Analysis on the operation characteristics of the denitration facilities utilized in coal-fired power plants of a province in Southern China

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Abstract. This paper firstly introduces the capacity,proprtion and type distribution for the denitration facilities utilized in a province in Southern China,and then analyzes the impact of the situation that the SCR exit operation in equipment fault and low smoke temperature under low load combined with the power plant de NOx equipment running status statistics.The data showed that the annealing time in low temperature for SCR denitrification facility account for 99.7% of the total exit operation time,which has become a major problem of SCR denitration facilities operation. Finally,in order to solve this problem,the suggestion for the improvement of heating surface transformation in the boiler is put forward to improve the load adaptability of SCR denitrification system.

1. Introduction

According to the data provided by the Internal Federation of Electric Power Enterprises,a large amount of coal has been burning to generate electricity.Up to the December in 2011,the National power generation capacity has reached 1.06×10^9 kW, of which the thermal power is 7.7×10^8 kW, accounting for 72.6% of the national total installed ,and the thermal power generating capacity accounts for about 82.4% of the total power generation capacity.Besides,the form of the thermal power is almost coal-fired power generation,and other forms still account for less than 0.1% of the total generating capacity,Which consumes about 18.2 tons of the raw coal in over 6000 kw of the coal-fired plants[1-2].However,pollutants generated by the coal is the main source of atmospheric pollutants.According to the data provided by the Internal Environmental Monitoring Station,the total amount of NOx emissions in home was 2.4×10^7t in 2011[3], of which was 1.73×10^8 from the industrial,but the thermal power industry in the process of the NOx emission accounted for more than half of the industrial .Therefore, it is necessary to take measures to curb the increasing momentum and gradually reduce the NOX emissions .Take the internal as an example,from the beginning of January 1th in 2012, atmospheric pollutant discharge standard for the fossil fired power plant in GB 13223-2011, Regulating the limits of the nitrogen oxide emission from 450mg/m3 to 100mg/m3 for the new units and 200mg/m3 for the one in service, has been carried out and the " economic and social development in national five year plan"adopted the fourth National People's Congress of the eleven meeting in March 2011,which clearly put forward the nitrogen oxide emission reduction 10% of the binding targets in the Twelfth Five Year[4].

Since the beginning of the Eleventh Five Year, the state has strengthened the management of pollutant emissions, requiring the power generation enterprises to carry out denitrification transformation.With the denitration facilities utilized in coal-fired plant, the complexity of the operation of the unit would be added,which brings new problems of the unit in safe and stable operation[5-6].Especially in recent years,this influence has become more and more serious with the more strict environmental standards ,which will to increase the uncertainty of the whole system.Therefore,this paper firstly introduces the denitration facilities utilized in a province in Southern China,and then analyzes statistically the operation status from 2012 to 2014 combined with the power plant de-NOx equipment running status statistics and the impact of the situation that the

SCR exit operation in equipment fault and low smoke temperature under low load combined with the fault case in operation..

2. The overview of denitrification facilities for coal fired power plant in a province in Southern China

The Summary of the denitrification facilities for 10 coal fired power plants in a province in Southern China is summarized in Table 1。As is shown in Table 1，the total capacity of generating unit accounts for 93.8% of the all installed capacity of the coal-fired power plants in a province in Southern China.There are ten 600MW，eighteen 300MW and two 200MW among the units,which respectively accounts for 47.7%,42.9%,3.2% of the total capacity of the coal-fired power plants in a province in Southern China.Among which,the 600MW coal-fired generating units are all used W type in boiler and designed for burning anthracite,and the 300MW coal-fired generating units are all used the subcritical pressure boilers,of which is twelve tangential firing boilers and six circulating fluidized bed boilers,and designed for burning lignite or bituminous coal.

As is shown in Table 1,all units in coal-fired power plants with the SCR denitrification technology to reduce the NOX except circulating fluidized bed boilers with the SNCR denitrification technology.A classification map of denitrification device in the coal-fired plant in a province in Southern China in Figure 1.

Tab. 1 An overview on the Denitrification device of coal-fired power plant in Yunnan Province

