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Application and Effect Evaluation of AIG Optimization Adjustment Strategy for SCR Denitrification System After Ultra-low Emission Transformation of Coal-fired Units

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Abstract. In order to solve the typical problems that occurred after the ultra-low emission reform of coal-fired power plants, the AIG optimization strategy was used to study the denitration system of a 600MW unit. The research shows that the uniformity of NO_X concentration at the outlet of the denitrification reactor is significantly improved, and the relative standard deviation is reduced to less than 15%, which eliminates the local high concentration of ammonia slip. The deviation of NO_X monitoring data from the denitration reactor outlet and the desulfurization outlet was significantly improved. The AIG optimization adjustment strategy can be used as an effective means to mitigate and solve the typical problems of denitration systems after ultra-low emission retrofit.

1. Introduction

In recent years, in order to improve environmental air quality, China has formulated stricter standards and policies for pollutants discharged into the atmosphere by thermal power industry. On December 11, 2015, The Ministry of Environmental Protection, the National Development and Reform Commission and the Energy Bureau jointly issued *The Notice on Printing and Distributing the Work Plan for the Full Implementation of the Ultra-Low Emission and Energy-Reconstruction of Coal-Fired Power Plants (Huanfa [2015] No. 164)*, the requirements in the notice from coal-fired power plants under the condition of 6% oxygen content will NO_X emission concentration fell to below 50 mg/m^3, in order to meet more stringent emission limit, coal-fired power plants as ultra-low emissions. In the transformation of ultra-low emission denitrification system, SCR denitrification technology is selected by most coal-fired power plants due to its characteristics of reliable operation, high efficiency and good economy [1]. After ultra-low emission transformation, as the running time of the denitrification system goes by, some typical problems gradually appear in the SCR denitrification system, such as: NO_X distribution at the outlet of denitrification system is not uniform [2,3], ammonia escaping from the exit of denitration system exceeds the standard [4,5], the online monitoring data of the outlet of denitrification system deviates greatly from that of the total outlet,and deviation of measured data and monitoring data occurred [6-8]. The emergence of these problems poses challenges to the safety, economy, reliable operation of coal-fired power plants and the stability of NO_X emissions [9]. In order to solve the above problems, this study based on the equipment characteristics of the SCR denitration, taking a 600MW unit as an example, the SCR denitration system tuning of AIG strategy effectiveness is evaluated.

2. AIG structure

AIG is short for ammonia injection grid. The research object is a typical AIG structure in China. Each reactor has 9 sets of ammonia-spraying pipelines along the furnace width direction in the inlet vertical section flue. Each group of upper and lower 2 branches is installed at different depths. The regulating valve controls the amount of ammonia sprayed, and has lateral and longitudinal adjustment functions. The gas ammonia is mixed with the dilution air and then enters the reactor through the AIG. The structure and layout of the 600MW denitrification system's ammonia spray grille are shown in figure 1

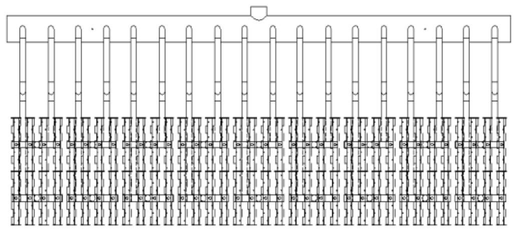

Figure1` Ammonia grid structure diagram

3. Adjust the strategy

- Baseline test. The unit adjusted the ammonia flow rate at full load to make the denitrification efficiency reach the designed value, measured the distribution of NO_X and ammonia escape concentration at the inlet and outlet of the reactor, and preliminarily evaluated the actual efficiency of the denitrification system and the distribution status of ammonia injection flow.
- Optimization and adjustment of ammonia injection. Under the full load of the unit, the denitrification efficiency was set. According to the NO_X concentration distribution at the outlet section of the reactor, the manual butterfly valve opening of the ammonia spray grille at the SCR inlet was repeatedly adjusted to maximize the uniformity of NO_X distribution at the outlet of the reactor. After levelling at full load, verification is carried out under 75% and 50% load.

