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DRY DESULPHURIZATION PRACTICE OF No.1 SINTER MACHINE IN BAOSTEEL[1]

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Abstract
With the domestic steel production capacity gradually expanded, iron and steel enterprises have become one of largest source of SO_2 emissions. And the sintering process can produce lots of SO_2. According to review itself characteristics and the experience of the domestic and foreign desulfurization, the LSJ-FGD flue gas desulfurization process was chosen which is one way of circulating fluidized bed desulfurization. The principles, processes and system configuration of desulfurization systems as well as the matching operation with the main exhaust fan were introduced. Up to now, the process of desulfurization system had been operating stably. And the synchronous operation rate and average desulfurization rate were better than 90%. At the same time, the dust emission concentrations was less than 20 mg/m^3.
Key words: Sintering; Flue gas desulfurization; Dry desulfurization.

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1 INTRODUCTION

With the process of industry, the emissions of SO_2 and acid rain are becoming more serious in China. According to China Environmental Status Bulletin in 2009 by the State Administration of Environmental Protection, the emissions of SO_2 was 2,214.4 t, which reduced by 4.6% in 2008.[1] From now on, more than 70% cities were affected by the acid rain in Zhejiang, Shanghai, Chongqing and other eight provinces. Take the Shanghai for example, the pH of rainwater was 4.66 and the frequency of acid rain was 74.9% in 2009, which is still quite serious.[2]

SO_2 is mainly from coal-fired power plants, iron and steel plant in the sintering and metallurgical furnaces. Sintering machine is the important equipment in modern iron and steel production. And it is the key pollution sources of the gas and dust emissions in iron and steel plant, which is about 42.3% in the total steel production emission, and the emission of SO_2 is 59.7%. In the past the raw sintering materials mainly were high-grade, low sulfur iron ore. However, with the depletion of high-grade resources, the requirement of low cost production and the expansion of production capacity, the load of SO_2 also rises subsequently. So the new FGD project would have to be built.

In 1970's, the research of sintering flue gas desulphurization was begun in the world. And the leading position in this field is Japan, whose sintering FGD methods are Limestone-Gypsum, active coke absorption, Ammonia-Ammonium sulfate method. In order to control the investment, and to decrease operation cost and desulphurization products, LJS-FGD was introduced to Baosteel, which is suitable for the gas characteristics of the No.1 sintering machine(450 m^2 of strand surface) and was put into production in 2010.

2 PROCESS AND PRINCIPLE

2.1 Principle of Chemical Reaction

The chemical reactions of the Ca(OH)2 and SO2, SO3, HCl, HF are completed in desulfurization tower and the chemical reaction equation as followed.

$Ca(OH)_2+SO_2=CaSO_3\cdot 1/2H_2O+1/2H_2O$

$Ca(OH)2+SO_3=CaSO_4\cdot 1/2H_2O+1/2H_2O$

$CaSO_3\cdot 1/2H_2O+1/2O_2=CaSO_4\cdot 1/2H_2O$

$Ca(OH)_2+CO_2=CaCO_3+H_2O$

$Ca(OH)_{2+}2HCL=CaCl2\cdot 2H_2O$（~70℃）

$2Ca(OH)_2+2HCL=CaCl_2\cdot Ca(OH)_2\cdot 2H_2O$（>120℃）

$Ca(OH)_2+2HF=CaF_2+2H_2O$

2.2 Process and Principle

The LJS-FGD of sintering flue gas dry desulfurization and multi-component pollutant synergistic purification process system is mainly composed by absorbent preparation, desulfurization tower, material recycling, water system, dust remover after the desulfurization and instrumentation control system (Figure 1).

Process principle: the sintering flue gas goes through the desulfurization tower from the bottom and reacts with the addition of absorbent (lime), circulating ash and water. Finally, the SO_2, SO_3, HCl, HF, heavy metals and other pollutants are removed.