Serial number	Unit type	Furnace type in Boiler	Peak load （%）	Denitrification process	Design of entry NOx （mg/Nm^3）	Design of efficiency （%）	Design of ammonia escape （ppm）	Operating temperature （℃）	Operating load （%）	Operation time
1	4*600MW in subcritical	W 型	≥ 60.0	SCR	1100	81.0	≤3	340~ 420	≥ 63.3	2013-6 至 2014-11
2	2*600MW in subcritical	W 型	-	SCR	1200/ 536	83.3/80.0	≤3	333~ 430/ 310~ 425	≥ 55.0	2009-9 至 2013-12
3	2*600MW in supercritical	W 型	≥ 60.0	SCR	1100	82.0	≤2.28	305~ 430	≥ 60.0	2012-7 至 2012-12
4	2*600MW in supercritica	W 型	≥ 60.0	SCR	1100	80.0	≤3	380~ 420	≥ 50.0	2012-1 至 2012-3
5	4*300MW in subcritical	tangential firing	≥ 53.3	SCR	500	75.0	≤3	310~ 420	≥53.3/ 58.3	2013-10 至 2014-12
6	6*300 MW in subcritical	tangential firing	≥ 56.6	SCR	400	80.0	≤3	314~ 400	≥53.3	2013-3 至 2014-5
7	2*200MW in supercritica 2*300MW in subcritical	hexagonal tangentially fired/tangential firing	≥ 45.0	SCR	650	85.0	≤3	325~ 420	≥ 45.0	2014-10 至 2014-11
8	2*300MW in subcritical	circulating fluidized bed	≥ 50.0	SNCR	350	70.0	≤5	750~	≥ 23.3	2014-12 至 2015-1
9	2*300MW in subcritical	circulating fluidized bed	-	SNCR	350	70.0	≤10	-	≥33.3	2015-2 至 2015-3
10	2*300MW in subcritical	circulating fluidized bed	-	SNCR	250	65.0	≤7.6	830~ 1000	-	2014-12

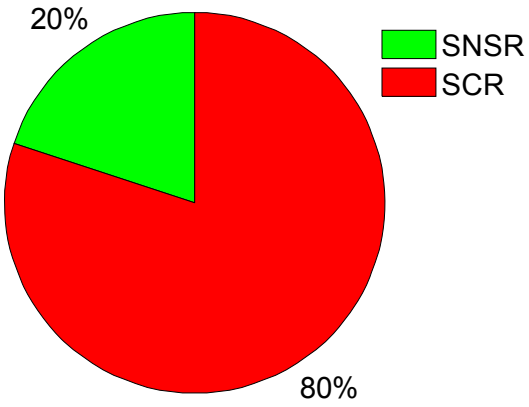

Fig.1 A classification map of denitrification device in the coal-fired plant in Yunnan province

As is shown in Figure 1,with the high denitration efficiency ,the SCR technology are widely utilized in denitration facilities in a province in Southern China,which accounts for 80％of the total units.If so, the nitrogen oxide emission concentration of the unit is maintained under the 100 mg/m3, which can meet the current standards on the nitrogen oxide emission. For the conventional coal-fired units,with the low NOx burning technology,the nitrogen oxide emission concentration for boiler output is only maintained under the 400 mg/m_3[7],and if the discharge concentration in the unit reach the standard, the denitrification efficiency will need to reach at least 75%.However,at present the SNCR technology is very difficult to meet the requirements. As is shown in Table 1,the efficiency of the design can reach more than 80% with the SCR technology,while the SNCR technology can reach at most 70%.

As is also shown in Figure 1,the minimum operating temperature of SCR denitrification facilities is mainly distributed at 305~340℃and the maximum operating temperature of SCR denitrification facilities is mainly distributed at 400~430℃,which is mainly determined by the reaction temperature of the catalyst.If the reaction temperature is too low, ammonium hydrogen sulfate will be generated, which will lead to the loss of the system;while if the reaction temperature is too high, it may cause the phase change of the catalyst materials, resulting in the degradation of the catalyst activity [8].According to the Figure 1,Through the lowest peaking load in plants contrast the minimum operation load of the design for the denitrification facilities,it is not difficult to find that 14 sets of SCR denitrification devices in the lowest operation load is less than or equal to the limit of the peak load regulation,which accounts for 63.6% of the total.However,for the SNCR denitrification facilities,the minimum operation load is lower than that of SCR combined with the feedback information from the plants,such as the 8# power plant (23.3%) and 9 (33.3%) power plant in the Figure 1.

According to the Figure 1,Comparing the design value of NOx in the inlet of the denitrification facilities for the variety of boiler types,the conclusion can be found that the NOx in W type boilers is the highest that the data is basically 1100~1200mg/Nm3 except from the SCR denitrification device of the2# boiler in the second plant;the quantity of the inlet NOX of the denitrification facilities in tangential firing boilers are basically 400~650mg/Nm3 that next to in W type boilers,while the design value of NOx concentration of the SNCR denitrification device inthe circulating fluidized bed boilers is minimum,which is basically between 250~350mg/Nm3.Therefore, according to the “air pollutant discharge standard in the thermal power plant” beginning to be carried out in January 1,2012,the design value of the SCR denitrification devices for the pulverized coal-fired boilers is 75~85%, while in the SNCR for the circulating fluidized bed boilers is 65~70%.

