Applying the Technology of Compounded Type Power Control Rapping to Reduce the Outlet Emission Concentration

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Abstract: This paper discusses the development and application of the technology of compounded type power control rapping, introduces the two basic parts of the technology: high and low voltage related mode power-off rapping and enhanced type timing power-off rapping, and analyzes the effect of the technology of compounded type power control rapping in the aspect of reducing the outlet flue dust emission concentration with the project rebuilding instances.

Keywords: rapping, power control rapping, power-off rapping

1 INTRODUCTION

As is well known, electrostatic precipitator (ESP) is a kind of high efficient equipment that can collect, recover dust and purify gas. The collected dust is commonly adhered to the collecting plate and emitting wire by the electrostatic and adhesion forces. Then we use tumbling hammer to rap the collecting plate and emitting wire to make them tremble, then the dust falls into the hopper and finally clear the dust out of ESP from the hopper. Modern experience and theory both prove that, rapping system is an important part of ESP, which has important influence on ESP's normal running and dust removal efficiency.

Generally speaking, as for both new installed ESP and just repaired ESP, their collecting plate and emitting wire are clean at the beginning of the running, therefore their dust removal efficiencies are both good. However, after a period of running, the ESP's collecting plate and emitting wire begin to have deposited dust on, which decreases the dust removal efficiency. When the deposited dust on collecting plate and emitting wire achieves to a balance degree, the ESP may keep running at a fixed level. The reason is that, during rapping and dust cleaning, the rapping force needs to conquer electrostatic and adhesion forces of dust to clean the dust. When rapping force couldn't conquer the two forces, the dust will deposit graduately as time passes, which will result in that the dust on both emitting electrode and collecting electrode become thick. Consequently this situation will affects corona current and work voltage of electric fields and will even cause problems such as open circuit, trip (while corona current is approaching 0 while work voltage is high) and the electric field voltage couldn't be raise and so on, which accordingly reduces dust removal efficiency. Because the adhesion force of dust is decided by dust characteristics, it is commonly hard to be changed by electrical means, but can only be altered with the change of boiler work condition. Therefore, in order to improve the rapping effect and to avoid dust accumulation, we could reduce or remove dust adhesion force, that is to say, reduce or stop power output of high voltage equipment, making dust adhesion force disappear. Then by means of rapping, it will be easy to clean the collected dust, to greatly improve work current and voltage of electric fields, and to reach higher dust removal efficiency.

2 THE RESEARCH AND DEVELOPMENT OF THE TECHNOLOGY OF THE COMPOUNDED TYPE POWER CONTROL RAPPING OF LONGKING

Based on the discussion of the first part, how to improve ESP's dust removal efficiency by means of performing reduced power rapping or power-off rapping has become a greatly important research subject.

After long-term experimentation, debugging and research, we gradually summarize and perfect a whole set of scientific technology of compounded type power control rapping, of which the core is two types of advanced power control rapping mode (power-off or reduced power): one is power-off rapping with high and low voltage related mode, the other is enhanced type timing power-off rapping, which together constitute the technology of compounded type power control rapping with have the characteristics of Longking. To realize the two technologies, high voltage (mainly refers to K type controller) and low voltage systems not only need to be extended with power-off rapping related functions on the basis of their old function, but also need to make their software and hardware coordinated and cooperated with each other. The dispatching management and control strategy of IPC system is also added in the enhanced type timing power-off rapping. The experiences and result of on-site application have proved that the usage of the two technologies at the same time makes the effect of power-off rapping become better than before.

