

Optimization of NO_x emission control based on high sulfur coal combustion

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Abstract: Combined with the operation of an 800MW supercritical boiler burning high sulfur coal, in order to control the emission of nitrogen oxides, the optimization adjustment of ammonia injection and NO_x emission reduction based on combustion adjustment is proposed. According to the test of the inlet and outlet of denitration system under 800 MW condition, the parameters of NO_x, O₂, NH₃, wind speed and so on at the inlet and outlet of denitration system are tested, and the ammonia injection manual valve is adjusted according to the test results. After adjustment, the NO_x distribution at the outlet of denitration system is uniform, and the ammonia injection quantity is reduced. After adjustment, the flow field under 800 MW and 500 MW conditions is tested, and the flow field distribution under the two conditions is uniform. The adjustment test has achieved the expected effect.

1 Preface

Affected by the coal market supply, some power plants need to burn high sulfur coal. Burning high sulfur coal is easy to increase the mass concentration of NO_x at the furnace outlet of the boiler, and increase the production of ammonium sulfate or ammonium bisulfate in the flue, which will have a great impact on the control of key indicators such as the mass concentration of NO_x at the outlet of denitration system, SO₂ / SO₃ conversion rate, mixing effect of NH₃ and NO_x, NH₃ escape rate, and the safe and stable operation of denitration reactor body and air preheater. ^[1]Affected by the residual rotation of flue gas in the furnace, the flue gas baffle in the tail flue, the increase of large particle dust in the case of abnormal ash transportation of the economizer, which leads to the aggravation of the wear of facilities in the tail flue, the problem of uneven flue gas flow on both sides of the denitration system is easy to occur, which is easy to cause the mismatch between the amount of ammonia injection and the concentration of NO_x in the flue gas, and then the phenomenon of high ammonia escape rate. ^[2]In order to master and optimize the operation state of denitration system, the purpose of improving the uniformity of ammonia injection in the reactor of denitration system, reducing the ammonia escape rate, meeting the denitration efficiency, and protecting the safe and stable operation of boiler and its auxiliary equipment is achieved through experiments.^[3]

2 Equipment Overview

2.1 overview of boiler equipment

The boiler of a power generation Co., Ltd. is a single furnace with T-shaped symmetrical heating surface. The boiler is composed of furnace and two downcomers connected by horizontal flue. Two independent water channels and two independent steam channels are arranged in the furnace. In the flue of the boiler, the furnace jaw tube, stage I platen superheater, stage II and stage III platen superheater, feston tube 1, high temperature convective superheater, feston tube 2, high temperature section convective reheater and feston tube 3 are arranged along the flue gas flow. In the descending shaft, the low temperature section convective reheater, smooth tube economizer and three types of regenerative air preheaters, i.e.

2.2 overview of denitration system

Selective catalytic reduction (SCR) is used in denitration process, and liquid ammonia is used as reducing agent. Each boiler is equipped with two reactors. The reactor is located behind the economizer and in front of the air preheater. The flue gas is evenly divided into two paths at the outlet of the economizer. Each path of flue gas enters a vertical SCR reactor in parallel. The cross-section of the reactor is 18m × 10.85m. The catalyst is arranged in 2 + 1 mode. Two layers (middle and lower layers) of catalyst are filled from top to bottom. One layer (top layer) of catalyst is reserved and added on

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February 18, 2016. The three layers are all catalysts produced by Wuxi Longyuan Environmental Protection Technology Co., Ltd.

3 test items and methods

The grid method was used to test the flow field of flue, and the inlet and outlet flue gas composition, air

temperature, wind speed and other parameters of denitration system were tested under different stable conditions.^[4] The test grid distribution of the flue is shown in Figure 1. Five measuring holes are evenly distributed on the front and back walls of the inlet and outlet flue, and the flow field distribution is obtained by measuring and recording the data every 50cm in the flue depth.^[5]

