01µ) particles*
- ✓ *Low pressure drop*
- ✓ *Large volumes of gas can be handled*
- ✓ *It can be operated at high temperature also.*

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3.2 Stack Emission Apparatus:

The name of the apparatus used for testing stack emission is **VAYUBODHAN STACK SAMPLE VSS1.** Monitoring of stack and vent emissions is now becoming a routine requirement not only for large but even the medium and small industrial units. There has also been a growing realization that gaseous pollutants, chemical fumes and fine mists are hazardous as particulate ashes and dusts. **VAYUBODHAN STACK SAMPLER VSS1** has been developed to provide a simple, sturdy, reliable and cheap sampler for such situations.

In stack sampler **VSS1** simultaneous sampling for PM and gaseous pollutants can be carried out to save on effort and time. For special applications special accessories like heated probe (for high moisture leden emissions), sampling cyclone (for high SPM gases), Fluoride Monitoring kit etc., are available. Provision has also been made to monitor temperature and pressure at the inlet of the flow meter to normalize the volume of the gas sampled.

Some of the new features include in the VSS1 are:

- ✓ Cumbersome Manometer has been replaced with digital pressure cell
- ✓ Designed to determine the velocity of gases also
- ✓ Measures total quantity/volume of the emissions very conveniently
- ✓ Size and weight of panel has been reduced considerably
- ✓ Pitot and probe pipe is being provided with extendable arm of 0.6m each
- ✓ Calibrated pitot, probe pipe, thimble holder, nozzles, tools etc, all accommodated in a carrying case
- ✓ Temperature and pressure at inlet of the rotameter, in order to normalize volume of the sampled gas.
- ✓ Number of joints have been reduced & thus changes of leakages are minimized.

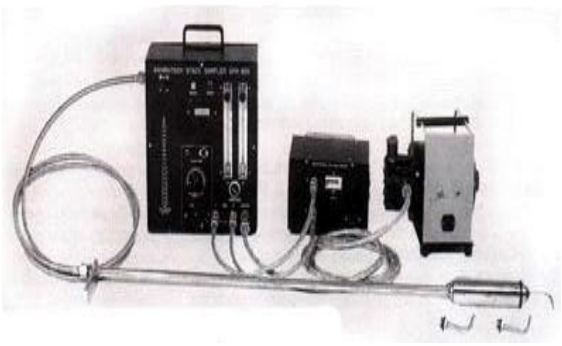

Fig 1 Vayubodhan Stack Sampler VSS1

- ✓ Tripod stand for better accessibility
- ✓ Compact hardware & protable light weight rotator vane type pump etc,.

- ✓ Standard accessories like rotameter, pressure & temperature, metering system & provision for simultaneous sampling.
- ✓ Sampling train with improved glass joints & ice tray for better cooling.

4. METHODOLOGY

In the present work, a detailed study on literature regarding the study of flue gas monitoring in coal Fired Power Plants. Collection of five year Stack and Ambient Emission data from TTPS to determine the past status. Finding the possible Physical and Chemical process that are needed for my project. Initial Stack emission data are taken. The Analysing of coal are being done. Blending Variation of imported coal and Indian coal are done and coal is send to the mill accordingly, then injection of ammonia is also done in varying dosage so as to identify the decreasing data of Stack Emission. No of Indian coals used in mills are also made variation and ammonia is being injected.. These techniques are relatively quick, easy to use, and cheap. Steps Involved In Methodology:

- ✓ Collection of five year Ambient and stack emission data from TTPS.
- ✓ To find possible Physical and Chemical Process.
- ✓ Initial Stack and Ambient Emission Data are taken.
- ✓ Analysing of Coal.
- ✓ Blending of Indian Coal and Imported Coal.
- ✓ Injection of Ammonia Gas.
- ✓ Finding Cost Vs Benefit analysis.
- ✓ Stimulation is done using ANSYS Software.

Application of Using Ammonia

Achieve good collection efficiency.

- ✓ Agglomerates fine particulate in the gas stream, which produces an attendant reduction in opacity.
- ✓ Reduces rappers re-entrainment and emissions.
- ✓ Increases the efficiency of ESP.

