# Collection of High Concentrations of Desulfurized Dust with ESP & FF

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**Abstract:** The application experience for electric static precipitator (ESP) or fabric filter (FF) fitted in 200 MW dry/semi-dry FGD system is introduced. The flexibility, invest and maintenance cost for these two kinds dust collector are generally compared when they are collecting high concentration desulphurization dust. The suggestion of how to choose desulphurization and dust collecting technics for the environmental protection are provided.

**Keywords:** ESP/ FF flexibility

## 1 INTRODUCTION

Nowadays, about 15% of flue gas desulphurization market is occupied by dry and semi-dry technics. The ESP was often used after flue gas desulphurization system in the project of new building, expansion and reformation before 2005, for example, the de-dusting system adopted after semi-dry flue gas desulphurization in Baotou power plant (200 WM) and Jinmen power plant (200 WM) were four-fields ESP which successfully achieving to contract requirements and national standards. With the enhancement of environmental protection requirements, lower and steady dust emission will be the policy trend. Therefore, the type of ESP should be considered from the view of invest and operation and maintenance cost, for example, FF de-dust system was used in Jiaozuo power plant (200 MW) and Jiulong paper mill (210 MW) after flue gas desulphurization. It is necessary to study how to choose reasonable de-dusting system after flue gas desulphurization.

## 2 ESP

Semi-dry technology which is characterized with gas circulating is one of the main flue gas desulphurization technics in china. How to collect high concentration and viscosity of dust effectively and economically is an important subject. Due to the innovation of ESP, it was often adopted after flue gas desulphurization after 2001. The excellent operation effects indicating the collection of high concentration of dust with ESP is technical feasibility.

Typical parameters for outlet of flue gas desulphurization are as following: 8%-12% of humidity (by volume), 1500 g/Nm$^3$ of concentration. In order to comprehensive utilize fly ash, pre-dedust system is often equipped before flue gas desulphurization. The parameters of physic-chemical property of pre-dedust outlet are as following: higher viscosity compared with fly ash from boiler, 1%-2.5% of humidity, 600 g/Nm$^3$-1000 g/Nm$^3$ of bulk density, 25μm of median pore diameters. Innovating ESP configuration, power source and polar matching are thought to be the effective way to treat high concentration and viscous of dust. The key factors in high concentration and viscosity of dust collection are including: how to sufficiently charge the dust, how to enhance the de-dust efficiency and how to collect super fine particles effectively.

## 3 FF

The application of FF dedust system in coal power plant is not always smooth in china. Along with development of filter material and maintenance technology, the application of FF dedust system in coal power plant is in benign starting stage. Common FF dedust system in domestic market are including: pulse spraying type FF, rotary pulsed type FF and reverse blow FF.

One of the main FF dedust technology applied in china is LKPN type which is a medium pressure pulse spraying type FF aiming to treat high concentration of dust and designed by ALSTOM company. The properties of LKPN type FF are as following: (1) settling chamber is designed in the inlet of FF to lower concentration of dust. (2) A full flow bypass is equipped in internal to limit the gas temperature and gas humidity. (3) The gas stream is rectified two times in the system to ensure the gas stream distribute evenly and not directly impact on surface of filter. (4) The dust collected on FF is evenly and moderately cleaned by medium pressure (0.3 MPa-0.5 Mpa) and medium flow pulsed blowing technology which is composed of OPTIPOW pulse valve and flow balanced tube.

The filter material is usually PPS which has properties of high temperature resistance, hydrolysis resistance and acid/alkali resistance. The PTFE based PPS is treated through the processes of singeing, waterproof and oil-proof and has widely successful experience and high performance price ration on collecting dust after semi-dry flue gas desulphurization. The air door is equipped on the inlet and outlet of every filter chamber. The inlet air door is designed to on-line inspect and repair filter chamber, but the set will enhance invests and increase fault sources. In contrast to inlet air door of single dust collector situation, the air door is economically equipped on partial flue for multi dust collector. Fault dust collectors are inspected and repaired by lowering boiler load and closing part of air doors.

## 4 COMPARISON OF TYPICAL APPLICATION PROJECTS

**Case 1**: The Jiulong paper mill (Guangdong, 210 MW) adopts FF as dust collector after circular and semi-dry process flue gas desulphurization. These FF is developed by ALSTOM Company with impulse injection and its bag filter is made by PTFE based PPS with sewing technology. This is the first large scale project which equips FF after gas desulphurization system in china. The project is accomplished and handed over to paper mill in December 2005.

