The Application of ESP-FF Hybrid Dust Collector

In India Coal-fired Power Plant 600MW Unit

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Abstract：There have been already several sets of ESP-FF hybrid dust collector for 600MW units provided by Zhejiang Feida Environmental Science & Technology Co. Ltd. (hereafter short as FEIDA) being operated in India. This paper introduced the structure style of ESP-FF hybrid dust collector, and concluded that it's relatively suitable to apply the separated type in India for the special electric power industry. And the ESP-FF hybrid dust collector is a correct selection with the enhancing of outlet emission standard. In India, the FEIDA ESP-FF hybrid dust collector is still in good operating condition.

Keywords：ESP-FF hybrid dust collector

1 Introduction

According to the data from India Ministry of Coal, 85% of the domestic coal production is from the open mine with a poor quality. India coal which has the average calorific value of only 3900 kcal is with the characteristics of low heat, low carbon content and high ash content. Dust concentration in the dust collector inlet is usually at about 80g/Nm^3 to 100g/Nm^3 or even higher, the summation of SiO_2 and Al_2O_3 is higher than 80%, the sulphur content is of about 0.5% and content of Na_2O and K_2O is less than the coal used in China. Thus, more than seven electric fields and specific collecting area over 200m^2/(m^3/s) will required if electrostatic precipitators are applied. In order to satisfy the requirements in India market, FEIDA has been started to provide ESP-FF hybrid dust collector for many projects of India Electric Industry from 2007.

2 The structure style of ESP-FF hybrid dust collector

ESP-FF hybrid dust collector can be divided into integrated type and separated type.

In the integrated type ESP area and FF area are arranged in one case, where the two areas are connected directly without separating in the flue gas flowing space. In this type, dust collector is separated into several passages, each chamber of which is set with exit damper. Meanwhile it's not separated in the dust and gas area that the whole dust collector including the ESP area is one part below the checkered plate, where has no passage and can not set the entrance damper for each chamber. The entrance of bypass duct is set in front of or on top of the ESP with the usual design of 50% of the boiler load for the gas volume. This type has the biggest advantage of simple duct and low resistance, but also obvious disadvantage. For example, it has to set insulation valves on the main passage when online maintenance is required, but only one passage(four passages in 600MW unit) not a separate chamber can be

insulated by the setting that the load of the boiler is affected largely. During maintenance, servicemen have to enter into the dust collector, where the temperature is high and air condition is poor. In addition, as the dust and gas area are not separated, the filter bag is still being affected by the high temperature flue gas, even opening the bypass duct.

In the separated type ESP area and FF area are connected by duct, and the FF area is a whole independent dust collector with several separated chambers. Each chamber in the separated type, which is designed with built-in bypass duct, is set with entrance damper and exit damper. This type has the advantages of easy maintenance and good security. For example, if a chamber is required to be maintained, the online maintenance can be operated by just closing the entrance and exit dampers of this chamber, what will make it insulated from flue gas. And servicemen can carry out the job in an open space with a better condition. As with a large number of chambers (there are more than 20 chambers in ESP-FF hybrid dust collector for 600MW unit), the impact of closing one chamber will be so slight that maintenance can be put into practice under full load of the boiler. Furthermore, since the set of built-in bypass duct, it can be realized that all of gas pass through the ESP area while not pass the FF area, which could make the filter bag not influenced by high temperature flue gas in case of boiler failed with gas of high-temperature, so as to ensure the security of the system. This setting can also provide a better protection to filter bag when firing the boiler. Meanwhile, as all the bypassing flue gas is guided to pass the ESP area, the emission will be in low dust concentration that the influence on the following facilities such as FGD and ID Fan will be small. The disadvantage of this type is that as a result of evenly distribute the flue gas to each individual chamber after passing through an electric field, there will be 100Pa ~ 200Pa resistance loss produced when the flue gas flowing through facilities such as guide plate and entrance damper.

3 Original design parameters and technical conditions of some typical power plants with 600MW units

3.1 Original design parameters and technical conditions of dust collector for A power plant 600MW unit

3.1.1 Boiler type and technical condition

The boiler is: subcritical, one reheat, forced circulation, suspension structure, balanced ventilation, dry bottom, all-steel frame, open layout drum boiler. The fuel used in the stage of boiler starts to 10% BMCR is light oil; combustion-supporting with heavy oil during low load operation, and the system output is 30% BMCR when using heavy oil. The boiler can burn steady on not higher than 40% BMCR without oil.

Table 1 Flue gas parameters and technical conditions

No.	Description (unit)	parameter
1	Flow volume of treated gas (m3/h)	4.02×10^6
2	Flue gas temperature (□)	126
3	Inlet dust concentration (g/Nm^3)	80.2
4	Outlet dust concentration (mg/Nm^3)	≤50
5	Equipment resistance (Pa)	≤1400

3.1.2 Coal quality and ash composition analysis

Table 2 Coal quality and ash composition analysis

No.	Description	Design Quantity%	Worst Quantity %
1	Carbon %	37.5	33.9
2	Hydrogen %	2.1	2
3	Oxygen %	5.6	5.06
4	Nitrogen %	0.9	0.84
5	Sulfur %	0.4	0.6
6	Ash %	41.6	43.9
7	Moisture %	11.9	13.7
8	GCV kCal/kg	3300	3000
	ASH ANALYSIS		
1	Moisture %	0.14	
2	Unburnt Carbon %	0.36	
3	SiO_2 %	54.9	59.6
4	Al_2O_3 %	25.4	30.75
5	Fe_2O_3 %	9.3	6.5
6	TiO_2 %	1.3	1.75
7	P_2O_5 %	0.1	0.47
8	K_2O %	0.3	0.27
9	CaO %	3.6	0.1
10	MgO %	1.8	0.08
11	Na_2O %	0.3	0.3
12	SO_3 %	2.3	0.03
13	Mn_3O_4 %	0.2	0.15

3.1.3 Dust resistivity

The Specific Resistance of ash given to you i.e.≥ $l0^{12}$ ohmcm can be presumed to be as that given at design flue gas exit temperature of the boiler (130 degC).