4. Effect evaluation

4.1. Outlet NO_X uniformity

First to carry out the baseline test, using the grid method, delay the reactor transverse direction of the eight points, each horizontal on the measuring point layout 4 longitudinal station, under high load condition to carry out the test.The concentration distribution of NO_X at the reactor inlet is shown in figure 2.

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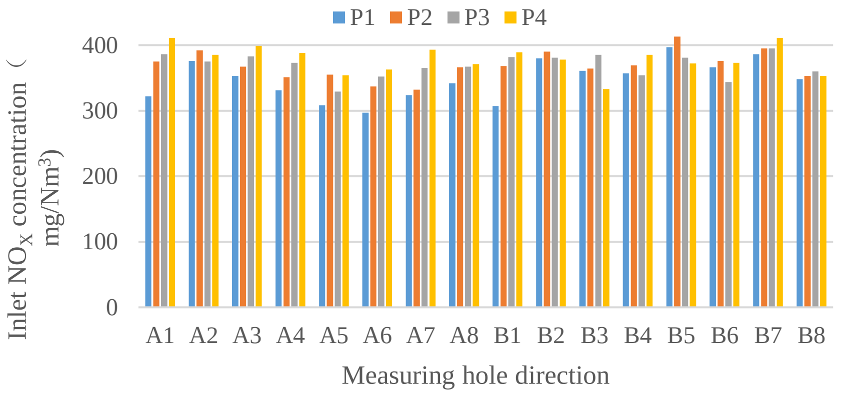

Figure 2 Test results of NO_X concentration at the inlet of SCR reactor before adjustment
A side relative standard deviation:7.58%,B side relative standard deviation:5.95%

As can be seen from figure 2, the distribution of NO_X at the reactor inlet is relatively uniform. The standard deviation of NO_X concentration at the reactor inlet at side A is 7.58%, and the standard deviation of NO_X concentration at the reactor inlet at side B is 5.95%, indicating A relatively good uniformity.

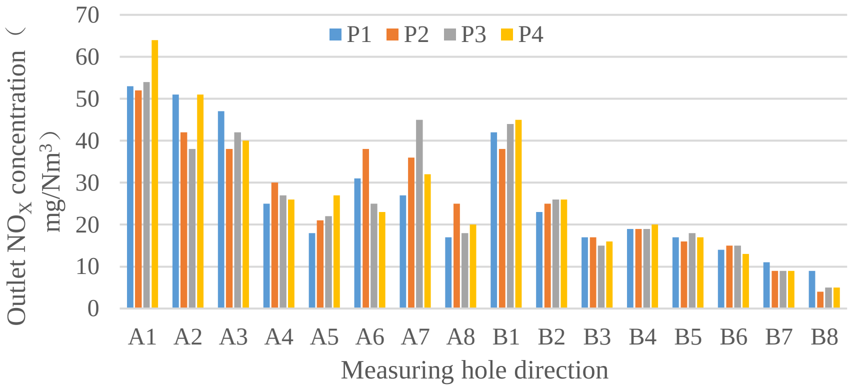

Figure 3 Test results of NO_X concentration at the outlet of SCR reactor before adjustment
A side relative standard deviation:36.68%,B side relative standard deviation:57.47%

It can be seen from figure 3 that the NO_X at the outlet is not uniform, and the direction of the reactor along the measuring point at side A (A1-A8) generally shows A decreasing trend, and the concentration of NO_X rises sharply at the measuring points A6 and A7. The direction of the extension measuring point (B1-B8) of the reactor at side B shows a downward trend. At the measuring point B8, the concentration of NO_X at the reactor outlet has been as low as below 10 mg/Nm^3. From the standard deviation of the concentration of NO_X at the reactor outlet, the standard deviation of the concentration of NO_X at the reactor outlet of side A was 36.68%, and the standard deviation of the concentration of NO_X at the reactor outlet of side B was 57.47%, both far exceeding 15%.

According to the NO_X distribution at the reactor outlet, the corresponding AIG was adjusted, and the corresponding AIG adjustment degree was adjusted. The distribution of NO_X at the reactor outlet after the adjustment was shown in figure 4.