For every electric field, the correspondence relation between high voltage system and low voltage rapper is always confirmed. The function of high and low voltage related mode power-off rapping control is mainly refers to that when some electric field rapper starts to work according to its running schedule, the control system send a signal to the corresponding high voltage system, then this system performs some responding operation to carries out the function of high

and low voltage related mode power-off rapping. After K type controller receives the signal, firstly, it will save the current operation parameter, and then it will automatically adjust its power output according to its own set power-off rapping parameter, and start to perform reduced power rapping or power-off rapping. The way of reduced power can be selected as full pulse operation mode or intermittent energizing operation mode. Electric current limit may also be set according to its need. While the set value of electric current limit is zero, the system is operating in extreme status of reduced power rapping: power-off rapping. After the rapping signal has disappeared, it automatically returns to its original running mode, electric current limit and so on, restore the normal power output. For the aspect of low voltage control, the system is added with parameters such as relation times of power-off rapping, rapping advance time, through the former of which the frequency of high and low voltage related mode control can be set flexible, through the latter of which the system can send signal to high voltage system before the rappers start to work allowing its electricity fall down in advance so as to avoid the dust especially the high resistivity dust bringing remained static electricity to affect the rapping effect.

High and low voltage related mode power-off rapping is an independent action of the single equipment, while enhanced type timing power-off rapping is to carry out the power-off rapping from the angel of the whole ESP system for the better effect. Firstly, between the IPC system and high & low voltage system, the extended control command for power-off rapping must be defined and carried out respectively by each of the two systems. Secondly, set the timing power-off rapping schedule of all the HV and LV equipments in the IPC system, such as power-off start time, length of power-off time, power-off operation parameter of the HV and LV equipments, etc. Finally, the united sends power-off start commands, parameters, end commands and recovery parameters to the HV and LV equipments according to dispatch arithmetic of IPC system, and then the HV and LV equipments perform power-off rapping accord to corresponding commands: high voltage reduces or stops its power output, while low voltage raps continuously. After longer time power-off rapping, we can clear off dust more effectively, keep collecting plate and emitting wire clean, let the electric field have higher electric current, voltage and better effect of collecting dust.。Although power-off rapping would bring short time entrainment, it is not severe, because the well rapping increases the dust removal efficiency of the whole ESP effectively and clears off dust more drastically at the same time. After comparing the situations before and after power-off rapping, the users also recognize that it is more important to keep collecting electrode clean and higher dust removal efficiency for long term.

3 PROJECT APPLICATIONS

3.1 5# and 6# boilers ESP of Meixian power plant

5# and 6# boilers of Meixian power plant have two 135 MW coal burning units, which adopts circle fluidized bed 440 t/h boiler that burns anthracite. The ESP is 270**Error! Bookmark not defined.** m^2**Error! Bookmark not defined.** BE type with double rooms, four electric fields. It started to run at the beginning of the year 2006. After that, because of the change of coal type and deposited dust of plate, the effect of dust collection gradually became worse and worse (at that time power-off rapping has not been adopted yet). In March, 2007, 5# and 6# boilers was reconstructed, added the function of power-off rapping. With the power-off rapping devices running entirely, the result of dust collection was improved greatly. We have tracked power-off rapping technology application in the two ESPs for one year. From the different data of the power-off rapping between two years(take #5 as example), we can distinctly know that the significant effect of power-off rapping.

From the following table, we can see that the difference of average voltage between fore-and-aft electric fields without power-off rapping is great. The rare electric field, the lower voltage it has. After power-off rapping, the voltage increases much in the rare electric field and the average voltage between fore and rare electric field is close. It is possibly because in the fore electric field the dust is of bigger size, which is easier to fall off by rapping. Along with the electric field moves afterward, dust becomes of smaller size and of increasing resistivity. Then adopting power-off rapping will have significant effect that the voltage increases evidently and dust removal efficiency improves greatly.

Table 1 The average voltage before and after power-off rappingin every electric field of 5#

5# boiler	Average voltage (kV) (with power-off rapping)	Average voltage (kV) (without power-off rapping)
TR1	58.88	62.86
TR2	60.62	56.04
TR3	62.46	49.32
TR4	61.67	49.13
TR5	58.48	46.56
TR6	61.64	45.29
TR7	61.69	42.82
TR8	61.55	43.87
TR9	61.81	41.58
Average	60.98	48.61

At the following figures, Fig. 1 is curve contrast figures, which show the daily average work voltage of the ESP (the arithmetic average value of all the electric fields' daily average voltage) between before and after power-off rapping. We can also distinctly see that, after power-off rapping, the whole boiler's average work voltage is always higher than that without power-off rapping.

