Modernizing the Pollution Control Equipment in Power Plants

K. N. V. D. Maheswari[1], B. Kiran Babu[2]

[1]KL University, EEE, Student of B. Tech, Vaddeswaram, A.P, India
mahi.30909@gmail.com

[2]Assistant Professor, KL University, EEE, Vaddeswaram, A.P, India
kiranbabu.b@gmail.com

Abstract: ***Electrical energy is an essential ingredient for the industrial and all-round development of any country. This electrical energy is obtained by conversion from fossil fuels(coal, oil), nuclear and hydro sources. The availability of coal advances the promoters to install thermal power plants. Earlier, the power plant planners were concentrated more on generating power and hence not concentrated on pollution aspect and this continued up to late 70s. Later, the awareness has been created on pollution effect on the society and that makes the authorities to implement strict controlling norms to the power plant personnel to retrofit the present pollution control equipment. They have to change the older pollution control equipment like precipitators with the new ones or modify it by adding new components.***

Keywords: Electrical energy, precipitators. corona, thermal power plant.

1. Introduction

The society is facing pollution effect and therefore the authorities had to take strict actions to control this pollution effect. For that the pollution control legislation has to change the availability of technologies and resources by providing the old pollution equipment to the latest level. The retrofitting concept have revolutionized from the simple part to part replacement to renovation, enhancement, up gradation. The users, consultants, manufacturers of precipitators applied their thoughts to provide suitable solutions for pollution control.

2. Precipitators

Precipitator is a motionless, effective dust-capturing device. Precipitators had been a main pollution control equipment in power plants. In India the design and usage of precipitators have undergone many changes because of the availability of good technology, expertise acquired and stringent environment norms. There were installed with an aim of "good neighbor approach". These records from thermal plants in the following manner:

Boiler size	*Protected area*	*Old(before 1979)*	*Other area (after 1979)*
Less than 210MW	150 mg/Nm^3	600 mg/Nm^3	350 mg/Nm^3
200MW and above	150 mg/Nm^3		150 mg/Nm^3

3. Need For Modernization

The reasons could be one or many factors which were followed below:

Modifying of fuel properties

- Not good quality of fuel, change of fuel.
- Modification in environmental legislation.
- Modification in behavior of boiler
- Worse boiler performance, use of multi fuel firing, conversion of firing type and change in the plant rating.
- Precipitators: Inadequate design of available precipitators, poor quality equipment, low electrical and mechanical conditions like improper gas distribution/re-entertainment, unstable operating conditions of precipitator, low process knowledge, plant beyond serviceable conditions, poorly erected and commissioned equipment and ineffective maintenance.

4. Methods of Retrofitting

4.1 Rehabilitation

In mechanical and electrical systems:

- Padding of empty fields
- Insert continual charging
- Placing improved collecting electrodes.

4.2 SCA Supplementing

- To introduce series field
- Introducing series and parallel precipitators
- Replacing precipitators internal with new internals
- Rebuilding new precipitator

Padding of Empty Fields

The old precipitators have been improved with an added feature of dummy field either in inlet or outlet of it. Later to provide additional collection area, these empty sections were filled with active components. The major active components include collecting electrodes, discharge system including discharge electrodes, electrical system, rapping system, thermal insulation and other steel materials required for covering. Now, plant owners specify the present emission with one field out of service condition per pass.

Intert Continual Charging

The earlier precipitator gets active with full wave Transformer- Rectifier set. Previously the limit control for power supply is provided with automatic spark controller. By transistor phase control the power input to precipitators are limited to the point of sparking. Due to the back corona this controller has been used for low resistivity dusts whereas not for high resistivity dusts. Increase in the power input beyond the back corona causes wastage of power and decreases the precipitator emission. This can be reduced by degrading the resistivity or by controlling current through dust layer; it can be implemented by introducing the intermittent charging controllers in many old power plants for improving the emission level. This technique blocks certain cycles and allows current for few cycles to achieve this current limit. To eliminate the back corona, we need to reduce the dust layer that improves precipitator performance and reduces the power consumption. The TABLE-1 results show this point.

Table 1: Results from retrofit continual charging energisation

Project	*With CR 1: 1*		*With varying CR 1: 159*		*Reduction in emission in Percentage*	*Reduction in corona power in KW*
	Outlet mg/ Nm^3	*Corona power In KW*	*Outlet mg/ Nm^3*	*Corona power In KW*		
Plant – A 500 MW	352	916.3	146	164.3	58.40	82
Plant – B 500 MW	375	1401	112	171	70.13	87.79
Plant –C 500MW	395	447.80	150	57.60	62.02	87.14
Plant – D 200 MW	371.60	428	145	40	60.98	90.65
Plant –E 210MW	175.70	310	61.90	75	64.76	75.81
Results from dummy field filling and intermittent charging						
Plant –F 210MW	203.3	280	50.80	120	75.01	57.14
Plant-G 210MW	200.20	280	64.10	120	67.98	57.14
Plant –H 200 MW)	277.90	250.80	88.30	52.80	68.22	78.95
Plant-I 200MW	441.10	124.80	127.60	38.40	71.07	69.23

Placing improved collecting electrodes:

This is also called as discharge electrode or rapping system which has been implemented in Kothagudam. This is captioned as “adding parallel precipitators, Kothagudam 1,4 (2x60MW)”

To introduce series field:

We can observe this type in Talcher 4x62.5 MW and captioned as “replacing the precipitator internals with additional internals, Talcher 1-4 4x62.5MW”.