**Case 2**: Second stage 2×300 MW unit extension project in Baotou second thermal power plant adopts 4-fields ESP as dust collector after circular and semi-dry process flue gas desulphurization. The project is accomplished and handed over to power plant in Jun 2005.

A single-field ESP which is neglected in comparison is set before desulphurization system in above two cases. That is to say, the parameters listed in Table 1.only consider the inlet and outlet of dust collector which is set after flue gas desulphurization system.

**Table 1** Comparison of design and operation parameters of FF and ESP in 200 WM unit

| | | | Jiulong paper mill 210 MW | | Baotou thermal power plant 200 MW | |
|---|---|---|---|---|---|---|
| No | Parameter | Units | Design value | Operation value | Design value | Operation value |
| 1 | Inlet concentration | $m^3$/h ($10^4$) | 112.4 | 115 (87% load) | 133.23 | 161.73 |
| 2 | Inlet concentration | g/$Nm^3$ | 35.52 | 32 | 30.38 | 13.48 |
| 4 | Emission concentration | mg/$Nm^3$ | 50 | 49.3 | 100 | 79.73 |
| 5 | Inlet gas temperature | □ | 137 | 130-150 | 130 | 132 |
| 6 | Outlet gas temperature | □ | 78 | 70 | 75 | 79 |
| 7 | Drop pressure of gas desulphurization and dust collector | Pa | 3800 | 3000-3800 | 1500 | 1528 |
| 8 | Air leakage rate of gas desulphurization and dust collector | % | 4.5 | 3.8 | 4.5 | 3.14 |
| 9 | Power consumption of desulphurization and dust collector | KW | 462 | 456 | 1852 | 1845 |
| 10 | Power consumption of fan | KW | 2454 | 2561 | 2043 | 2490 |
| 11 | Power consumption of air compressor* | KW | 197 | 176 | | |
| 12 | Land occupation (L×W) | m×m | 26.8×14 | | 40×23.6 | |
| 13 | Power consumption of secondary dust collector | Kw | | | 1258 | 1150 |
| 14 | Invest | million | About 14,04 | | About 12,02 | |

Notes: 1. "*" indicates the power consumption which excluding ash transportation.

2. Operation time of dust collector: 6500 hr/year.

## 5 COMPREHENSIVE ANALYSIS ON PERFORMANCE OF FF &ESP

ESP and FF have their own advantages. ESP is a high efficiency and widely application dust collector, whereas FF is able to remove super fine particles and unaffected by specific resistance.

### 5.1 Adaptability to composition of flue gas and dust property

The ESP has advantages of huge capacity to treat flue gas, high temperature ($\leq$500 □),high pressure and high humidity operating environment, low drop pressure and may automatic controlled by PC. Also, the ESP has some disadvantages like easily affected by dust property, collection efficiency can not be enhanced obviously by optimization and need some modification in order to adapt higher environmental protection standards.

The FF can remove super fine particles and its collection efficiency is not affected by dust specific resistance. Sustainable low concentration emission, off-line maintenance and small land occupation can also be realized by FF.

However, FF dedust system has some disadvantages, for example, to remove oil mist, water mist and high viscosity of dust, the filter material must take oil-proof treatment, waterproof treatment, and PTFE film covering respectively. To avoid bag sticking (typically caused by dewing) in treating high relative humidity of flue gas, the filter material should have the property of hydrolysis resistance and take some insulation measurements. When cleaning high temperature (≥220 □), corrosive and high $O_2$ content (≥9%) gas, the filter material should take some insulation, anti-corrosion and antioxidant measurements respectively.

### 5.2 Adaptability to environmental protection standards

The ESP is the first choice from the view of economical and technical feasibility for wet gas desulphurization. For new building and expansion power plant which dose not need gas desulphurization according to environmental capacity, the four or five fields ESP is still a mainstream technology. However, on a long view, the steady and low emission of FF is more adapt to the changing of environmental protection policy. Although the maintenance and operation cost are high, the FF is a reasonable technology to treat high specific resistance of dust.

### 5.3 Initial invests

ESP technology in china has small gap to international level and has largest application scope all over the world. For FF dedust system, due to the backward technics of filter material, its quality and property are far from international level. Although the home made filter material is relative inexpensive, the import filter materials are often applied in large scale gas desulphurization project. Hence, the costs of FF are usually 20% higher than ESP with the same dedust scale. Initial invest of FF and ESP for 200 WM units are compared in Table 2.

