Application of Electrostatic Fabric Hybrid Particulate Collector

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Abstract: This paper introduced several examples of electrostatic fabric hybrid particulate collector (EFPC), and discussed their advantages and shortcomings. In addition, the suitable application conditions for the use of EFHDC are presented.

Keywords: EFPC, COHPAC, Fabric filter

1 INTRODUCTION

Electrostatic precipitator (ESP) has been used for several decades in the power industry of China. The basic theory of the ESP is that the particulates are charged when passing through the high electrostatic fields of the ESP. Under the high electrostatic field, the charged particulates are moving toward the collecting plate and settle on it. The ESP has the advantages of low pressure drop and long running life. However, the performance of ESP will be greatly influenced by the composition of fly ash. Consequently, the dust emission cannot be easily reduced to be less than 50 mg/Nm^3.

The fabric filter (FF) is a dust collector by filtration, and has the advantages of high efficiency. In addition, the collection efficiency will not affected by the composition of fly ash, and the dust emission is usually less than 50 mg/Nm^3. ESP is the main precipitator in coal-fired plants of China, but coal-fired plants began to use FF after the new dust emission standard for coal-fired plant come into force from 2004.

There are two main types of EFPC, one is the Compact Hybrid Particulate Collector (COHPAC) developed by the Electric Power Research Institute of America (EPRI), and the industrial application of COHPAC was realized by the Hamon Rasearch-Cottrell Company. The other is the advanced hybrid particulate collector (AHPC) developed by the University of North Dakota, Energy and Environmental Research Center of America. COHPAC has two types: separated type (COHPAC I) and integrated type (COHPAC II). Compared to the COHPAC, the AHPC has a complicate structure, and the gas flow goes through the porous collecting plate first and then through the fabric filter.

In China, the EFPC used in power plants are similar to COHPAC type. Zhejiang Feida Environmental Science & Technology Ltd. has installed several separated and integrated type of EFPC. For the integrated type, the biggest one is used for a 200MW unit in the Baotou Power Plant. For the separated type, the biggest one is used for a coal-fired 210 MW unit located in the Guangzhou Jiulong paper industry plant. In Tianjing Chentang Power Plant, the EFPC is an integrative type, and the emission mass concentration of particulates is only 3 mg/Nm^3. In 2007, Feida contracted with Jharsuguda Power Plant of Indian to install EFPC on downstream of 6×600 MW Unit.

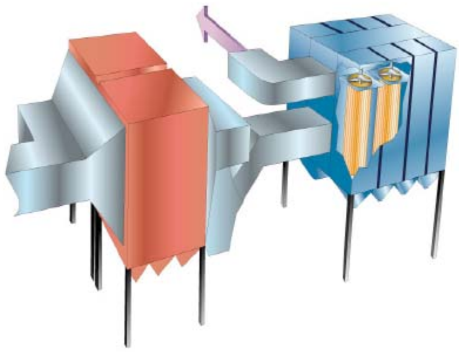

Fig. 1 COPHPAC I

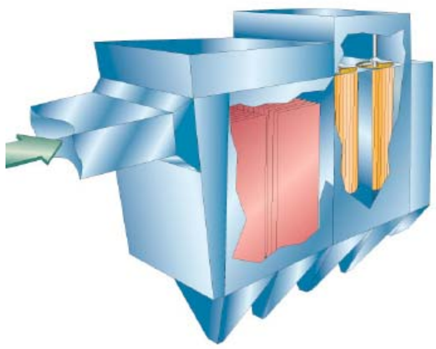

Fig. 2 COHPAC II

2 APPLICATION OF EFPC

2.1 Application Of COHPAC in America

In order to meet the strict emission standard, Two COHPAC type of 575 MW boilers ESP-FF hybrid precipitators were installed in the Big Brown power plant of America. The FF was directly installed on downstream of the hot-side of ESP, and the Schematic diagram of the COHPAC as shown in Fig. 3. One boiler is equipped with four fabric filters and each FF has 8 filter chambers. The main design parameters of FF in COHPAC are as follows:

The inlet particulate concentration: 1 g/Nm^3 (given the efficiency of ESP is 98%)

Velocity of filtration: 4.2 m/min (when one chamber is in off-line clearing)

Pressure drop: < 2120 Pa (compared between the inlet and outlet flange)

Filter: 2.7 D Ryton fibre, 610 g/m^2 needle felt, Singed both sides

This is the first commercial example of the COHPAC, and two COHPAC operated in 1995 and 1996, respectively. But the pressure drop exceeds that of the designed and the life of the filter bags is less than 1.5 year. One of the reasons is that the difference in coal composition leads to the low collecting efficiency of ESP and the inlet particulates concentration exceeds the designed concentration. The other reason is that the filtration velocity is too high. Latter, the PPS fiber was changed from 2.7 D to 6 D and operated for 22 months, the pressure drop was about 1750 Pa–2000 Pa Almost half of the filter bags were broken. Though the pressure drop decreases compared with the designed, but it is still not accepted by the consumers in China due to the short operation time.

