Study of Using Mixed Discharge Electrodes and Mixed Spacing of Pole to Pole for Electrostatic Precipitator

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Abstract: In order to increase the collecting efficiency of ESP and to meet requirements of saving energy and reducing emission, the new ESP design technology, according to the need of high efficient operation, is proposed under the full consideration of coal component and content, ash chemical component and content. Namely, use this technology of mixed wires and mixed same–polar distance for ESP. Through several years' operation, the present technology by approved is good and its performance is good, reliable and stable.

Keywords: Chemical component, Mixed wire, Mixed spacing of pole to pole, Collecting efficiency

1 INTRODUCTION

At present, most of ESPs for coal fired boilers have been adopted by power stations, its main merits are that there are the smaller operation resistance, the longer using life, the lower maintenance cost and the higher bearing high-temperature performance. However, the coal qualities and boiler conditions are the big influence on performance of ESP. When the coals are changed for boiler, the collecting efficiency will be subjected to serious effects due to the changes of boiler fly-ash performance and the changes of particle resistivity and its size etc. After, especially issuing the "emission standard of atmosphere pollutant for coal fired power plants"(GB13233－2003), more and more serious emissions standards were stipulated by state for dust emissions in different period of time, among that the highest emissions at third time period is under 50mg/Nm3. If hitting this requirement, the most operating ESPs should need to carry out the retrofit so as to increase the efficiency of ESPs such as the ESPs of boilers firing the special coals, of CFB boilers and flue gas process after FGD etc., like this, the conventional technologies of ESPs could already not meet the requirements for collecting efficiency of special conditions, therefore, the new technique research, optimizing design and testing selecting technology for ESPs are imperative under the situation, so using the mixed discharge electrodes and mixed spacing of pole to pole for electrostatic precipitator is a new direction of developing ESP' technologies.

2 COAL AND ITS ASH FEATURES FOR COAL FIRED POWER PLANTS

Although, the ESP is the high effective equipment, it is often subjected to the effect of physicals and chemicals characteristics from dusts collected, which are as follows:

1. Low sulfur content, there are only 0.2–0.3 for most coal in power stations. In national standard, if the sulfur content from coal is lower than 1.5%, it belongs to low sulfur coal. When a coal has the high sulfur content, the conductivity of dusts may be increased and it can have the conditioning action for dusts with high resistivity that can rise the collecting efficiency of ESP. When the sulfur content is lower than 1%, the gas conditioning action almost zero

2. The AL_2O_3 content in dusts, according to national standard, should not exceed the 50%, but AL_2O_3 content in some of coals is up to 55.66%. The ratio of true specific gravity for this kind of ash to volume specific gravity has the big difference, exceeding the 1: 10 and the melting point of AL_2O_3 is 2100□, therefore, this is a difficult coal with high melting point, high resistivity, light gravity, fine particulates and large viscosity to cause the charging difficulty and dusts re–entrainment as well as back corona, it is adverse to the dusts collection for ESP.

3. The sum of contents for SiO_2, AL_2O_3, Fe_2O_3, CaO in the dusts is too big and the some over 90%. Tests indicate that when this value reaches the 90%, the collecting efficiency will be subjected to great influence. CaO in dusts is such an ash which has the high resistivity, difficult charging, light gravity, fine particulate and big viscosity as well as uneasy rapping from collecting plate and causing easily back corona.

4. The resistivity of dusts is higher. When flue gas temperature is up to 120□, the resistivity can hit $n\times10^{11}\Omega\cdot cm$—$10^{13}\Omega\cdot cm$. Meanwhile, the collecting efficiency is reduced due to back corona.

5. Content of K_2O andNa_2O in fly-ash is lower. K_2O is as with Na_2O, has the conductive action, but it is a little weak comparing with Na_2O. The content of Na_2O in dusts is 0.22%–1.8% and the content of K_2O 0.12%3.2% .

3 BASIC PRINCIPLE

The basic principle of mixed wires and mixed pole spacing is as follow: in order to reach the collecting efficiency, 4 or 5 fields, in general, should be adopted, aiming to the coal performance and ash feature, and each field should use the mixed wires and mixed spacing. The wires with good discharge performance should place in the field 1 and 2, this is because the field 1 and 2 have the higher dusts concentration, and when dusts enter into the ESP from ductwork, the dusts can be fully charged quickly. More often than not, the new type wide saw wires with the same pole spacing of 300 mm–420 mm are chosen in field 1 and 2, and it is not only a good discharge performance, but also has the more discharge orientation, strong electric wind and avoidance of the corona dead area, so it excels other type of wires under the high dust concentration condition. For the third field, because the dust concentration is comparatively low, the wires with good performance also are needed for fully and rapidly charging. So, the integral tube type thorn wires or wide saw wires with spacing of 400 mm–420 mm were selected in field 3, it has the good discharge performance, strong electric wind and avoidance of the corona dead area and excel the other type of wires, and the dusts can be fully charged under the high gas velocity. For field 4 and field 5, the fishbone wires plus auxiliary electrodes with spacing of 440 mm–500 mm and the two rows of channel plates with the maze type are selected, which can effectively reduce the dusts re-entrainment.