3. Analysis on the operation of denitrification devices

As is shown in Table 2, the operation situation of the denitrification facilities for above ten plants has been collected ,which can be found that the denitrification rate of SNCR is lower, but the reliability is very high. Although the denitrification rate is high that generally more than 80%,the case

of annealing operation has increased significantly in the fault probability and low temperature.Furthermore,the exit operation of the SCR in low temperature when the unit load is relatively low is the main problem of the SCR operation.As is shown in Figure 2,in recent years ,while the time of the SCR annealing operation for all units is only 87.5 hours because of all kinds of equipment fault, the exit operation time, due to the low temperature in lower load, has reached about 28332 hours,which has accounted for 99.7% of the situation of the SCR denitrification facilities exit operation and become the main problem of SCR devices operation..

Tab. 2 A statistical summary of the operating status for the NOx removal device of a province in Southern China

Serial number	Actual of export NOx(mg/Nm^3)	Actual of export NOx(mg/Nm^3)	Average efficiency(%)	Average ammonia escape(ppm)	O_2/SO_3Conversion rate（%）	pressure drop in System (Pa)	Minimum operating temperature(℃)	Annealing operation time in low temperature (h)	The types and times in the fault
1	1100	200	82.4	1.8	0.8	800	340	-	无
2	1329/1066	168/187	88.5/83.8	2.03/1.67	-	170/320	340/340	0	The fault of ammonia evaporator in #2 unit in2012, The SCRexit operation period is 3.58h in a unitat one time. The leakage of ammonia area in #2 unit in2013, the SCRexit operation period is 3.58h in a unit at one time.
3	890	180	≥85.0	≤2.21	≤0.93	650	305	2012-7 to 2014-12，#1 6769.96；2012-12 to 2014-12，#2 14496.51	无
4	1335/1366	175/165	81.5/83.0	1.32/1.45	0.72/0.72	720/736	380/380	-	The SCRexit operation period is 2h in a unit at one time as the obstraction of flame arrester in the transporting ammonia pipeline in 1#unit in2013. The SCRexit operation period is 1h in a unit at one time as the fault of the liquid ammonia Control Valve in 1#unit in2014.
5	523/580/623/630	120/136/130/133	≥75.0	1.01/1.3/1.65/1.61	≤1.0	539/510/505/530	310	0	无
6	330	80	≥80.0	≤3	≤1.0	360	300	2013-6 to 2014-12，#7 1523.83；2013-6 to 2014-12，#8 2184.48；2013-12 to 2014-12，#9 610.31；2013-12 to 2014-12，#10 772.42；2013-3 to 2014-12，#12 1974	无
7	550	100	≥82.0	≤3	≤1.0	30	315	0	The SCRexit operation period is 35.4h in a unit at two times as the fault of the mixer of the ammonia and air in 3#unit in2014. The SCRexit operation period is 26.8h in a unit at one time as the blocking air preheater in 3#unit in2015. The SCRexit operation period is 3.3h in a unit at one time as the leakage of the spray ammonia valve in 4#unit in2014. The SCRexit operation period is 2.17h in a unit at two times as the blocking diluting wind flowmeter in 2#unit in2014. The SCRexit operation period is 12.08h in a unit at two times as the blockage of the mixer of the ammonia and air diluting wind flowmeter in 4#unit in2014.
8	-	-	85.0/84.0	-	/	/	750	0	无
9	350	180	≥70.0	≤10	/	/	-	0	无
10	-	-	≥70.0	0.97/1.02	/	/	760	0	无

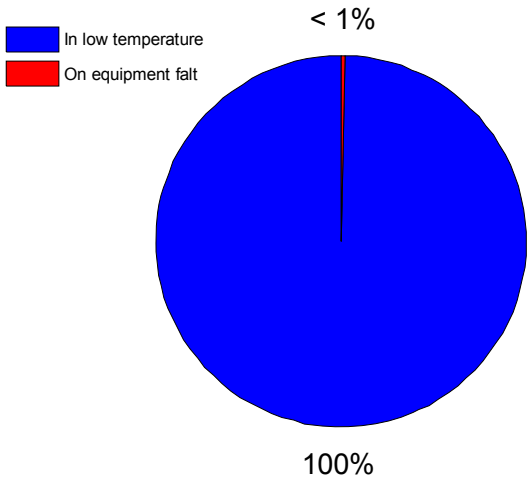

Fig.2 The distribution of the SCR device in exit operation

4. The Conclusions and recommendation

（1）In a province in Southern China,the SCR technology is mainly utilized in denitration facilities of the Coal-fired power plants while the SNCR technology is used for the circulating fluidized bed units.

（2）comparing the two kinds of denitrification devices, the reliability of SNCR technology is very high but the denitrification rate is lower, which is only suitable for the circulating fluidized bed boilers.

（3）The time of the SCR denitration facilities annealing operation in low temperature under lower load is longer that accounts for 99.7% of the total in units,which is the main problem for the SCR technology.The recommendation on the transformation of the boiler heating surface to improve the load adaptability for the SCR denitrification system.

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