The second example of the COHPAC is in the E.C.Gaston power plant of America. The COHPAC installed after two 270 MW unit capacity and operated in 1996 and 1999, respectively. In 2003, the experiments of common filter and the high permeability filter were conducted for 6 months on the third boiler. The results show that the pressure drop of the high permeability filter is dramatically less than that of the common filter. The practical pressure drop is 1870 Pa, and the service time of the fabric bags is about 5 years. The main design parameters of FF in COHPAC are as follows:

Filtration Velocity: 2.58 m/min (the efficiency of ESP is 98%)

The inlet particulates concentration: 200 mg/Nm^3

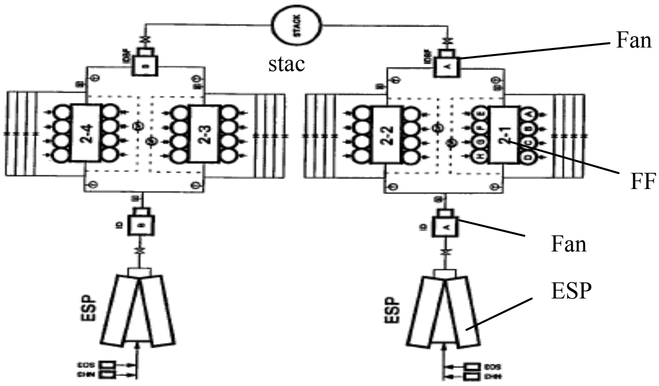

Fig. 3 Schimatic Diagram of COHPAC

2.2 Application of COHPAC in China

2.2.1 Zhejiang Juhong Coal-fired Power Plant with 135 MW

In 2006, Zhejiang Feida Environmental Science & Technology Company installed a desulphurization and dust collection system, downstream of the #9 boiler 400 t/h of Zhejiang Juhong Thermal Power Plant. This system is the NID (new integrated desulphurization) semi-dry desulphurization process and LKP fabric filter. In front of the desulphurization system, additional ESP was used to pre-dust remove. It is a EFPC which similar to COHPAC I type when the desulphurization stops running. The main designed parameters as follows:

The inlet gas flow: 800000 m^3/h

Gas temperature: 150 □

Particulate concentration: 30 g/Nm^3 (1500 g/Nm^3 with the desulphurization on)

Area of the filter bags: 13580 m^2

Filter: PPS needle felt, PTFE dipping treatment

The inlet particulate concentration of FF is up to 1500 g/Nm^3 with the desulphurization running, but the FF operates well. The pressure drop is about 1600 Pa, and the emission particulate concentration is 28.6 mg/Nm^3. After running for one year, when the desulphurization system stops running, the emission particulate concentration is 20 mg/Nm^3. The pressure drop is less than 1100 Pa and the period clearing time exceeds 2 hours.

2.2.2 Dongguang Jiulong Paper Industry Coal-fired Plant 210 MW

The same type of EFPC was installed in Dongguang Jiulong paper industry coal-fired plant. The main designed parameters are as follows:

The inlet gas flow: 1600000 m^3/h

Gas temperature: 145 □

Particulate concentration: 30 g/Nm^3

Area of the filter bags: 30500 m^2

Filter: PPS needle felt, PTFE intrinsic coating treatment

This system was constructed in August of 2005. With the desulphurization running, the pressure drop is less than 1500 Pa, and the emission particulate concentration is 35 mg/Nm^3. When the desulphurization system stops running, the pressure drop is less than 1000 Pa, and emission particulate concentration is less than 20 mg/Nm^3.