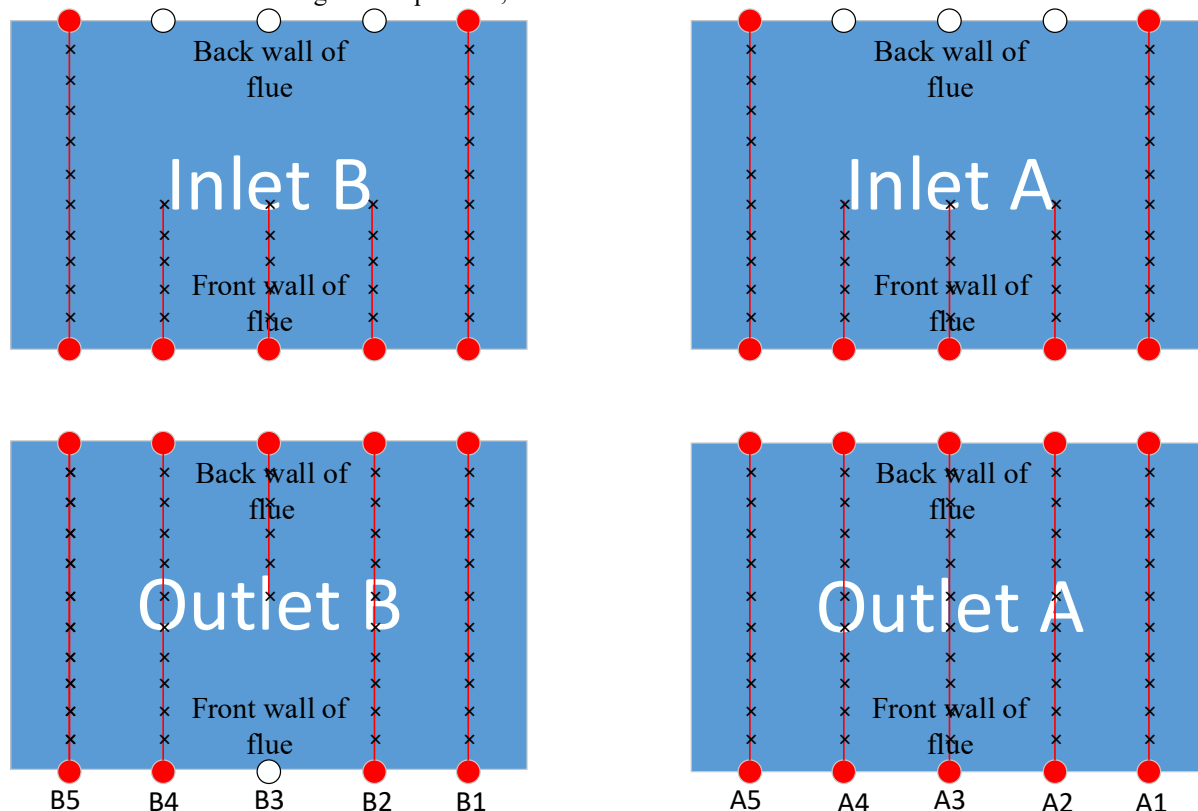


Figure 1. Test diagram of denitration system (blank round hole cannot be opened)

3.1 bottom test under 800 MW condition

The test was carried out under 800 MW stable condition. Before the test, the parameters of the boiler should be adjusted within the normal range (according to the requirements of the operation regulations) to maintain stable combustion and load. Soot blowing is not allowed during the test.

According to the principle of equal section grid method, the flue gas sampling system is installed at the inlet and outlet sections of the denitration system. During the test, the flue gas analyzer and the flue gas sampling device are used to continuously extract flue gas samples for flue gas composition analysis, and the NO_x, O₂, NH₃ and other components in the flue gas are tested and recorded. At the same time, the grid method is used to measure the wind speed and temperature at the inlet and outlet of the denitration system, and the results are obtained. The distribution fields of flue gas composition, wind temperature and wind speed were analyzed.

3.2 adjustment test of ammonia injection manual valve under 800MW condition

Adjust the manual valve of ammonia injection according to the test results. There are 25 manual valves of ammonia injection in the flue on both sides of a and B. adjust the manual valve of ammonia injection according to the distribution of inlet and outlet wind speed, NO_x and other parameters of denitration system. The adjustment range is not more than 20% each time. After each adjustment, sample and analyze the flue gas at the outlet of denitration system. If the NO_x distribution at the outlet is uniform after adjustment, adjust the manual valve. If the adjustment is successful, the adjustment will continue.

