Characteristics and Technical Improvement Investigation of Electrostatic Precipitator before Sintering Machine

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Abstract: By analysising on process of sintering machine and flue gas characteristics in electrostatic precipitator (ESP) before sintering machine, this article introduces several issues that should be paid more attention in the application of ESP before sintering machine and gives some solutions for these issues in order to meet the emission standard and requirements of sintering process. Finally the flue gas is purified and our environment is protected.

Keyword: sintering machine, electrostatic precipitator, high negative pressure, high resistivity, re-entrainment

1 INTRODUCTION

As dust collecting equipment, ESP before sintering machine can collect waste dust and has the capability of air purification. As process equipment, ESP before sintering machine plays an important role on production and technology of sintering. Our company mainly studies on design and manufacture of dust collecting equipment in metallurgy system. We have designed hundreds of ESP before sintering machine which are operated successfully, so we have accumulated a lot of design and maintenance experience. With the application of high basicity sintering process, however, the capacity of sintering machine increases and the sintering layer becomes thick, so the component of smoke and dust becomes more complex, which can reduce the collecting efficiency and bring many problems to ESP design. This paper makes further illustration on characteristics of dust and ESP technology and according to the change in sintering process and problems in application, and also gives some improved methods.

2 CHARACTERIATICS OF ESP BEFORE SINTERING MACHINE

2.1 Characteristics of ESP before Sintering Machine

2.1.1 High negative pressure: 16000 Pa-23000 Pa

Negative pressure of flue gas in normal ESP, such as ESP for power plant boiler, is between 4000Pa and 9000Pa, while ESP before sintering machine is different. With the application of high basicity sintering process, the capacity of sintering machine increases and the sintering layer becomes thick in addition of using large air flow fan imported from abroad, so the negative pressure of flue gas is quit high, generally between 16000 Pa and 23000 Pa, and even can reach 260000 Pa instantaneously. The high negative pressure poses a great challenge to stiffness and strength of ESP before sintering machine .

2.1.2 High resistivity dust (1011 Ω·cm -1013 Ω·cm) is hard to collect

The practice shows that when the range of dust resistivity is between104 Ω·cm and 5×1010 Ω·cm, dust is easily to be collected and the collecting efficiency is high. When resistivity is lower than 104Ω•cm, collecting efficiency decreases dramatically with the reducing of resistivity, then re-entrainment generates. When resistivity is higher than 5×1010 Ω·cm, back corona occurs, so collecting efficiency decreases with the increasing of resistivity.

Table 1 Dust resistivity in sintering machine of some steel plant

Temperature	Resistivity (Ω·cm)		
	The first field	The second field	The third field
80 ℃	3×10^{6}	1×10^{11}	3.7×10^{10}
135 ℃	1×10^{11}	1.1×10^{11}	5×10^{10}
150 ℃	2.8×10^{12}	3.7×10^{11}	1.8×10^{11}
170 ℃	3.3×10^{12}	1.5×10^{11}	3.7×10^{11}

2.1.3 Fine particle with high content of K_2O, Na_2O is light and easy to lead to re-entrainment

Table 2 Test results of dust from some kinds of ESP in a steel plant

Kind	TFe	K_2O	Na_2O
Dry Dedusting	21.47%	5.06%	1.93%
Dedusting Before Furnace	40.75%	1.74%	2.83%
Secondary Dedusting In stell Zone	20.5%	0.57%	0.33%
Main ESP For Sinter Machine	48.44%	6.3%	13.13%
Environmental ESP For Sinter Machine	52.04%	0.17%	0.38%
Combination Dedusting For Sinter Machine	33.71%	0.14%	0.23%
Iron Alloy Dedusting	1.04%	0.26%	0.05%
Iron Waking Combination Dedusting	53.24%	0.1%	0.33%

Iron Waking Gravity Dedusting	34.62%	0.23%	0.39%

We can see from table 2: K_2O and Na_2O content in ESP before sintering machine is obviously higher than those of other kinds of ESP.