Introducing series and parallel precipitators:

Series precipitators, kothagudam-7&8:

As series control equipment, APGENCO has introduced 2 no 110MW power plant and series multi-cyclone separators and precipitators which were supplied by BHEL. Keeping in mind about the boiler ageing and not good quality of coal retrofitting program of the precipitators and boiler in the plant have been taken by APGENCO. They are:

- Placing the new working components in the place of not working components and also removing the cyclone separators.
- For improving the collection area series precipitators have to be used.

The work was done in this manner for limiting purpose:

- New precipitators were installed above the ID fans.
- Providing RCC platform below the precipitators to avoid spill-over of ash on fans.
- Ash handling system has been installed with the existing system.
- Cyclone separators and ductwork has to be dismantled.
- All the supplies has to be erected and commissioned and providing the performance.

The below TABLE -2 shows the performance data:

Combined Precipitator performance data

Parameters	*Existing ESP +NEW ESP in series*	
Design data of the precipitator		
Total gas flow	195	
Gas temperature	150	
Inlet dust concentration,	50	
Outlet emission	115	
Combined collection efficiency	99.865	
Precipitator details	*Existing Precipitato*	*New precipitator*
No. of precipitator	1	2
No.of passes per boiler	2	2
No Series fields per precipitator	4 (F1- F4)	2 (F5- F6)
Length of each field	3.60	4.50
Width of each field	11.00	11.20
Height of each field	9.00	9.00
TR set rating	60/1000	80/600

Parallel precipitators, kothagudam-1&4:

As a parallel control equipment ,APGENCO has introduced 2 no 60MW power plant with multi-cyclone separators at kothagudam. Later these cyclone separators were replaced by precipitators.

This precipitator design is done to achieve emission of 50mg/nm^3.

New parallel precipitator steel works, electrical and internals were introduces.

- PC based control system has been provided for both old and new precipitators along with rapping controller and intermittent charging controller.
- For existing system , ash handling is supplied. Conducts flow model study.
- ID fans are installed which take care of two precipitators. Complete design of civil work and provided performance.

Design data is given below in TABLE-3:

Kothagudam- 1 &4, (2 x60 MW), Combined Precipitator performance data:

Parameters	*KTPS – 1*		*KTPS – 4*	
	Existing ESP	*NEW ESP*	*Existing ESP*	*New ESP*
Design data of the precipitator				
Total gas flow,	176		176	
Gas temperature	205		205	
Combined collection eficiency,	99.938		99.938	
Precipitator details				
No. of precipitator	1	1	1	1
No. of series fields per Precipitator	3	4	3	5
Length of each field	4.00	4.50	3.00	4.50
Width of each field	2x8.40	2x9.30	16.80	14.10
Height of each field	11.00	13.50	12.50	15.00
TR set rating	70/1200	70/1200	70/1200	70/1800

Replacing precipitators with new internals:
4x62.5MW thermal power station was supplied by M/s. Babcock Wilcox at Talcher with cyclone separators. They were replaced by 2no.s each having 5 fields with dimensions 3.413x6x12.9m. later the plant was taken by NTPC in order to meet the pollution norms it has replaced the various equipment.

To extend the service life of precipitator by next 25 years specifications were drawn:

Parameters	*Guaranteed*	*Penalty*
Collection efficiency	99.85 %	3.4.69 Million INR (77100US$) for drop in every 0.05 % in test efficiency.
Pressure drop across precipitator	12 mmWC	0.265 Million INR (5900 US $) for increase in every 1 mm WC.
Air in leakage	1.20 m^3 /sec	0.588 Million INR (13070 US $)for every 1 m^3 /sec increase of air in leakage.
Corona Power consumption	Bidder to declare	0.125 Million INR (2781 US $) for every KW increase.

Rebuilding new precipitators:

Nasik 3.1x210MWalong with precipitator was commissioned. In 90s there was a fire accident in precipitator casing so temporary repair has been done by replacing the electrodes partially and precipitators were kept in service running with low efficiency. The state electricity board had done a detailed study and observed poor quality of coal, low efficiency obtained by repaired precipitators, minimum shutdown period of 52 weeks, erection.

To avoid these following has been done:

- Use of wide pitch
- Providing taller collecting electrode
- Complete replacement

Nasik –3, 1 x 210 MW - Existing and new precipitator design parameters

Parameters	*Old ESP design data considered in 1980*	*New ESP design data*
Design data of the		
Gas flow,	370	460
Gas temperature,	135	160
Inlet dust concentration	19.15	64
Outlet emission	176	80
Collection efficiency	99.08	99.875
Precipitator details		
No. Of precipitator/boiler	2	4
No .of gas paths per	2	1
No. of gas paths per boiler	4	4
No of electrical fields in series	5	6
Field length	3.60	4.5
Field width	9.50	11.6
Field height	9.00	15.0
Gas velocity	1.08	0.66
Treatment time	16.63	40.90
Aspect ratio	2.0	1.8
Pitch	250	400
TR rating	60/800	95/1000

5. Conclusion

The function of precipitator performance is precipitator rate parameter and specific collection area. The present plant demands restoring the precipitator to original performance design, to give very high efficiency than it was designed. In both the cases, functions have to be enhanced. Later, it is a tough task for the old plant owners to decrease the emission as the legislation becomes more stringent.. This paper describes briefly the methods which are available and implementation parts of each methods to retrofit the pollution control equipment helps the users in India.

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Author Profile

K. N. V. D. Maheswari is pursuing B. Tech from K L University (2009-13) in Electrical and Electronics Engineering

B. Kiran Babu received the B. Tech degree from JNTU Hyderabad in the year 2004, the M. Tech degree in power system engineering from MNIT Jaipur , Rajasthan in the year 2007. His research area includes distribution system reconfiguration, transmission loss allocation.