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"COMPARATIVE FEASIBILITY STUDIES OF ESP IN POWER SECTOR "A CASE STUDY"

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Abstract

Air pollution is now considered to be the world's largest environmental health threat, accounting for 7 million deaths around the world every year. The main substances affecting health are: nitrogen oxides (NOx), sulphur oxides (SOx), ozone and particulate matter with the latter – especially particulate matter below 2.5 microns (PM 2.5) – being of greatest concern, as these tiny particles penetrate deep into the lungs, affecting both the respiratory and vascular systems. Both extent and duration of the exposure influence health outcomes. Major reason of air pollution is Industrial Emission from various industries like Cement plant, Power Sector Still division Paper Mills etc. Emission from industries can be minimized by using ESP. But time to time its maintenance and non availability of ESP field, causes either stack emission above permissible value or minimize the production. This paper presents the research that how availability of ESP can be increased and the stack emission can be reduced even in case of one or two field failure. For 90TPH boiler whose flue gas flow was $40m^3$/sec need three ESP field, which has been studied and exactly same two new ESP field has been provided series. For two new ESP field installation 2.99crore rupees and running cost will be extra 1.43lakh rupees per month. After installation of two new fields stack emission reduced to 27 mg/Nm^3(March2023 month average) from 41 mg/Nm^3 (March2022 month average). Increase of two ESP fields had drastically decrease stack emission as well as it reduces the shutdown of boiler due to one or two field failure which increases the production.

Key words :- ESP(Electrostatic Precipitator), Stack Emission, TPH(Ton per Hour)

Introduction

An Electrostatic Precipitator (ESP) is a device that is used to remove and collect the particles from a flue gas by using the force of an induced electrostatic charge from a high voltage power supply unit. This is the most efficient way to solve the pollution problem as a result of coal combustion.

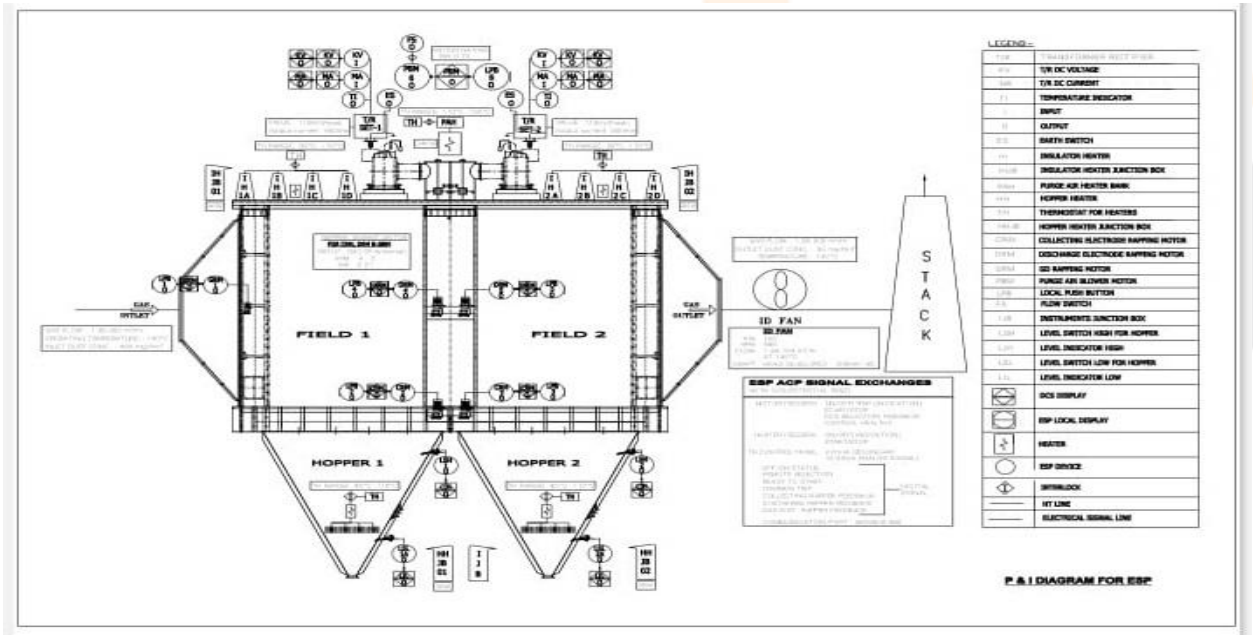
When gas that contains an aerosol (dust, mist) flows between the collecting plates and the discharge wires, the aerosol particles in the gas are charged by the ions. The coulomb force caused by the electric field causes the charged particles to be collected on the collecting plates, and the gas is purified. This is the principle

When gas that contains an aerosol (dust, mist) flows between the collecting plates and the discharge wires, the aerosol particles in the gas are charged by the ions. The Coulomb force caused by the electric field causes the charged particles to be collected on the collecting plates, and the gas is purified. This is the principle of electrostatic precipitation, and Electrostatic Precipitator applies this principle on an industrial scale. Electrostatic precipitators are highly efficient filtration devices that minimally impede the flow of gases through the device, and can easily remove fine particulate matter such as dust and smoke from the air stream. Nowadays these ESPs are gaining importance as to obtain the environmental clearance for setting up of new industrial plants and green environment.