Table 3 Dust component analysis of ESP before sintering machine in a steel plant

component	The First Field	The Second Field	The Third Field
TFe/10E-2	54.35%	39.5%	22.5%
FeO	5.8%	4.47%	0.73%
Fe_2O_3	71.3%	51.5%	31.4%
CaO	6.51%	4.44%	3.55%
MgO	1.63%	0.3%	0.51%
AL_2O_3	1.54%	1.43%	1.46%
SiO_2	4.6%	2.78%	1.66%
K_2O	2%	9.45%	17.5%
Na_2O	1.3%	6.25%	11.5%

We can see from table 3: K_2O and Na_2O content in back field is higher.

Table 4 Dust component analysis of ESP before sintering machine both in China and some other country

component	Some steel plant in China	Some Steel Plant in other country
FeO	7.86%	42.14%
Fe_2O_3	0.89%	15.82%
CaO	1.80%	9.92%
MgO	2.38%	2.59%
AL_2O_3	1.43%	0.36%
SiO_2	2.00%	4.25%
K_2O	35.00%	0.50%
Na_2O	5.05%	0.36%
C	11.46%	3.55%

Table 4 shows that: the component of dust in ESP before sintering machine from China and that country is different dramatically. Most dust in China is light and flocculent, and has a high content of K2O and Na2O. This kind of dust is fine and has high resistivity, so it is hard to be collected.

3 REASONS FOR OVER EMISSION

3.1 Sintering Material in China

3.1.1 Most of sintering materials using in Chinese steel plant are from mines of other countries, such as Australia, Brazil, South Africa and India.

3.1.2 The foreign mines are soaked with some seawater during the transportation to domestic docks. So NaCl and $MgCL_2$ in seawater are mixed in the mines.

3.1.3 The content of K_2O and Na_2O increases in sintering material soaked by seawater in the process of sintering, and the content is higher in back field. The packing density of this kind of dust is lower than $0.3t/m^3$. It is hard to discharge. Even when the dust is collected on the plate, it is difficult to settle by raping and re-entrainment will occur, so the emission requirement can hardly be meted.

3.2 Velocity is too High

Formula: $V=Q/F$[2]

Q - gas quantity

F - effective basal area

At present, the velocity in most of the unqualified ESP is more than 1.0m/s. Because sintering dust is fine and light, residence time is short, so the dust can't be charged and collected efficiently and also turbulence intensity of gas increases, re-entrainment occurs when raping.

3.3 Influence of Air Leakage

As the high negative pressure operation condition, Air leakage easily occurs in many parts of sintering ESP, such as joint of body components, manhole door, flanges in inlet and outlet and junction of pipeline and expansion joint. It may lead to gas quantity increase and temperature decrease, even will generate condensation of gas resulting in corona electrode hypertrophy, creepage of insulating parts and equipment corrosion.

Dust unloading mechanism also has some influence. If we unload the dust by manual termly, dust will be unloaded completely, which may lead to air leakage of unloading valve and temperature decreasing of gas right on the hopper. Dust below the electrodes will be moist, which will result in negative effects on dust removal from the hopper. The experiments show that, when air leakage of hopper is 5%, collecting efficiency decreases by 50%; when air leakage of hopper reaches 15%, collecting efficiency decreases to 0[3].

3.4 Dust Recovery

We can see from Table 3, dust collected in back field is light and flocculent. Resistivity of this kind of dust is high and packing density is small. It is hard to collecting and has a low utilization value. When it returns to mine, most dust will return to the gas, and result in ESP efficiency deterioration. The high content of alkali will make rnodulation occur in boiler and tuyere will be burn out. If this situation continues, the production will reduce.