4 APPLICATION STATUS OF MIXED WIRES AND MIXED SPACING OF POLE TO POLE

Recent years, the present technology, aiming to the feature of coal in coal fired power station, has been used for tens of boilers for A power station (135 MW), B power station (330 MW) and C power station (660 MW) and obtains the good experiences, for example:

Table 1 Coal performance analysis for A (135 MW unit)

Name	Unit	Design coal
C content received	%	51.76
H content received	%	3.33
O content received	%	3.99
N content received	%	0.82
S content received	%	0.23
Ash content received	%	34.45
Water content received	%	—
Water(dry base) received	%	0.59
Volatile content(non dusts base)	%	29.77
Heat quantity for low line	MJ/kg)	20.94
Grindability index	—	89

Table 2 Ash component analysis for A (135 MW unit)

Name	Unit	Design coal
SiO_2	%	54.8
Al_2O_3	%	24.9
Fe_2O_3	%	9.4
TiO_2	%	0.94
SO_3	%	0.82
CaO	%	6.28
MgO	%	0.98
K_2O	%	0.47
Na_2O	%	0.22
MnO_2	%	0.064

Table 3 Fly-ash resistivity analysis for A (135 MW unit)

Test temperature		Design coal
26.5 ℃	Ω•cm	8.77×10^{9}
100 ℃		6.33×10^{11}
120 ℃		2.14×10^{12}
150 ℃		4.54×10^{12}
180 ℃		2.86×10^{12}

Table 4 Coal (Zhungeer) performance analysis for B (330 MW unit)

Name	Unit	Design coal
C content received	%	43.21
H content received	%	3.42
O content received	%	10.55
N content received	%	0.69
S content received	%	0.43
Ash content received	%	31.7
Water content received	%	10.0
Water(dry base) received	%	2.94
Volatile content(non dusts base)	%	40.87
Heat quantity for low line	MJ/kg)	16.294
Grindability index		

Table 5 Ash component analysis for B (330 MW unit)

Name	Unit	Design coal
SiO_2	%	38.22
Al_2O_3	%	51.72
Fe_2O_3	%	1.38
TiO_2	%	1.30
SO_3	%	1.75
CaO	%	1.36
MgO	%	0.23
K_2O	%	0.43
Na_2O	%	0.02
MnO_2	%	—

Table 6 Fly-ash resistivity analysis for B (330 MW unit)

Test temperature		Design coal
18 ℃	Ω•cm	4.5×10^{12}
100 ℃		9.4×10^{12}
120 ℃		4.00×10^{13}
150 ℃		6.5×10^{13}
180 ℃		1.20×10^{13}

Table 7 Coal (Zhungeer) performance analysis for C(660 MW unit)

Name	Unit	Design coal
C content received	%	58.11
H content received	%	3.39
O content received	%	9.74
N content received	%	0.92
S content received	%	0.45

Ash content received	%	17.79
Water content received	%	9.60
Water(dry base) received	%	—
Volatile content(non dusts base)	%	27.13
Heat quantity for low line	MJ/kg	22.06

Table 8 Ash component analysis for C (660 MW unit)

Name	Unit	Design coal
SiO_2	%	40.63
Al_2O_3	%	41.28
Fe_2O_3	%	7.69
TiO_2	%	0.57
SO_3	%	0.32
CaO	%	2.35
MgO	%	4.00
K_2O	%	0.82
Na_2O	%	0.16
MnO_2	%	—

Table 9 Fly-ash resistivity analysis for C (660MW unit)

Test temperature		Design coal
18 ℃	Ω•cm	4.3×10^{11}
100 ℃		2.4×10^{11}
120 ℃		1.5×10^{12}
150 ℃		1.7×10^{12}
180 ℃		2.8×10^{11}

Table 10 The parameters table of mixed wires configuration and spacing of pole to pole for A, B and C power stations

Name	A power plant	B power plant	C power plant
Field 1 Wires Spacing mm	J 410	J 304	J 410
Field 2 wires Spacing mm	J 410	J 304	J 410
Field 3 Wires Spacing mm	Yf 500	Rs 400	J 410
Field 4 wires Spacing mm	Yf 500	Yf 451	Yf 448
Field 5 Wires Spacing mm		—	Yf 448
SCA m^2/m^3sec	82.36	118.57	112.17
Efficiency %	99.4	99.7	99.77

Notes: J – wide saw wires
RS– integral tube type thorn wires
Yf– fishbone plus auxiliary electrodes

5 DEVELOPING DIRECTION

At present, the coal fired power plants also take the ESPs as the main equipments for collecting dusts, but, with the increase of national environmental standard, the technologies for ESP itself must updated. Firstly, technologies of ESP should be suitable for the collection of over-fine, over-light and high aluminum dusts, then solve the charging problems for these kind of dusts. And that the application of new type mixed wire and mixed spacing technology plus the electric control unit developed recently can effectively settle these problems, it is possible for ESP efficiency to hit over 99.9%.

6 CONCLUSIONS

1) It is the effective approach for ESP using technology of mixed wires and mixed spacing to increase the collecting efficiency.
2) Aiming to the concentration of dust content and performance of physical and chemical of dusts, the retrofit for existing ESPs by using this technology can be done, it can raise the collecting efficiency of ESP.
3) If using this kind of technology, the conception for using single sort wire and spacing will be changed, it is conducive to the development of high effective and low consumption for ESP.

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