Materials and Methods

The electrostatic precipitator, which was investigated is in Raipur industrial Growth Centre Siltara Raipur area, Industry name SEML (Sarda Energy and Mineral Limited) Which has 3 AFBC (Atmospheric classic fluidized Bed Combustion System) and 4 WHRB (Waste Heat Recovery Boiler).Total 7 ESP installed 3 for AFBC Boiler and 4 for WHRB Boiler. AFBC -3 ESP has 3 field and this fields data collection done. Two new ESP identical fields constructed and provided to AFBC to increase ESP efficiency. Two new ESP identical fields provided so that emission level can be controlled under limit in case of one or two fields not working due to any reason. It will reduce shutdown of boiler due to emission going beyond limit due to failure of one or two fields. It will increase Production and reduce emission to optimum level.

Schematic Diagram of two new fields



1. Schematic Diagram of two new field

Cost Analysis and details

Cost of installation of 2 new field can be categories in 3 parts.

1. E & I
2. Mechanical
3. Civil

In E & I Part major cost will be of

1. 3 ph ESP Transformer 700mA : - 2 Qty
2. ESP panel MCC for control of equipments.
3. Cable (Power Cable , Control Cable)
4. Monitoring Instrument of different Parameters.
5. Aluminum and Copper cable of different size and no are required.
6. Different type of junction box required.

Total E & I cost including installation is 4247110/- Rs

In Mechanical Part major cost will be of

1. Collecting Electrode with suspension system:-2 Set.
2. Emitting Electrode with suspension system:-2 Set.
3. Inlet and outlet Gas distribution Screen.
4. Ash conveying system for new 2 field ESP.
5. Other Expenses like MS channel plates, Ms channel angels of different sizes

Total Mechanical cost including installation is 20603500/- Rs

In Civil Part major cost will be of

1. TMT bar of different sizes.
2. PVC pipes of different sizes.

Total Civil cost including installation is 5105320/-Rs.

Total Cost for installation of 2 Extra field will be

1. E & I cost 4247110.
2. Mechanical cost 20603500/-
3. Civil cost will be 5105320/-

Total value:- **2,99,55,930**/- RS

In words its is **TWO CRORE NINETY NINE LAKH FIFTY FIVE THOUSAND NINE HUNDERED THIRTY**.

Monthly Operational cost Comparison between the old (3 fields) and new (2 new fields) is done to study the difference in running 2 new fields in series.

Table no 1. Comparing Cost of Operation of 3 fields and 5 fields

Date	ESP-1st+ESP-2nd+ESP- 3rd Field consumption in (KWH)	ESP-4th + ESP -5th Field consumption in (KWH)
1st March	1380	813
2nd March	1242	822
3rd March	1275	885
4th March	1230	855
5th March	1247	832
6th March	1227	822
7th March	1301	826
8th March	1325	866
9th March	1322	825
10th March	1326	845
11th March	1277	805
12th March	1308	820
13th March	1318	872
14th March	1322	830
15th March	1326	840
16th March	1318	886
17th March	1335	845
18th March	1285	855
19th March	1297	869
20th March	1289	890
21st March	1258	849
22nd March	1265	859
23rd March	1283	813

24th March	1265	852
25th March	1301	862
26th March	1235	852
27th March	1255	809
29th March	1268	849
30th March	1288	833
31st March	1292	819
Total	39926	26135

AVG (1 DAY) of First three field = 1287.93KWH

AVG (1 DAY) of 4th and 5th field = 843.06KWH

Cost of running first 3 field is = 39926*5.5 = 219593/- RS.

Cost of running 4th and 5th field is = 26135*5.5 = 143742/- RS.

After installation of 2 new fields in series to the existing 3 fields the comparison of the stack emission is done for complete month is given below.