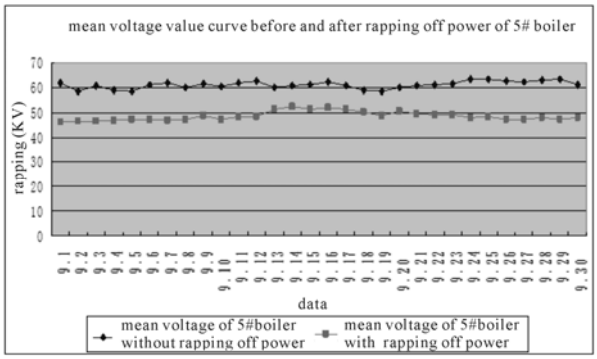

Fig. 1 The average voltage of before and after power-off rapping of 5# boiler

From the following table (Table 2), we can see that, as a whole, the former electric field's electric current is smaller, the rare electric field's electric current is larger. This is because the dust amount of the former electric field is large and the shielded function of the electric field's space charge is the main function, which plays a great part in restraining the corona current, while the dust space charge in the rare electric field is less, which plays a less part in restraining the corona current.

Table 2 Each electric field's average electric current of before and afterpower-off rapping for 5#

5# boiler	Average electric current (%) (with power-off rapping)	Average electric current (%) (without power-off rapping)
TR1	20.85	26.73
TR2	54.09	58.46
TR3	49.99	78.32
TR4	58.87	79.3
TR5	59.4	79.33
TR6	56.64	77.46
TR7	50.13	74.32
TR8	50.79	74.27
TR9	28.01	74.49
Average	47.64	69.19

Moreover, because the deposited dust on the plate is so serious that back corona becomes the main problem. The working voltage reduces, while the electric current is comparatively big with the volt-ampere curve increasing fast. But because the working voltage is low, dust collection result is poor. From the comparative data, after power-off rapping, the electric current reduces much and the electric current of the rare electric field reduces much more. This is because power-off rapping makes the situation of deposited dust on the plate improved. The reducing of back corona results in the reducing of electric current and the increasing of working voltage.

Fig. 2 is the curve comparative Fig of the whole ESP's daily average working electric current before and after power-off rapping. Simultaneously, we could distinctly see that, the whole ESP's average working electric current of power-off rapping is all the time lower than that of without power-off rapping.

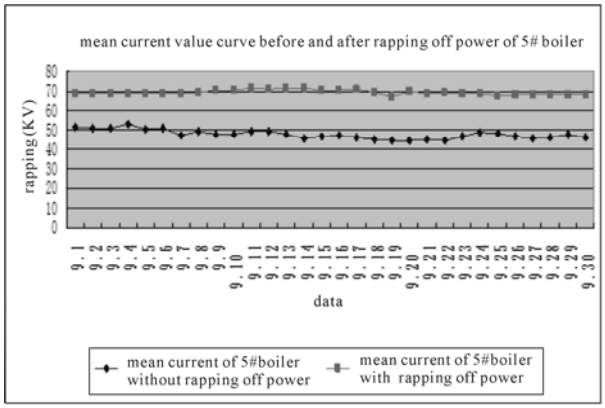

Fig. 2 The average electric current before and after power-off rapping for 5 # boiler

See from the volt-ampere curve, the volt-ampere curves of Figs. 3 and 4 are the typical representative before and after power-off rapping. The curve of Fig. 3 shows that the voltage reaches the maximum while the electric current increases to 5%-10% of the rating value, but the electric current increases to the maximum quickly. The curve of Fig. 4 shows the normal curve increase situation, without back corona, when the electric current reaches 50%. Therefore, the voltage of highest running point is comparatively high. This is because the deposited dust on the plate becomes thicker and thicker, resulting in part of back corona. Because the points of back corona increase gradually, the electric current increases quickly with the current zooming. After adopting power-off rapping, the deposited dust on the plate is less. It has no back corona at the most phases of the electric current increase, therefore, the volt-ampere curve is normal and the voltage reaches comparatively high level.