3.2 Original design parameters and technical conditions of dust collector for B power plant 600MW unit

3.2.1 Boiler type and technical condition

The boiler is: subcritical natural circulation, one intermediate reheat, single chamber, balanced ventilation, dry bottom pulverized coal boiler.

Table 3 Flue gas parameters and technical conditions

No.	Description (unit)	parameter
1	Flow volume of treated gas (m3/h)	3.36×10^6
2	Flue gas temperature (℃)	141
3	Inlet dust concentration ($g/Nm^{3)}$	77.33
4	Outlet dust concentration ($mg/Nm^{3)}$	≤40
5	Equipment resistance (Pa)	≤1400

3.2.2 Coal quality and ash composition analysis

Table 4 Coal quality and ash composition analysis

No.	Description	Design Quantity%	Worst Quantity %
	ULTIMATE ANALYSIS OF COAL		
1	Carbon %	38.0	31
2	Hydrogen %	3.3	3.2
3	Oxygen %	11.1	9.9
4	Nitrogen %	0.9	0.85
5	Sulfur %	0.6	0.55
6	Ash %	34.1	40
7	GCV kCal/kg	3800	3800
	ASH ANALYSIS		
1	Moisture %	0.14	

No.	Description	Design Quantity%	Worst Quantity %
	ULTIMATE ANALYSIS OF COAL		
2	Unburnt Carbon %	0.36	
3	SiO_2 %	48.58	54.58
4	Al_2O_3 %	21.14	25.21
5	Fe_2O_3 %	24.75	13.35
6	TiO_2 %	1.50	1.40
7	P_2O_5 %	0.61	0.32
8	CaO %	1.38	1.88
9	MgO %	1.73	2.03
10	SO_3 %	0.58	0.89

4 Model selection of ESP-FF hybrid dust collector

4.1 The structure style selection of ESP-FF hybrid dust collector

Because of the electric power shortage in the special market of India, once put into operation the dust collector will rarely to be stop or decrease the load. The integrated type can only be reconditioned in individual passage by decreasing the boiler to a low load, and once the flap door in front and back of the dust collector is not well sealed, the online maintenance may not be done. In addition, as the the coal complex, and the inlet dust concentration is changing, the phenomenon such as ash hopper clogging, boiler tube detonation, high temperature is more likely to happen. Thus, although the resistance of separated type is 200-300Pa higher than the integrated type, as the separated type has a built-in bypass system and online maintenance can be done at 100% boiler load, it is superior to the integrated type that separated type should be selected on new units. For the retrofit projects, the integrated type can be selected for the old casing or site limits.

4.2 The electric field number selection of ESP-FF hybrid dust collector

The basic idea of ESP-FF hybrid dust collector is that the front ESP collects most of the rough dust to reduce the dust content in the gas and then use the FF to collect the left fine dust to reach the discharging standard.

The inlet dust concentration of Indian coal is generally at 80g/Nm3～100g/Nm3, which is 2~3 times higher than the coal used in China. Added the inlet dust concentration is variety, it is normal that ash hopper clogging is of common occurrence, which makes the electric field lose efficacy, especially frequently occurs in the first electric field. From the ESP-FF hybrid dust collector practical operation of FEIDA, the ESP-FF hybrid dust collector applied in Indian should be of three electric fields, or at least two electric fields, to ensure the resistance of dust collector in the scope of design value.

5 The design parameters and using effects of ESP-FF hybrid dust collector

Table 5 Design parameters and using effects of ESP-FF hybrid dust collector

Description (unit)	Parameter	
	Plant A	Plant B
Flow volume (m^3/h)	4.02×10^6	3.36×10^6
Temperature (℃)	126	141
Inlet dust concentration ($g/Nm^{3)}$	80.2	77.33
Electric field number	2	3
SCA $m^2/$（m^3/s）	25	80.33
Filter velocity (m/min)	1.05	1.1
Filter material	PPS/PPS	PPS/PPS

Outlet dust concentration (mg/Nm^3)	≤50	≤40
Equipment resistance (Pa)	≤1400	≤1400

The first ESP-FF hybrid dust collector supplied by FEIDA for the 600MW unit was put into operated in November 2010, and taken the performance test after 8 months after operation, with the outlet discharge concentration of 19.6mg/Nm^3, the equipment resistance of 1200Pa, met the requirements specified in the contract rule that outlet discharge concentration lower than 50mg/Nm^3 and the equipment resistance lower than1400Pa. The above collector is still in good operating condition nowadays without phenomenon of bag broken.

6 Conclusion and recommendation

1) Although the ESP had been used widely in the India electric power industry before 2007, the ESP-FF hybrid dust collector is also a correct selection with the enhancing of outlet emission standard.

2) There still are misgivings for whether the ESP-FF hybrid dust collector successfully using in India, while, on the basis of the practical operation, the ESP-FF hybrid dust collector fits the India market.

3) The ESP-FF hybrid dust collector with three electricity fields should be selected because of the bad coal quality and high inlet dust concentration.