Automatic logic optimization of denitrifying ammonia system for supercritical unit

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Abstract: Based on the optimization of the automatic logic of the supercritical unit denitrifying ammonia system in a power plant, a cascade control system with the output NOx concentration as the main control loop and the supply ammonia flow as the secondary control loop is proposed, and on the basis of the cascade control system, the control strategy for eliminating system interference is added. Increase the response rate of the system. In particular, when the NOx concentration at the entrance fluctuates considerably, the optimized ammonia injection system quickly issues instructions to the ammonia flow regulator to adjust the NOx concentration at the flue gas outlet so that it tends to set values in a short period of time.

1. Introduction
The flue gas denitrification project of a supercritical unit of a power plant has received the attention of government departments and environmental protection departments at all levels since its construction started. This project has successfully completed the trial operation under the hard work and close cooperation of construction units, supervision departments, and commissioning departments. All parameters meet the design requirements since the operation[1]. Based on the design of the automatic logic optimization of the supercritical unit denitrifying ammonia system, this paper introduces the optimization scheme of the automatic logic, and illustrates the feasibility of this optimization scheme by comparing the results of denitrification before and after optimization.

2. Introduction to Process Flow of Dropout System
The denitrification system consists of an ammonia zone and a catalytic reaction zone. The ammonia zone is arranged on the periphery of the boiler, including evaporation tanks, ammonia storage tanks, compressors, and buffer tanks, providing ammonia gas for SCR catalytic denitrification. The catalytic reaction area is located between the air preheater and the coal economizer of the boiler. It consists of ammonia injection grille, reactor, dilution fan and other equipment[3]. First, the compressor compresses the liquid ammonia from the ammonia tank to the ammonia storage tank. The liquid ammonia evaporates into ammonia gas through a water bath in the evaporation tank and transports ammonia gas to the buffer tank. After decompression of the valve, the ammonia gas is transported to the mixer, fully mixed with the air from the diluted fan, and then sprayed into the boiler flue through the nozzle of the injection grate, and mixed with the flue gas into the reactor[3].
3. Automatic Control Scheme before Optimization

The denitrification control system of this power plant uses the Symphony Infi 90 system produced by ABB, and the software version number is PGP(Power Generation Portal) V3.2 and Compose V4.3. In this control mode, the system removes NOx from the flue gas according to a fixed NH3/NOx ratio. The main regulator of the ammonia injection system is the content of NOx at the exit of the denitrifying reactor, and the secondary regulator is the pre-ammonia flow rate of the ammonia air mixer of the denitrifying system[4].

The control strategy before the optimization adopts a cascade control method. The supply flow of ammonia in the main control loop is calculated as a public instruction. After calculating the total supply of ammonia, it is divided into two to two auxiliary control circuits to adjust the ammonia adjustment door. The NOX concentration selection of the process value outlet of the main control loop is a two-choice one to take a large value, and PID adjustment is performed according to the large value. When one of the measurement points is identified as a bad point by the bad quality judgment block, another measurement point is taken[5]. The common instruction is the product of the basic supply of ammonia and the output NOx concentration calculated by the PID calculated by the folding function after the unit load is calculated by the folding function, plus the value after the load change rate is converted, and the output NOx concentration measurement device is corrected. Since the control strategy was put into operation, the denitrification effect was significant when the NOx concentration was stable at the entrance, but when the NOx concentration at the entrance fluctuated greatly, the adjustment response was often slow, because NOx was selected on one side to adjust. The deviation of the A and B sides of the reactor can not be well adjusted, resulting in too little or too much injection of reducing agents, and the NOx concentration measuring instrument at the exit and entrance is regularly blown. When the measurement value is blown, it is not changed and can not be adjusted in time., resulting in large fluctuations in the export NOx. In this way, the automatic loop input of the ammonia injection system is unstable, which will seriously affect the long-term stable operation of the denitrification system for a long time[6].

4. Optimized Automatic Control Scheme

The optimized logic still uses the cascade control method. The A and B sides are changed to control separately. The main control loop calculates the amount of ammonia required by the corresponding side entrance NOx, multiplied by a coefficient of 0.8, and the exit NOx concentration is the process quantity. The desired export NOx concentration is calculated as a set PID value, and the ammonia requirement is added to the NOx concentration of the net flue gas outlet when its rate of change is greater than 38. The secondary control loop is an ammonia adjustment gate with the desired ammonia volume as the setting value compared with the actual ammonia injection amount[7].