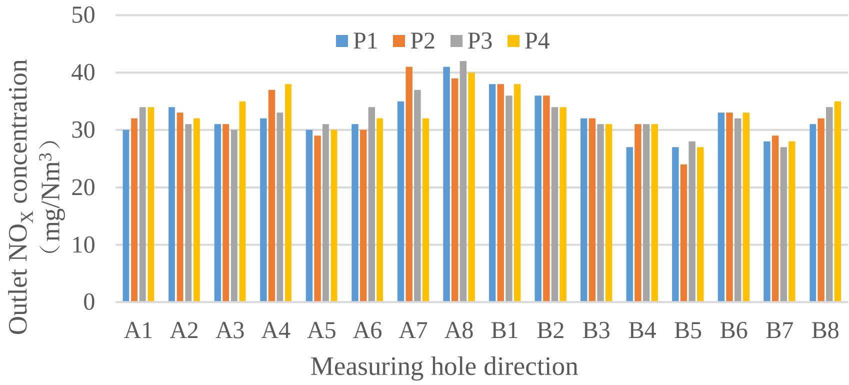

Figure 4 Test results of NO_X concentration at the outlet of SCR reactor after adjustment
A side relative standard deviation:11.02%,B side relative standard deviation:11.40%

Adjusted by figure 4 is obvious, the uniformity of the export of NO_X in the transverse and longitudinal direction of the measuring point measuring point were improved greatly, and the standard deviation of A side NO_X concentration of outlet of the reactor was 11.02%, the standard deviation of B side NO_X concentration of outlet of the reactor is 11.40%, less than 15%, and this can be seen that the export NO_X concentrations were uniformity adjustment before have greatly improved.

Furthermore, the optimization and adjustment effect is verified by medium and low load, as shown in figure 5 and figure 6

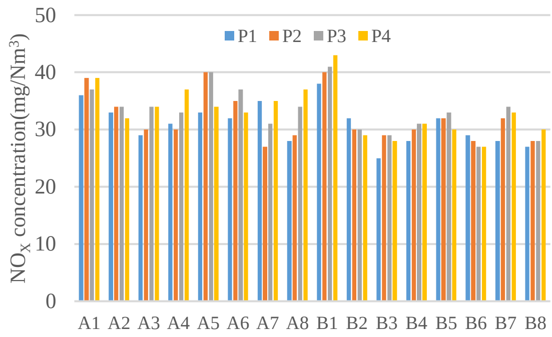

Figure 5 Verification test results of NO_X concentration at outlet of medium load SCR reactor
A side relative standard deviation:10.09%, B side relative standard deviation:13.64%

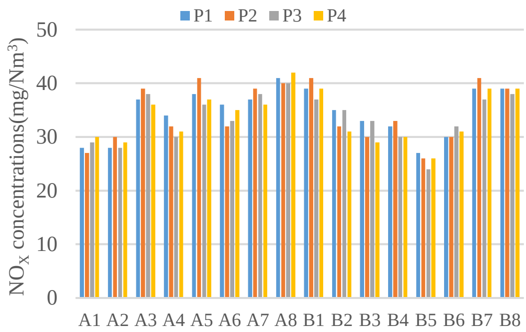

Figure 6 Verification test results for NO_X at outlet of low load SCR reactor
A side relative standard deviation:13.11%, B side relative standard deviation:14.33%

It can be seen from figure 5 and figure 6 that after AIG optimization and adjustment, the NO_X uniformity at the reactor outlet is relatively good under medium load and low load conditions. Under medium load conditions, the standard deviation of NO_X concentration at the outlet of side A and side B reactors was 10.09% and 13.64%, respectively. Under low load conditions, the standard deviation of NO_X concentration at the outlet of side A and side B reactors was 13.11% and 14.33%, respectively. According to the above tests of NO_X concentration at the outlet under various working conditions, after AIG optimization and adjustment, the uniformity of NO_X concentration at the outlet was significantly improved, and the standard deviation of NO_X concentration at the reactor outlet under all working conditions was less than 15%.

4.2.Ammonia escape

Ammonia escape at the reactor outlet before and after adjustment was tested under the main load, and the test results are shown in figure 7.