Table no 2. Comparing stack emission of 3 fields and 5 fields

Date	Emission in March 2022 with 3 ESP field. Average of day (mg/Nm^3)	Emission in March 2023 with 5 ESP field. Average of day (mg/Nm^3)
1st March	38	29
2nd March	42	26
3rd March	47	25
4th March	44	28
5th March	34	24
6th March	41	30
7th March	45	29
8th March	41	28
9th March	43	25

10th March	38	29
11th March	35	28
12th March	41	30
13th March	41	22
14th March	44	29
15th March	39	25
16th March	38	26
17th March	42	25
18th March	43	28
19th March	44	29
20th March	43	30
21st March	40	29
22nd March	44	29
23rd March	40	23
24th March	45	24
25th March	39	28
26th March	37	26
27th March	38	29
29th March	42	29
30th March	43	23
31st March	40	29
Total	1273	839

Average stack emission for month of March2022 is 41 mg/Nm^3 when three ESP fields where in operation. In month of March2023 stack emission average is 27 mg/Nm^3 when total five ESP fields are in operation.

This shows stack emission has reduced drastically frome 41 mg/Nm^3 to 27 mg/Nm^3. As well as in case of one or two field failure immediate shutdown is not needed, which increases the productivity of the industry.

RESULT

We have collected the data from old ESP, data like Volume of flue gas, No of Collecting Electrode No of Discharge Electrode, Rapping System, Seal air fan Seal air heater etc.

We have made exactly same ESP field and attached in series with old ESP. We had 3 old ESP field and now 2 new ESP field is connected in series.

We did analysis of cost required for the installation of the 2 new ESP field, and the operational cost for running all 5 fields.

Then we have compared the stack emission for March 2022 with 3 ESP field and March 2023 with 5 ESP field.

Finding of the project is that:-

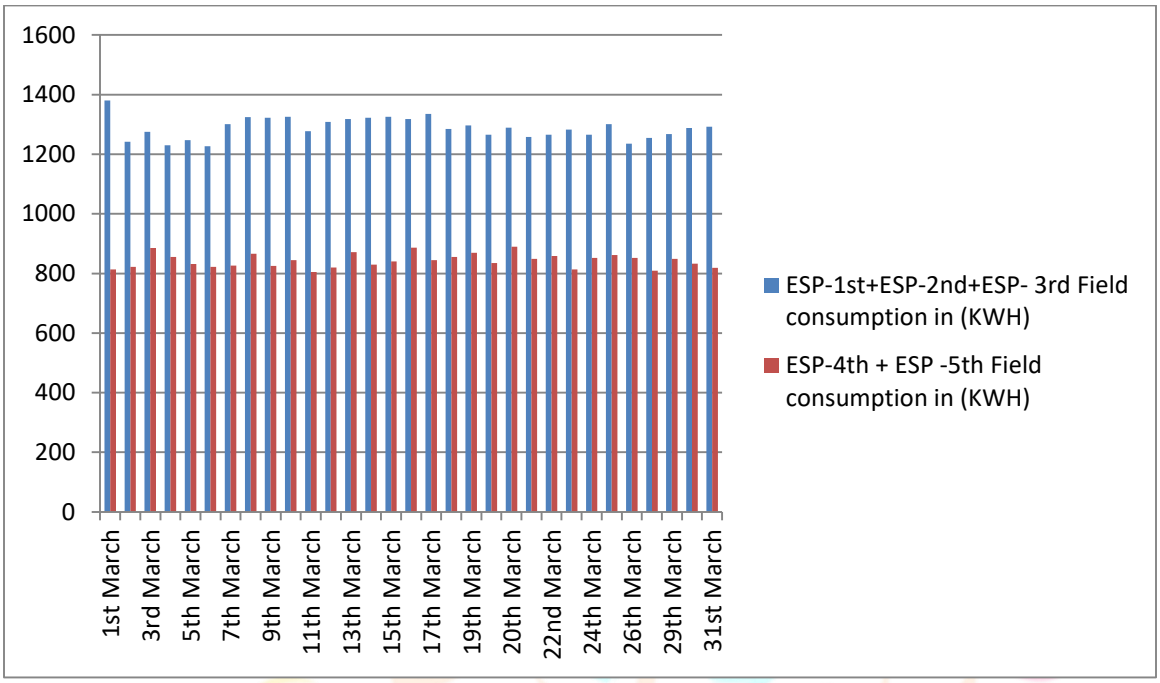
1. Installation cost of ESP field is very high.
2. Operation cost of running field is low.
3. Stack emission has reduced considerably, which can be seen in observation.
4. Use of external agent used to reduce Stack emission has been stopped.
5. Shutdown due to ESP field failure has been reduced.
6. Boiler Shutdown is reduced means productivity has been increased..

Installation cost

As discussed above the various cost required for the installation of two new field is high. It required nearly 2.99 crore rupees for installation of two new field.