2.2.3 Tianjing Chentang Coal-Fired Plant 50 MW Unit Capacity

In Tianjing Chentang Power Plant 50 MW, a three-fields ESP was rebuilt to an ESP-FF hybrid precipitator. The first-field was used as pre-dust remove precipitator, and the other fields were changed to the fabric filter precipitators. The main design parameters (desulphurization stops running) are as follows:

The inlet gas flow: 500000 m^3/h

Gas temperature: 145

Particulate concentration: 30 g/Nm^3 (550 g/Nm^3 with the desulphurization on)

Area of the filter bags: 30500 m^2

Filter: PPS needle felt, PTFE intrinsic coating treatment

This EFPC operated in 2006. The Tianjin Environmental Protection Bureau measured the emission concentration for 6 times in two days. The dust concentration of the outlet is 1.9 mg/Nm^3–2.4 mg/Nm^3 with the desulphurization on, and 2.1 mg/Nm^3 on average. The pressure drop of the EFPC is less than 1000 Pa, and the performance of the precipitator was appreciated by the user.

3 SUITABLE CONDITIONS FOR EFPC

The advantages of EFPC are low dust load in the fabric filter, low pressure drop and long cleaning period. Recently, some retrofit projects of old power plants and some new power plant projects used the EFPC in China. But any particulate collector has its limitations. In order to choose the suitable particulate collector, the suitable conditions, the economy and the operation of the EFPC are discussed as follows.

3.1 Costs of Precipitator

Compared with the fabric filter, the EFPCr has additional ESP costs. But increasing the filtration velocity of the fabric filter is saving the costs to some extend. In the retrofit projects, the first one or two fields of the ESP can be used as the pre-dust removing precipitator and the costs of the ESP parts can be saved.

From the experience of overseas, the designed velocity in the fabric filter of COHPAC is 1.8 m/s in the latest project in 2000. But the prerequisite of this design velocity is that the low dust load (less than 1 g/Nm^3) and high pressure drop (higher than 2000 Pa). In China, the fabric filter is usually added to the back of the ESP first field. But in America, the fabric filter is added to a whole ESP in the COHPAC. For this reason, the inlet dust concentration is very low in the fabric filter of COHPAC. For example, the inlet dust concentration is less than 0.2 g/m^3 in E. C. Gaston Power Plant. A critical problem of this CPHPAC is that the fabric filter is sensitive to the inlet dust concentration. A small increase in the inlet dust concentration can cause great pressure drop, and even cause the whole project stop running.

Usually, the design filtration velocity of FF in the EFPC is 1.2 m/min in China. At this filtration velocity, the costs of apparatus and the running cost of the EFPC are higher than that of the normal fabric filter. Increasing the filtration velocity is one of the main methods to save costs of the EFPC. But the pressure drop will increase with increasing of the filtration velocity, at the same cleaning period. Therefore, it is very important to find the balance between the apparatus costs and the apparatus performance.

3.2 Management of Precipitator

The EFPC has two types of dust collection apparatus (ESP and FF) which have different dust collecting theories and structures. Therefore, the maintenance of the EFPC is more complicated than ESP or FF. When repairing the ESP, the pressure drop of the fabric filter will increase. The trend of this influence increases with the increasing filtration velocity of fabric filter.

In view of the integrative type of EFPC, the precipitator cannot be maintaining by stopping one chamber. At least one line of gas flow of ESP must be switched when the FF is in maintenance. In addition, construction of the bypass gas flow duct is difficult in the integrative EFPC. In contrast, the FF in the separated type of EFPC can be maintained on line. But the apparatus costs higher and need more areas.

4 CONCLUTIONS

The EFPC has many advantages, but there are still some limitations, hich need further study on. In the retrofit projects, the EFPCr has evident advantages. But in the new construction projects, the costs of apparatus and operation of the integrative type of EFPC are higher than that of FF, and the difficulty of maintenance is also higher than that of FF. While the separated type of EFPC need more apparatus costs and areas. Therefore, the selection of what kind of dust collector should be considerated carefully according to the actual conditions of the power plant.

REFERENCES

1. Richard Miller etc., Effective use of both COHPACTM and TOXECONTM the “technology of the future” for particulate and mercury control on coal-fired boilers, International Power-Gen Conference, 2003.
2. Jean Bustard etc., TXU Big Brown COHPAC Performance Improvement with High Permeability Fabric, US EPA/DOE/EPRI Combined Power Plant Air Pollutant Control Symposium, 2001.
3. Jens Madsen and David Schowalter, Flow modeling design optimization of an advanced hybridTM particulate collector, Clearwater Coal Technology Conference, 2006.