The adsorbent and circulating ash with the flue gas are accelerated by the Venturi tube and engender intense turbulent state when it goes through the desulfurization

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tower. In this way the particle and flue gas have large relative slip velocity. And the particle interface reaction of constant friction and collision greatly enhance the heat transfer, mass transfer between gas and solid. At the same time in order to achieve the optimal reaction temperature, the flue gas is cooled above the dew point temperature of about 15 ℃ through spraying cooling water at the desulfurization tower. The flue gas which carried a lot of absorbent and the reaction products goes from the top of desulfurization tower into desulphurization bag dust collector to purify. The dust emission is not more than 20 mg/Nm^3 after gas-solid separation.

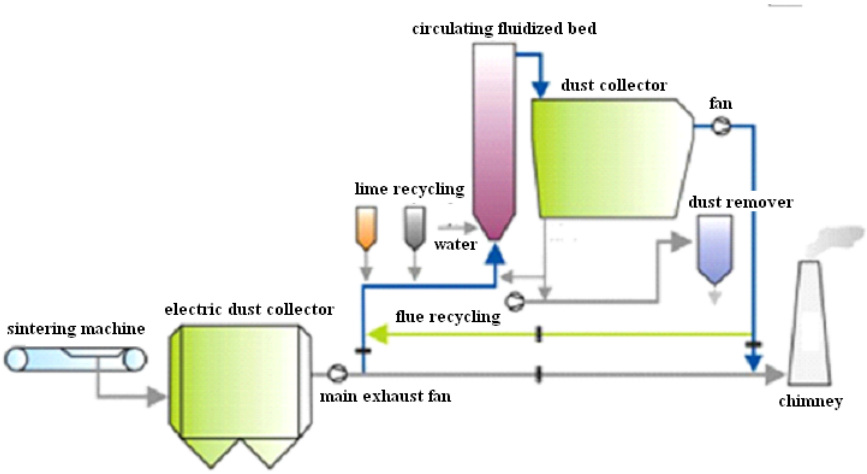

Figure 1. The LJS－FGD process of No.1 sintering in Baosteel.

2.3 Desulfurization System

Desulfurization system mainly consists of the desulfurizing tower, desulfurization bag dust collector, desulfurization ash recycle system, absorbent preparation and supply system, flue gas system, water system, air system, fluidized system.

2.3.1 Flue gas system

Through the main fan, flue gas enters the desulphurization tower from the bottom. After the bag dust collector, the emission from the top tower exhaust by the desulfuration fan. The SO_2 in the emission is not more than 100 mg/Nm^3 and the dust is not more than 20 mg/Nm^3.

They are relatively independent between the desulfurization system and sintering machine. There is a emergency flue system when the desulfurization system trips. And the loss of flue gas pressure from desulfurization system can be supplied by the desulfurization fan. So the desulfurization system can not be impact on the safety of sintering.

2.3.2 Desulfurization tower system

There is only one desulfurization tower which includes 7 Venturi nozzles. It consists of inlet section, lower transition section, Venturi section, conical section, straight pipe section, the upper transition section, top square section and outlet extending segments that are welded. And there is without any moving parts, the support rod, and anti-corrosion lining in the tower. Desulfurization tower is supported by using steel brackets.

In order to control the spray quantity and material circulation in the desulfurization tower, there are a flow equalizing device in desulfurization tower inlet and the measuring device of temperature and pressure in the outlet section. And an