When the NOx concentration measuring instrument at the A side entrance is blown, the B-side value is added with the time difference between the A side and the B side to maintain the correct change trend of the A side value in the automatic adjustment. The B-side principle is the same as the A side; When the NOx concentration measuring instrument is blown at the exit, the switching setting value is equal to the amount of process, the PID output maintains the pre-sweep value, and the entry NOx is converted by the function to a factor multiplied by 0.85 to enhance the entry. The effect of the NOx concentration on ammonia demand, Ensure that the instrument can be properly adjusted during the cleaning period[8]. After the cleaning is completed, the export NOx does not fluctuate much. It also added the main control loop PID variable integral switching function when AGC is put into R mode. After the R mode is put into, the integral effect is enhanced, the adjustment is faster, and the adjustment quality is guaranteed when the load fluctuates.

5. Debugging after logical optimization

According to the control strategy proposed in this paper, the ammonia supply automatic loop of the supercritical unit is reconfigured and programmed. According to the historical data, the initial value of the line function in the logic of the ammonia injection system is set, and the parameter trend curve
under different working conditions is observed, and the parameters are repeatedly tested and adjusted, and the automatic adjustment function of the control loop is basically realized. After debugging, the maximum deviation between the exit NOx and the set value is ±4mg/m3 when the AGC enters the O mode, and the maximum deviation between the exit NOx and the set value is ±8mg/m3 in the R mode, and the most time deviation is within ±3mg/m3. There are major improvements before optimization.

After the modification of the automatic loop of ammonia supply in the supercritical unit of the power plant, the relevant parameters were reset in the lower assembly. After dozens of grooves and tests by the relevant technicians, the parameters were finally set to the optimal value. The expected adjustment effect was achieved.

6. Control effect after logical optimization

As shown in Figures 1 and 2, when the NOx concentration at the entrance of the denitrification system of the supercritical unit of the power plant fluctuates significantly before and after the logical optimization of the denitrification system, Comparison of the changes of important parameters such as the concentration of NOx at the exit of A and B sides and the setting value of the ammonia injection regulator[9].

As can be seen from the contrast diagram, when the setting value in the logic is significantly different from the exit NOx, the optimized logic will quickly issue an instruction to the ammonia control door to adjust the NOx of the flue gas outlet, so that the exit NOx gradually tends to set values. The logic before optimization can not achieve this effect, and the optimized NOx content of the flue gas outlet is stable below 50mg/m3, and NOx is extremely low in emissions. It can be seen that after the automatic logic optimization of the denitrification ammonia system, Both in the control mode and denitrification efficiency can achieve satisfactory results.

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1. Reactor A entrance NOx
2. Generator power
3. Ammonia air mixer A ammonia supply valve position
4. Net flue gas NOx concentration
5. Reactor A exit NOx setting value
6. Reactor A exit NOx measurement

Fig. 1 Control effect of denitrifying ammonia system before optimization
Fig. 2 Control effect of denitified ammonia system after optimization

However, due to the denitrification equipment of the plant, we encountered many problems in the configuration process: There are sometimes deviations between the NOx concentration of the SCR reactor outlet and the NOx of the net flue gas outlet due to different measurement methods and equipment, and the time is small and large. It is difficult to control. Continue to optimize in future work; There are too few sampling points at the exit of NOx, and the flue gas field in the flue pipe is complex. It is difficult to use one point to represent the NOx concentration of the entire flue. It is recommended to use the grid method to measure to ensure the accuracy of NOx concentration measurement[10].

7. Conclusion
In this paper, the process of flue gas denitrification system in thermal power plant is briefly introduced, and the automatic logic of a supercritical unit denitrifying ammonia system is optimized. The optimized control strategy can effectively eliminate the deviation caused by the fluctuation of NOX content in the denitrifying inlet flue gas. It can overcome the pure lag in the control process, improve the efficiency and stability of the denitrification system, and provide reference for similar scientific research and engineering projects.

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