4 test results

4.1 test results under 800 MW condition

4.1.1 distribution of inlet wind speed of denitration system

The distribution of NO_x at the inlet of denitration system is shown in Table 1. (A1 and B1 in the table refer to flue measuring hole 1 on side a and flue measuring hole 1 on side B, the same below)

Table 1. NO_x test results of denitration system outlet

Outlet NO _x	Front wall of flue (ppm)				Back wall of flue (ppm)			
	1	2	3	4	4	3	2	1
Frount→Back								
A1	90	88	92	92	54	41	71	38
A2	76	84	87	88	45	25	34	21
A3	42	43	45	50	23	37	48	16
A4	11	9	8	11	42	17	41	27
A5	27	28	28	23	51	27	38	57
B1	23	13	8	7	37	11	26	12
B2	6	5	5	7	28	9	16	35
B3	×	×	×	×	21	30	26	19
B4	41	47	45	43	24	11	30	26
B5	61	61	60	60	26	41	18	31

After adjusting the manual valve of ammonia injection, the change distribution of NO_x at the corresponding outlet is shown in Table 2.

4.1.2 distribution of flue gas at denitration outlet after adjustment of ammonia injection manual valve

Table 2. NO_x distribution at outlet after adjusting ammonia injection manual valve

The fourth adjustment	Front wall of flue (ppm)					Back wall of flue (ppm)					
	Frount→Back	Point 1	Point 2	Point 3	Point 4	Point 5	Point 1	Point 2	Point 3	Point 4	Point 5
A1		61	64	63	63	60	26	26	25	26	26
A2		59	57	59	60	59	30	29	26	28	28
A3		42	44	46	49	51	44	44	42	41	43
A4		23	22	15	27	29	41	43	43	43	40
A5		20	21	20	21	33	49	48	49	49	48
B1		34	37	32	32	36	41	38	45	44	44
B2		27	26	28	26	31	30	31	31	27	27
B3		×	×	×	×	×	30	29	29	27	28
B4		42	40	44	45	47	24	22	20	21	21
B5		42	46	43	43	46	21	20	19	18	16

After four adjustments, the NO_x distribution at the outlet is more uniform than before.

4.1.3 change of ammonia injection during adjustment

After the adjustment, the ammonia injection amount of denitration system decreased, and the change of ammonia injection amount is shown in Table 3.

Table 3. Statistical table of ammonia injection during test

Time	Total ammonia injection at side A (m ³ /h)	Total ammonia injection at side B (m ³ /h)	Total (m ³ /h)	Statistical interval ammonia injection (m ³ /h)	Statistical interval ammonia injection (Kg/h)
2020/7/8 8:00	2659495.5	2765599.2	5425094.7	3106.5	2395.1
2020/7/8 16:00	2661087.5	2767113.7	5428201.2		
2020/7/9 8:00	2663957.7	2769629.5	5433587.2	2841.5	2190.7
2020/7/9 16:00	2665489.5	2770939.2	5436428.7		

2020/7/10 8:00	2667717.7	2773253.2	5440970.7	2108.5	1625.6
2020/7/10 16:00	2668804.7	2774274.5	5443079.2		
2020/7/11 8:00	2671468.7	2776955.5	5448424.2	2316.7	1786.2
2020/7/11 16:00	2672549.7	2778191.2	5450741.0		
2020/7/12 8:00	2674708.0	2780571.5	5455279.5	2117.5	1632.5
2020/7/12 16:00	2675667.5	2781729.5	5457397.0		

5 conclusions

5.1 optimize and adjust the denitration system according to the field measured data. It is found that the distribution of NO_x content in the flue is uneven, which is the main reason for the uneven distribution of NO_x concentration at the outlet.

5.2 after adjusting the manual valve of ammonia injection for four times, the NO_x distribution uniformity at the outlet of the denitration system is improved, and the ammonia injection quantity of the denitration system is decreased after adjustment. The flow field of the denitration system is tested under 800 MW operation condition, and the test results show that the NO_x distribution at the outlet is uniform, which achieves the expected effect of adjustment.

5.3 it is suggested to control the NO_x content at the inlet of denitration system through combustion adjustment, formulate reasonable NO_x control methods, greatly reduce the ammonia injection amount by reducing the NO_x content at the inlet of denitration system, reduce the corrosion and loss of air preheater and its auxiliary equipment, and extend the service life of equipment.

5.4 regularly check and calibrate the local measuring points of NO_x at the denitration outlet, and timely adjust the ammonia injection manual valve when the deviation is large, so as to ensure the normal display of NO_x content on the dial and reduce the amount of ammonia injection.

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