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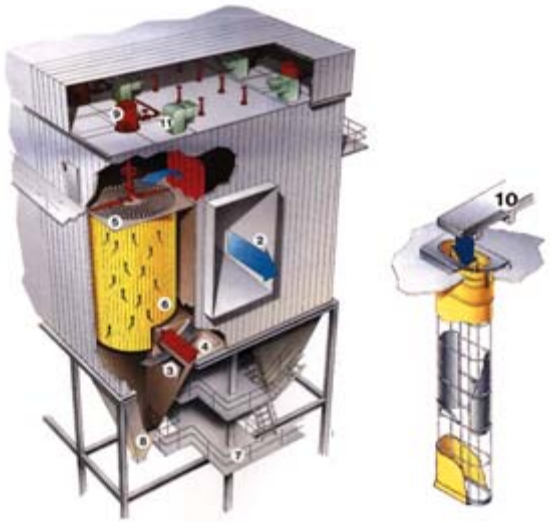
emergency ash discharge device and a blowing device for plug are equipped below the bottom of the tower to prevent the jam.

2.3.3 Desulfurization of bag dust collector

This dust collector is low pressure rotary pulse type that has the characteristics of high dust collection efficiency and no sensitive to dust. And it is shown in Figure 2.



1, net gas chamber
2, outlet flue
3, inlet flue
4, inlet door
5, plate
6, filter bag
7, maintenance platform
8, hopper
9, blowing device
10, ash cleaning arm

Figure 2. The LJS－FGD bag dust collector of No.1 sintering in Baosteel.

2.3.4 Materials circulating system

In order to establish a stable fluidized bed, reducing the absorbent consumption and meeting the desulfurization reaction, the ash circulating system is designed.
And this system has two air chutes which can transport the desulfurization ash back to the desulfurization tower. The quantity of circulating ash is controlled by the desulfurization tower pressure drop signals according to the opening of circulating valve. There are some fluidized fans for the hopper and the air chute in order to ensure good fluidity.

2.3.5 Absorbent preparation and supply system

Absorbent preparation and supply system is a relatively independent system, which includes lime groove, lime metering device, digestive apparatus, fluidized fan and pneumatic conveying equipment.
Lime is shipped by tanker, delivered to the lime groove with air compressor, entered the double-shaft stirring dry digestion device with metering equipment. Finally, lime becomes the suitable absorbent whose water content can be controlled no more than 1%, average particle diameter is about 10um, specific surface area is up to 15 m^2/g and temperature is about 100°C. The suitable absorbent is delivered to the groove with air compressor. And it is conveyed to desulfurization tower after metering equipment when the desulfurization efficiency is not suitable. The lime consumption is about 3.6 kg/t-s.

3 OPERATION AND RESULTS OF DESULFURIZATION SYSTEM

The desulfurization system of No.1 sintering machine in Baosteel put into operation in October 28, 2010. It reduces the emissions of SO_2 and dust in Baosteel, which makes

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positive contribution to the surrounding environment.
In 2011, the annual average raw flue gas processed was 1520000 Nm^3/h, the annual average SO_2 concentration of entrance flue gas was 474 mg/Nm^3, the annual average SO_2 concentration of discharge flue gas was 30 mg/Nm^3 (Figure 3) and the emission of dust was 18mg/Nm^3 in last year. The average desulfurization efficiency was 93%. The average emission of SO2 was far lower than the standard of 100 mg/Nm^3 which is the Chinese standard to the new sintering machine. The average emission of dust is lower than the standard discharge of 20mg/Nm^3 which is the Chinese standard to the bag dust collector.

4 ENVIRONMENTAL BENEFITS OF DESULFURIZATION

Table 1 shows the change of SO_2 and dust concentration after the desulfurization project. The emission is greatly reduced in the sintering plant. According to emission calculate based on the entrance and export of SO_2 content, the annual reduction emission of SO_2 were 5170t, which reduced the harm of acid rain to surrounding area.