4 BY ANALYZING OF OVER EMISSION REASONS, WE NEED TO IOMPROVE THE SINTERING ESP BOTH IN DESIGN AND SINTERING PROCESS

4.1 Anti-deformation Technology

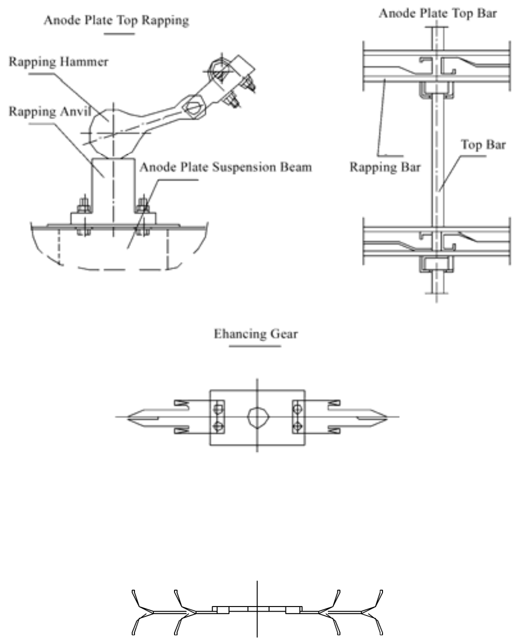
To adapt to the high negative pressure operation condition, our company developed a software on anti- deformation of steel structure in ESP independently. It can calculates out the strength and intensity of the steel structure, when the design pressure is provided, we can select material and arrange the structure reasonably to make the steel component become a complete system and adapt to the high negative pressure operation condition. The steel shell can keep its shape to ensure ESP and sintering process in normal operation.

4.2 Precharge Technology in Sintering ESP

Set a row of precharge equipments before the first field, (share the same power supply with the first field), to make dust charged in advance, to reduce the quantity and time of charging in field. Dust can be collected on anode plate more easily and collecting efficiency is enhanced. This technology has applied to many sintering ESP of metallurgy industry successfully.

4.3 Compound Raping and Ejector Pins Technology in Anode Plate

Add a set of raping equipments for anode plate in the top of ESP and set ejector pins in the middle. It can increase the unloading efficiency of anode plate. This technology has applied in many ESP, such as 280m^2 sintering ESP in Tangshan steel plant, and achieved good effects.

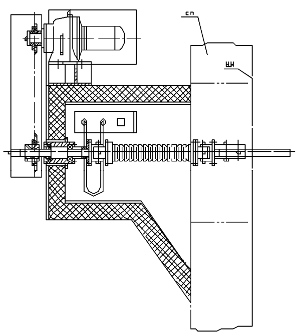


4.4 Special Raping and Transmission technology on Negative Plate

According to the high temperature and humidity characteristics of sintering ESP gas, our company has developed the raping and transmission equipment, which differs from the normal quadrate and dustproof board structure. The under plane of porcelain axle box was designed to be inclined without dustproof board and was cleaned termly by handwork or self-motion. The box is outboard of the column. What inboard the column is sealed according to the gradient of the under plane. So the dust in the box can slide into the field. The power can be supplied in long-term and efficiently. And the collecting efficiency can be enhanced further more.

4.5 Airflow Uniform Technology of Air Inlet

Diversion plate and airflow distribution plate are set in air inlet. Layer number of the plate and opening ratio are determined by experiments to make the root mean square of airflow be lower than 0.25. If it is necessary, we can set diversion plate in inlet pines to make the large particles non-uniform, so the collecting situation of the large particles will move up on the plate and the probability of re-entrainment will be reduced.



4.6 Reducing Air Leaking Points and Decrease the Leakage Rate

Hoppers and junctions of flanges are sealed with special sealing material; Manhole door is sealed with silicone rubber; Seal material compressing equipment is used on the raping axle (seal material is tetrafluoride plate) to reduce the leakage in rotating area. And the places where air leaks easily are sealed by welding.

4.7 Setting Intercepting Device

4.7.1 Designed position of intercepting device

The intercepting device is set in air outlet. The upper and lateral parts of air outlet are designed to be plane, which can make the setting of intercepting device easily and have little influence of airflow. The attached drawing is as follow:

The intercepting device is set according to the height and breath of air outlet. Its framework is layered along the gas flow direction and designed as labyrinth. The attached drawing is as follow:

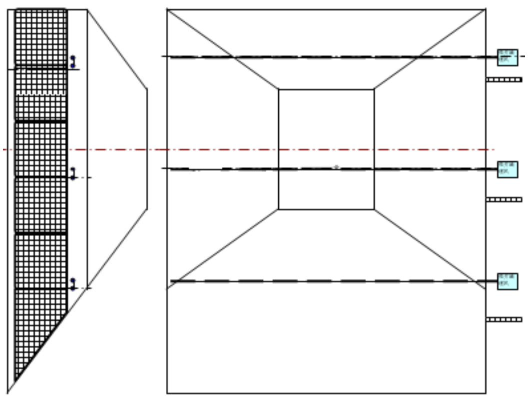
A layer of intercepting device is set every other distance. There are four to six layers in vertical direction and in horizontal direction the layers apart by fixed distance. The device is fixed by profiled materials and sealed in the junction with the lateral pine. On installing, toy bricks installation method is used. Layers accumulate one by one from down to up of air outlet. One layer is connected and fixed with anther by bolts. The roof of the outlet is set after the intercepting device. It can be connected fixedly or also by bolts.