Operational Cost

Operational cost of total two new field is calculated for its day to day consumption and found its operational cost in low, as compare to its benefits. Operational cost of three field and two new field is compared in below graph.



Above graph shows operational comparison of old(3 fields) and new(2 fields) ESP consumption

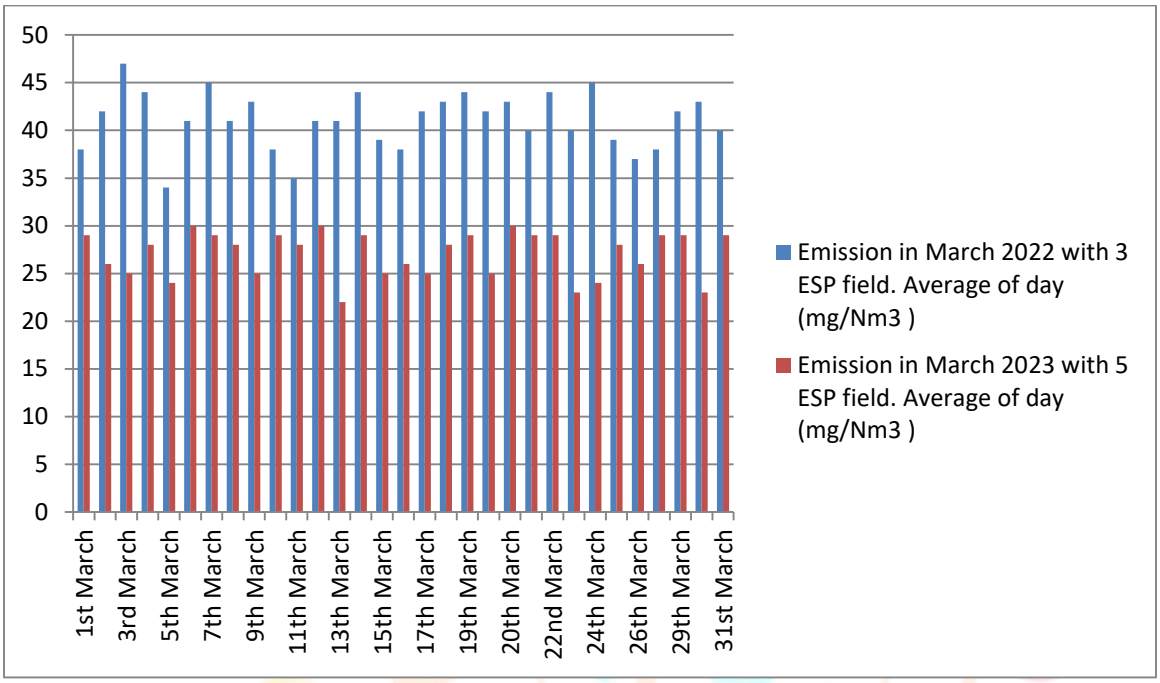
Stack emission comparison

Stack emission data for the month of March2022 and March2023 is collected and compared in table no.1.

Average stack emission for the Month of March2022 is 41 mg/Nm^3 when three fields are in operation with full load of Boiler at 90TPH.

Average stack emission for the Month of March2023 is 27 mg/Nm^3 when five field are in operation with full load of Boiler at 90 TPH.

It's comparison is shown in below graph.



Above graph shows stack emission from chimney.

External agent use stopped

External agent use to increase collection in ESP has been stopped. To reduce stack emission external agents like ammonia dosing was done in ESP field which increases ionization effect. Due to which dust collection is also increased. But after proving two new fields dust collection is increased automatically so use of external agent is stopped.

Shutdown due to ESP field failure has been reduced

When we had three field in operation and any field failures due to electrical reason or due to mechanical reason the stack emission is increased. Due to increase in stack emission industry (boiler) need to take shutdown and ESP has to be taken in maintenance.

When we have five field in operation even in case of field failure stack emission remains under control, if online maintenance of field can be done its good otherwise four field maintains the stack emission under control. Even if we have two field failure then also stack emission can be controlled with remaining three fields.

CONCLUSION

AFBC 90TPH boiler of SEML has installed 3 field . Flue gas at inlet of the ESP has flow of 40m^3/sec. Now addition of 2 identical fields has been installed to reduce stack emission. Stack Emission has been reduced from 41mg/Nm^3 to 27mg/Nm^3.

Installation cost of two new field is high, but it's operational cost is low.

More issue like one field failure or two field failure , KV not building in field, any external problem due to which field is not working, Electrical panel problem or due to any other issue plant boiler shut down can be eliminated.

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