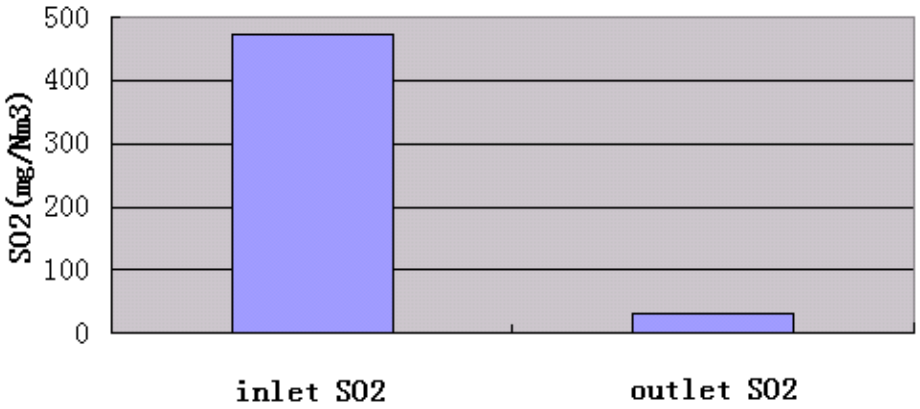

Figure 3. The contrast of SO_2 concentration.

Table 1. The change of SO_2

scheme		unit	before	after	annual reduction emission of SO_2
LJS	SO_2	t/a	5545	375	5170
		mg/Nm^3	477	32	---

It is the focus of environmental protection to reduce the emissions of SO_2 in China's eleven-five period. Sintering process is the mainly source of SO_2 in Iron and steel industry. The energy-saving and emission reduction are believed as the basics of survival and development in Baosteel when they accelerate the development of enterprise at the same time. Baosteel does this work in heart and enhances the quality of enterprise development in recent years. Especially, building the desulphurization device on No.1 sintering machine about 405 m^2, the reduction emission of SO_2 received a good social benefits. According to the State Council' Administration Regulations on Pollution Discharge Fee of Collection and Use and the national development and Reform Commission and other four ministries 'Administration Measures on Pollution Discharge Fee of Collection and Use, annual sewage charges may be reduced 600,000 Yuan.

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5 FLY ASH COMPREHENSIVE UTILIZATION

With the development of dry desulfurization, the product of desulfurization is used synthetically. So it not only reduces environmental pollution, but also creates certain social and economic benefits. It is mainly used for land backfill, roadbed, the concrete admixture of road materials and cement. Now it is used for the admixture of cement in Baosteel and this business is assumed by Baosteel development company.

6 OPERATION DIFFICULTIES

6.1 Attachment on Desulfurization Tower

The desulfurization ash can attached on the desulfurization tower because of much spray water , the quality problems of lime, the temperature fluctuation of flue gas. It happened when the sintering machine does not work or the main fan shut down. In order to avoid this condition the worker should understand advance of this special working conditions, reduce the amount of water and appropriately increase the exit temperature of the tower. And automatic control condition must be switched when sintering machine return to normal condition as fast as possible.

6.2 Collapsed of Fluidized Bed

The collapse of fluidized bed is the most serious accidents. It may be happened because of the obvious fluctuation of sintering flue gas flow. In order to avoid this condition the worker should strengthen contacting, understand advance of this special working conditions. In addition, workers must open the tower bottom hole to check falling ash and clear them if there is falling ash at the bottom of the tower. And it belongs to the extremely rare condition because of the obvious fluctuation of sintering flue gas flow.

7 CONCLUSIONS

This project reduces the emissions of SO_2 and dust in Baosteel, which makes positive contribution to the surrounding environment. The average desulfurization efficiency was 93%, the average emissions of SO_2 was far lower than the standard of 100 mg/Nm^3 and the average emissions of dust is lower than the standard discharge of 20 mg/Nm^3 in last year.

- The desulfurization agent，lime consumption, is the important composition of desulfurization cost. How to increase desulfurization ash cycle is one best way to reduce the lime consumption in the next step so as to reduce the cost of desulphurization.
- There is multi-component removal interface reserved when it was designed because multi-component removal will be the direction of future efforts.

REFERENCE

1 China Environmental Status Bulletin in 2009.
2 Shanghai environmental bulletin in 2010.