### 5.4 Maintenance and Operation cost

The Maintenance and Operation cost of ESP are including the power consumption in transformer, flap system, electric heating of ash bucket and overcoming operation resistance of ESP (200 Pa-300 Pa). However, the operation costs for FF are mainly power consumption in compressor and overcoming operation resistance of FF (1500 Pa-2000 Pa). Maintenance and Operation cost of FF and ESP for 200 WM units are listed in Table 3.

## 6 CONCLUSIONS AND SUGGESTIONS

ESP is a high efficiency dust collector, thus it is still an important technology in present and future dust removal industry. Due to the advantages of low and steady emission and unaffected by dust property, the FF will occupy larger market share of atmospheric environment protection in a near future. The collection of high concentration desulphurization dust can be summarized as following:

(1) It is technically feasible to collect high concentration (1500 g/Nm$^3$) dust for ESP after innovating power source and control system. But it has many restrictive factors for 4-fields ESP to ensure 50 mg/Nm$^3$ emission which is also unsteady.

(2) The FF can remove super fine particles and its collection efficiency is not affected by dust property. Sustainable low concentration emission, off-line maintenance and small land occupation can also be realized by FF. That is to say, the FF is more suitable to remove high concentration of desulphurization dust. But FF dedust system have some restrictive factors, such as relative humidity, $O_2$ et al.

(3) The initial invest of FF is about 15% higher than ESP for the same scale power unit. Given FF and ESP need overhauling every 4 years, their maintenance and operation cost are almost same. If poor filter material or low life service filter bag is used, the total maintenance and operation cost of FF will about 10% higher than ESP.

**Table 2** Initial invest of FF and ESP for 200WM units

| No | Name | Invest (million yuan) | | No | Name | Invest (million yuan) |
|---|---|---|---|---|---|---|
| | | Home made | Import | | | |
| 1 | Filter material | 5.4 | | 1 | Positive electrode system | 8.05 |
| 2 | cylinder mould spiders | 1.3 | 1.3 | 2 | Negative electrode system | |
| 3 | Blowing | 0.2 | 0.2 | 3 | Flap system | |
| 4 | Blowing valve | 0.65 | 0.65 | 4 | Body structure | |
| 5 | Body structure | 3.2 | 3.2 | 5 | Transformer and motor | 2.5 |
| 6 | Gas Source System | 2 | 2 | 6 | System Control | |
| 7 | Insulation | 0.3 | 0.3 | 7 | Insulation | 0.43 |
| 8 | Steel support | 0.7 | 0.7 | 8 | Steel support | 1.02 |
| 9 | Inspection door | 0.05 | 0.05 | 9 | Material level measurer | 0.02 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | Steam cylinder | 0.19 | 0.19 | | | |
| 11 | Sealing Fan et al | 0.05 | 0.05 | | | |
| Total invest | | 14.04 | | Total invest | | 12.02 |

**Table 3** Maintenance and Operation cost of FF and ESP for 200 WM units

| FF | | | | ESP (4Fields) | | | |
|---|---|---|---|---|---|---|---|
| No | Item | Power consumption /year | Maintenance & Operation cost/year (million yuan) | No | Item | Power consumption /year | Maintenance and Operation cost/year (million yuan) |
| 1 | Compressor | 1.144 Million KWh | 0.57 | 1 | Power source | 7.5725 million KWh | 3.78 |
| 2 | Air door | negligible | negligible | 2 | Flap system | 0.038 million KWh | 0.019 |
| 3 | Fan and electric heating of ash bucket | 0.364 million KWh | 0.18 | 3 | Electric heating of ash bucket | 1.456 million KWh | 0.72 |
| 4 | Overcoming operation resistance | 4.5825 million KWh | 2.29 | 4 | Overcoming operation resistance | 0.687 million KWh | 0.34 |
| 5 | Maintenance cost in 1st year | | 0.06 | 5 | Maintenance cost in 1st year | | |
| 6 | Maintenance cost in 2nd year | | 0.12 | 6 | Maintenance cost in 2nd year | | / |
| 7 | Maintenance cost in 3rd year | | 0.18 | 7 | Maintenance cost in 3rd year | | / |
| 8 | Maintenance cost in 4th year | | 5.4 | 8 | Maintenance cost in 4th year | | 0.45 |
| 9 | Pre-spraying medium | | 0.108 | | | | |
| Total cost in 4years (million yuan)=(1+2+3+4)×4+5+6+7+8+9 | | 18.044 | | Total cost in 4years (million yuan)=(1+2+3+4)×4+5+6+7+8 | | 19.956 | |

Notes: the units price of electrical consumption and steel in table 4. are 0.5 yuan/kWh and 6800 yuan/ton respectively. The operation time is 6500 hr/a.