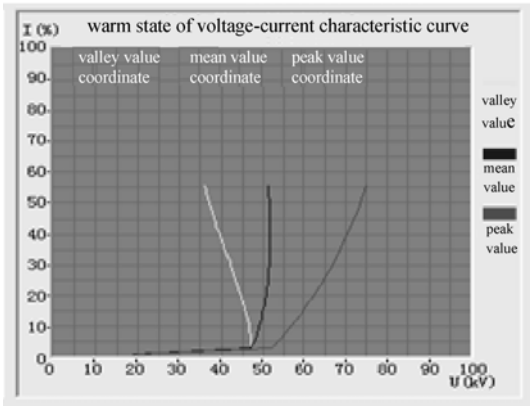

Fig. 3 Volt-ampere curve of some electric field before

power-off rapping

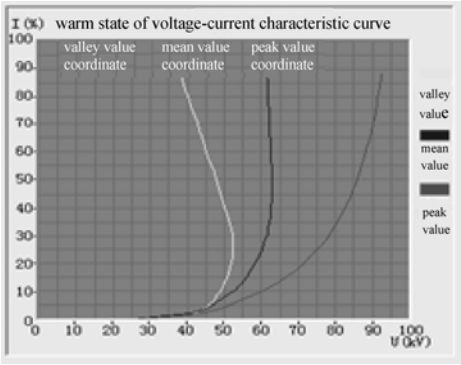

Fig. 4 Volt-ampere curve of the same electric field after power-off rapping

From the analysis of the data upwards, we can draw the conclusion that: after performing power-off rapping, the average voltage of electric field increases distinctly, the electric current decreases obviously, the volt-ampere characteristic curve is improves greatly, the invalid energy consumption reduces, the migration speed rises effectively, the dust collection effect improves and the outlet emission concentration reduces.

3.2 The a of Meixian power plant 3# and 4# boilers ESP

Meixian power plant 3# and 4# boilers are coal burning units of 125 MW, pulverized fuel fired boiler with the amount of evaporation of 420 t/h. The ESP is top electromagnetic rapping of 110 m^2 cross area, with 8 sets of HV power supplies of GGAj02-0.8 A/72 kV type. This ESP's total dust collection area is 15758 m^2, the normal treated flue gas volume is 812168 m^3/h, the gas temperature is 140 ℃-160 ℃. When it started to run in 1997, the running effect of the ESP is very good. But after many years, the boiler started to burn anthracite of lower volatility, and in order to increase the burnout rate of coal, it reduced the size of coal to about 5. It not only raised the resistivity of flying dust, but also increased the attachment force of flying dust. Therefore, the collection efficiency is not stable, the dust collection effect is good at the beginning, and then poor gradually. When stopped to check, we found that the accumulated dust on the plate and emitting wire was severe, at the back of ESP, the accumulated dust of gas flue was severe and the wind leaf of exhaust fan was abraded.

In 2004, when 3# and 4# boilers ESP were reconstructed,

the technology of power-off rapping was added in. At the beginning, we just applied high and low voltage related power-off rapping. Similarly, compared them with each other at the fixed charge, the ESP's electric running parameter improved much than that of before, the running effect was good. However, just running for short time, each electric field of the ESP's secondary current became lower and lower, and the blackness of export gas gradually became heavy, the turbidity value stayed around 50-60%, it proved that there was accumulated dust on the plate and emitting wire. Therefore, we added in the enhanced type timing power-off rapping, carried out long time power-off rapping on each current to clear the accumulated dust.