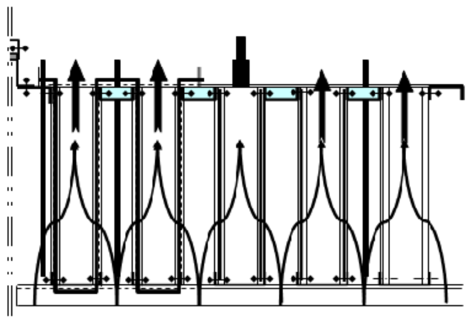
4.7.2 Material selection for the intercepting device

We finally chose stainless steel net as the material of dust intercepting device by experiments. This material can intercept dust efficiently and have little influence of ESP resistance. The stainless steel net is also layered according to the framework and fixed in each framework. In each layer thick and thin nets are used in combination and set as toy bricks.

4.7.3 Design of raping device

After the using of the intercepting device, dust of certain thickness is accumulated on the steel net, so we need some raping device to make the dust unload along with inclined bottom surface of the air outlet. We set lateral raping devices to unload the dust on the steel net. The raping devices are also set in layers. Each two steel nets frameworks share a raping device. According to the thickness of the dust, design reasonable raping period and hammer number. The hammers rap from up to down alternately to make the dust unload by pieces.





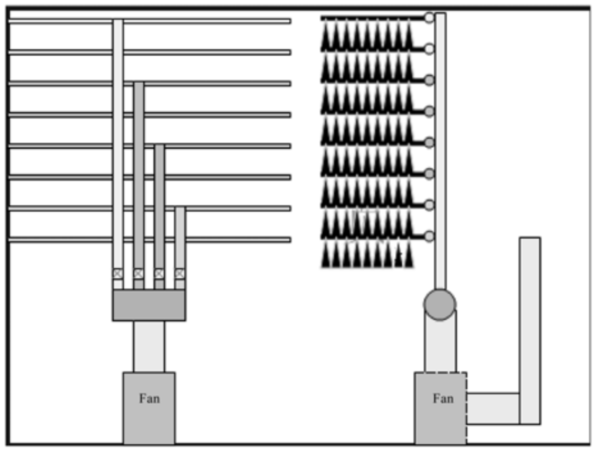
4.7.4 Hot air blowing and unloading system

To avoid the light and fine dust falls on the intercepting device again after raping, hot air blowing and unloading system is set between the layers. The attached drawing is as follow:

The blowing system inhales hot gas from the outlet which is next to the flue and the hot gas are transported to the frameworks by a fan set on the ground to avoid condensation of dust on the frameworks and the cycle operation can also save the energy. The hot gas is divided into several parts by pipes and then blows to the intercepting device. Every blowing system has its own electric valve which can be controlled by automation and manually operation. According to the pressure loss of the nets, unload the dust periodically. The raping device and blowing system are opened simultaneously to make the dust on the steel nets drop into the hopper rapidly. The raping and blowing is ordered in turns, controlled by program and the period can be adjusted. Because of the combined using of the raping device and blowing system, the re-entrainment can be avoided after raping.

4.8 Improvement of Sintering Progress

Make gas temperature stable and keep temperature in ESP higher than the dew point temperature.



Dust collected in later field has a high content of K_2O, Na_2O but little Fe. This kind of dust doesn't have recovery value. So it is discharged from the hopper and not sent to burn again to prevent too many light and fine dust in ESP.

Strictly control the structure of material particle and thickness of material layer to keep air volume, temperature and dust concentration stable which can make the ESP have a high collecting efficiency.

5 CONCLUSIONS

There are many factors that can influence the collecting efficiency of sintering ESP. To make ESP in optimal operation condition in long time, sintering equipment, body of ESP and power source must be controlled and reasonable, so dust emission from ESP can meet the emission standard. Our measures are proved to be effective by practice and expected aims are reached.

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