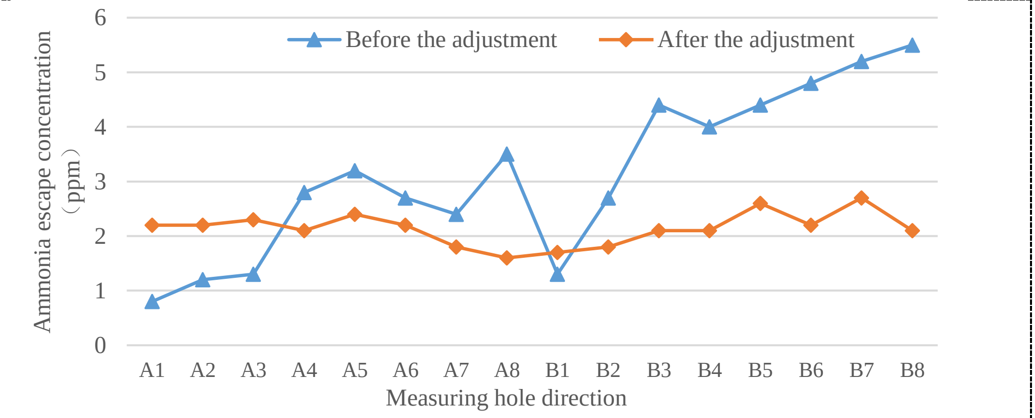

Figure 7 Test results of Ammonia escape concentration

As can be seen from figure 7, before the adjustment, the distribution of ammonia escape at the exits of side A and side B is uneven and on the local high side. For example, most measuring points on side B have exceeded 3ppm [10] and the highest has reached 5.5ppm. Through the adjustment, the ammonia escape distribution at each measuring point has been significantly improved, and the distribution is relatively uniform, which reduces the probability of air preheater clogging and provides an effective reference for unit operation adjustment.

4.3.Monitoring data deviation

The NO_X concentration test results of A and B reactor outlet and total discharge outlet before and after optimization and adjustment are shown in table 1.

Table 1. Comparison of NO_X concentration between outlet of denitration reactor and total discharge

Project	A side reactor		B side reactor		Total discharge	
	Before adjustment	After adjustment	Before adjustment	After adjustment	Before adjustment	After adjustment
Measured value(mg•m^{-3})	45	34	19	35	32	34
CEMS value(mg•m^{-3})	36	32	13	33	24	33
Relative deviation(%)	20	5.9	31.6	5.7	25	2.9

As can be seen from table 1, before the optimization and adjustment, the measured values of NO_X concentration at the outlet of the reactor A and B and the total discharge outlet were relatively different from the CEMS monitoring values, which were 20.00%, 31.6% and 25.00% respectively. It was easy to mislead the operation and adjustment of the denitrification system, and it also affected the reliability and authenticity of the monitoring data uploaded to the environmental protection department. After adjustment, the monitoring value of each CEMS measuring point is very close to the average value of A and B reactor outlet, and the relative deviation is 5.9%, 5.7% and 7.3%, respectively, indicating that the CEMS monitoring data is representative and can truly reflect the actual size of NO_X concentration in the flue, which can be used as the basis for operation adjustment and improve the reliability and authenticity of the data.

5.Conclusion

The above research shows that after the ultra-low emission transformation of coal-fired units, the uniformity of NO_X at the outlet of SCR denitrification system can be significantly improved through targeted optimization adjustment of AIG, and the relative standard deviation of NO_X concentration at the outlet of each working condition can be reduced to less than 15%. The ammonia escape concentration is significantly reduced, which eliminates the situation that the local ammonia escape concentration is on the high side, reduces the probability of NH_4HSO_4 generation and the probability of clogging the air preheater. The relative deviation is only 2.9% ~ 5.9%. Therefore, the CEMS value can be used as the true value for ammonia injection regulation, which improves the reliability and authenticity of NO_X monitoring data. Practice shows that AIG optimization and adjustment strategy can effectively solve the typical problems in the current denitrification system, and provide a reliable guarantee for the safety, economy, reliable operation of coal-fired power plants and the stable discharge of NO_X.

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