After implementing combined type power control rapping technology for a long time, on April 29, 2005, under fixed charge, we measured the export gas dust density of the two ESPs in 3# boiler and its value was 73.0, 80.0 mg/DNm^3 (<100 mg/DNm^3), respectively, the corresponding collection efficiency was 99.75%, 99.61%, respectively, the collection efficiency of the whole ESP was 99.68%(>99.5%), higher than that of efficiency request.

3.3 The rebuilding of 3# boiler of YangGuang power plant of Shanxi

1#-4# boilers of YangGuang power plant of Shanxi are 1025 t/h boilers of 300 MW unit, the kind of coal is YangQuan's anthracite and local small cave coal. It is side rapping ESP, and its emission exceeds heavily, it couldn't satisfy the request of environmental protection. In May, 2006, our company rebuilt 3# boiler ESP of YangGuang power plant of Shanxi (equipped with 16 TRs and side rapper), we mainly carried out the technology of combined type power control rapping, and it reduced the accumulated dust of discharging and collecting electrode greatly, increased working parameter of each electric current and voltage distinctly. Although without testing of the efficiency, the emission effect of the chimney improved greatly. 1# and 2# boilers use the same chimney, without rebuilding, often smokes, 3# and 4# boilers use the same chimney, 4# boiler uses fabric filter, 3# boiler was rebuilt electrically and after the rebuilding, we couldn't almost see the gas. Table 5 is the contrast of 3# boiler's running parameters before and after rebuilding. Fig 5 and 6 are the situation of chimney emission after continuing running for three months.

Table 5 The running parameters of YangGuang power plant 3# boiler

TR No.	U1 (V)		I1 (A)		U2 (kV)		I2 (mA)	
	Before the rebuilding	After the rebuilding	Before the rebuilding	After the rebuilding	Before the rebuilding	After the rebuilding	Before the rebuilding	After the rebuilding
A1	140	282	30	200	60	52	100	650
A2	108	320	20	220	50	51	100	710
A3	210	340	100	180	55	55	300	600
A4	230	320	100	196	50	55	300	780
B1	150	274	50	120	50	55	300	480
B2	140	300	50	180	50	52	400	600
B3	220	300	140	160	50	55	400	520
B4	140	280	100	160	50	54	400	600
C1	150	240	20	150	40	55	100	500
C2	170	300	40	161	50	50	200	600
C3	170	250	50	171	50	52	200	650
C4	120	310	80	200	55	60	400	700
D1	180	300	50	154	55	52	100	560
D2	220	300	80	193	50	50	200	600
D3	220	310	80	185	50	55	200	680
D4	220	340	80	210	50	60	200	750
Parameter records time before the rebuilding: April 26; Parameter records time after the rebuilding: May 24								

Fig. 5 The scene of power plant ESP

Fig. 6 Blown-up chimney of 3# and 4# boilers

Because of the success application of power-off rapping at 3# boiler, in the second year, they performed the power-off rapping rebuilding at 1# boiler, and reached good result.

4 CONCLUSIONS

At Meixian power plant 5#6#, 3#4# boilers, YangGuang power plant 3# and 1# boilers for the different types of boilers and ESPs (Top rapping, Side rapping), the technology of combined type power control rapping is applied successfully, which proves that the technology has good adaptability. It is not only adapted to top rapping ESP, but also adapted to side rapping ESP. It also illuminates that the technology plays an active part in enhancing rapping, dust collection, greatly reducing the accumulated dust on plate, greatly improving electric field electricity supply output and raising collection efficiency. Therefore, it is an effective method in improving ESP's running. Simultaneously, to a certain extent, it reduces ESP's energy consumption, prolongs life of rapping set, which fits the current requirement of energy saving. According to spot situation of each ESP, in the future, we need to further research the optimization of rapping system, rapping strategy, better exert the function of combined type power control rapping technology to make it serve for the increase of ESP's efficiency.

REFERENCES

1. Christer Mauritzson, etc. ESP emission reductions with advanced electrode rapping together with novel energizing methods.