5. ANALYSIS OF COAL

Coal consumption -16000MT/d

CONTENTS	INDIAN COAL	IMPORTED COAL
CALORIFIC VALUE *(kcal/kg)*	3300	5500
MOISTURE CONTENT (%)	8.8	12.92
ASH (%)	42.7	4.03
VOLATILE MATTER (%)	23.4	40.26
FIXED CARBON (%)	25	42.99

SULPHUR (%)	0.14	0.4

Table 1. Coal Analysis Value

6. RESULTS AND DISCUSSION

6.1 Case Studies of Ammonia Conditioning System In India:

Chemithon Engineers Pvt. Ltd. (CEPL), India, in the past five years has successfully tested and implemented Flue Gas Conditioning (FGC) systems:

1. Punjab State Electricity Board, Bathinda (Units 3 & 4 - 110 MW) Ammonia FGC.
2. West Bengal Power Development Corpn. Ltd., Kolaghat (Units 1, 2 & 3 – 210 MW), Bandel (Unit No. 5 – 210MW) Ammonia FGC.
3. Durgapur Projects Ltd., Captive Power Plant (Unit No.3, 4,5 77 MW each & 6 - 110 MW) Ammonia FGC.
4. Maharashtra State Power Generation Company Ltd. Khaperkheda (Unit No. 1 - 210 MW); Bhuswawal (Unit No. 3 - 210 MW); Chandrapur (Unit No.3 - 210MW) and Parli (Unit No.5 - 210 MW) Ammonia FGC.

Ammonia is available in the 50kg capacity cylinders. There are 20 nos. of cylinders arranged in such a way that 20 cylinders can be connected to Ammonia Manifold Header of size 50NB diameter. The above cylinders are near ESP area. Water spraying is available above the Ammonia Cylinders to dilute the Ammonia Gas Incase of leakage and also to vaporize the Ammonia inside the cylinder. The above Manifold Header is connected to the air blower discharge before injection point in the flue gas duct. Blower air is used for better distribution of diluted Ammonia in the Flue Gas Duct. Flow meter is fitted in Air line as in ammonia line to measure the flow rate. (shown in Fig 2 and Fig 3)

Fig 2 Ammonia Skid

Fig 3 Blowers

Ammonia gas mixture is injected into the flue gas duct through the vertically arranged 16 nos. nozzles provided at the top in each left and right side duct from boiler. Ammonia gas mixture flows along the flue gas path and help in reducing the resistivity of fly ash, which improves the collection efficiency of the ESP.

Initially unit 3 of the TTPS was running with the SPM value ranging from 200 to 430 mg/Nm^3. After ammonia injection, now the unit 3 is maintaining with SPM value ranging from 100 to 120 mg/Nm^3. The ammonia consumption rate is around 100 to 150 mg/Nm^3. The copy of the readings of SPM level before and after ammonia injection is enclosed in Table 1.

7. CONCLUSION

It is obvious that the SPM level could be reduced by dozing Ammonia. Since the Ammonia is very dangerous gas for human being, as for as possible the use of Ammonia should be made to the bearest minimum quantity for the above purpose. Further it is to be mentioned that the Ammonia flue gas conditioning will be effective in bringing down the SPM level only if the ESP intervals, both Mechanical and Electrical are in healthy condition

Hence the ammonia dozing is recommended only after taking all other possible steps to reduce SPM level, such as usage of Imported coal, Erection of Additional fields, Introduction of latest version controllers and taking all possible steps to revamp the existing ESPs, to make them more healthy. When all the above activities are carried out then the consumption of Ammonia will be minimum and we can meet out the statutory norms of SPM level in safe and economical way.

The Results have been obtained by the injection of ammonia in ESP and thereby values are under the limit of 150 mg/Nm^3. By also using blending ratio of coal the stack values have been controlled under the limit too. From the obtained result we come under the conclusion that the TTPS can be made to run by using Indian coal itself. Thereby we can reduce the cost of coal used in TTPS. Efficiency of TTPS can also

be improved.

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Load	No. of Mills in Service With		Ammonia Injected	SPM Level (mg/Nm^3)		Remarks
(MW)	Imported Coal	Indian Coal	kg/hr	Pass A	Pass B	
210	1	3	-		497.8	Before Ammonia Injection
210	1	3	-		675.9	Before Ammonia Injection
210	1	3	24		268.8	
210	1	3	24		178.5	
210	1	3	30		129.0	
210	1	3	30		146.0	
210	1	3	30		139.6	
210	1	3	33		129.1	
210	1	3	40		107.6	
210	1	3	40	402.2	106.7	
210	1	3	43		105.0	
210	1	3	43	408.3	103.0	
210	1	3	43		97.7	
210	1	3	43	410.4	97.1	
210	-	4	30	755.6	149.4	
210	-	4	30		146.3	
210	-	4	40		114.5	
210	-	4	35	699.3	130.9	
210	-	5	-	904.68	629.08	Before Ammonia Injection
210	-	5	40		268.38	
210	-	5	45		185.49	
210	-	5	50		146.58	
210	-	5	More than50		141.79	
210	-	5	50		132.58	
210	-	5	50		137.11	

Table 1 Stack Reading Before and After Ammonia Injection