Study on Temperature Control Strategy of Boiler Main Steam for Frequent Action of AGC Command in Power Grid

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Abstract. Traditional PID is widely used in the main steam temperature control system of thermal power unit Cascade control. Although this control scheme is easy to be debugged on site, it is impossible to solve the problem of large fluctuation and over temperature of steam temperature only by adjusting PID parameters due to the characteristics of variable parameters, large inertia and large time delay of main steam temperature control system. Especially when the AGC command of power grid fluctuates frequently, the conventional control strategy is difficult to deal with, resulting in the change of main steam temperature regulation quality Poor, affecting unit economy and safety. In this paper, the sub PID set value adaptive control logic and desuperheating water injection logic to prevent the main steam temperature overshoot are used to solve the problem of the quality deterioration of the main steam temperature regulation under the frequent fluctuation of AGC instructions.

1 Introduction

The main steam temperature is one of the main control parameters of the thermal power unit. Its control effect directly affects the safe and economic operation ability of the unit[1]. At present, the traditional PID is widely used in the main steam temperature control system of thermal power units Cascade control: Although the on-site commissioning of this control scheme is simple, it is difficult to solve the problem of large fluctuation and over temperature of steam temperature only by adjusting PID parameters due to the characteristics of variable parameters, large inertia and large time delay of the main steam temperature control system. Especially when the AGC command of power grid fluctuates frequently, the conventional control strategy is difficult to deal with, resulting in poor quality of main steam temperature regulation, Affect unit economy and safety. In this paper, the sub PID set value adaptive control logic and desuperheating water injection logic to prevent the main steam temperature overshoot are used to solve the problem of the quality deterioration of the main steam temperature regulation under the frequent fluctuation of AGC instructions.
2 Influence of frequent fluctuation of AGC command on main steam temperature

The main steam temperature control system is a control system with multiple disturbance sources, and the frequent change of AGC load instruction is one of the main factors affecting the main steam temperature. When the AGC command of the unit changes repeatedly in a small period, for the steam temperature automatic control system, it is equivalent to adding a small period of repeated disturbance to the main steam temperature system of the boiler. For the main steam temperature control system, when the CCS receives the AGC load command to control the control valve to open, the main steam temperature will change and the desuperheating water volume will decrease due to the main steam pressure drop[2]. When the increased fuel quantity takes effect, the main steam pressure will stabilize and rise again. The main steam temperature will rise rapidly due to the double effects of fuel quantity and main steam pressure. The desuperheating water volume must also be enlarged rapidly to stabilize the main steam temperature. When the unit load changes frequently within the range of 10% rated load, the desuperheating water volume changes frequently within the range of 0 ~ 100%. When the amount of desuperheating water is greatly increased, the change of steam quantity is increased. The change of fuel quantity regulation caused by load in turn affects the main steam temperature control, which causes new disturbance and fluctuation of regulation process. When the temperature control of the main steam is not stable, AGC performs reverse regulation, and the temperature regulation of the main steam must be opposite to the above regulation, so that the temperature of the main steam swings greatly, and it is difficult to attenuate, thus causing the overshoot of the temperature control system of the main steam, and finally causing the temperature of the boiler superheater to be too high or too low.

3 Optimization control strategy

When the load control signal from the AGC system of the power grid fluctuates up and down in a small period, the traditional PID cascade control main PID and auxiliary PID regulation are reversed, and the main steam temperature rises and falls abruptly. Aiming at this problem, the PID set point adaptive control logic and desuperheating water injection logic are designed to prevent the main steam temperature from overshooting.

3.1 Auxiliary PID set value adaptive control logic

When the AGC command signal of the power grid fluctuates frequently, the traditional PID control system always has a high alarm value of the actual main steam temperature, and the auxiliary PID is gradually closing the desuperheating water regulating valve, so that the main steam temperature cannot be reduced for a long time, resulting in the main steam temperature frequency over temperature. When the actual main steam temperature is low, and the auxiliary PID is still opening the desuperheating water control valve, excessive water spray, resulting in the main steam temperature cannot return to the set value for a long time, affecting the economy of the unit. The root cause of this problem is that the frequent fluctuation of AGC load instruction leads to the disorder of the auxiliary PID setting value, which leads to the inversion of the control system. Sama diagram of optimized cascade PID control circuit is shown in Figure 1. The control logic is discussed as follows:

The first situation: the temperature measurement value and the set value of the boiler main steam are within ± 3 ℃, which is a normal regulating state. The main PID is
normally regulated, and its output is the set value of the auxiliary PID. The auxiliary PID controls the opening of the regulating valve according to the deviation between the value and the temperature after the desuperheater.

The second situation: when the measured value of the boiler main steam temperature is less than the set value of -3 °C or below, the output value of the main PID often appears as the set value of the auxiliary PID which is less than the measured value of the temperature after the desuperheater, that is, the set value of the auxiliary PID is less than the measured value, because the auxiliary PID is positive, the regulating valve is gradually opened, so the control will only lead to the main steam temperature getting lower and lower. In order to thoroughly solve this problem and ensure the correct direction of regulation, the method of switching the set value of the auxiliary PID to the main PID output plus 2 °C is adopted as the set value of the auxiliary regulator for forced switching. In this case, the deviation between the input set value of the auxiliary PID and the measured value is reduced by 2 °C.

Figure 1. SAMA diagram of optimized cascade PID control circuit.
As a result of PID regulation, the regulating valve will be closed gradually for a period of time to prevent the further reduction of the main steam temperature and realize the auxiliary PID set value adaptive control.

The third situation: when the measured value of the boiler main steam temperature is higher than the set value by more than 3 °C, the output value of the main PID as the set value of the auxiliary PID is often higher than the temperature after the desuperheater, that is to say, the set value of the auxiliary PID is higher than the measured value, because the auxiliary PID It is a negative effect, and the regulating valve is gradually closed, so the control will only lead to the main steam temperature getting higher and higher. It is observed that this situation exists in a large number. In order to solve this problem thoroughly and ensure the correct direction of regulation, the output of the main PID is reduced. In this case, the deviation between the input set value of the secondary regulator and the measured value increases by 2 °C, and the regulating valve is gradually opened for a period of time to prevent the temperature of the main steam from further rising, so as to realize the adaptive control of the set value of the secondary PID.

3.2 Desuperheating water injection control technology to prevent main steam temperature overshoot

Under the condition of frequent fluctuation of AGC load command in power grid, the main steam temperature control system of boiler is in the process of continuous dynamic adjustment. Its main function is to control the main steam temperature within a reasonable range, so as to prevent the main steam temperature from being too high or too low and affecting the safe and economic operation of the unit. Desuperheating water injection control technology to prevent the main steam temperature from overshoot is a kind of control scheme to deal with this frequent load changing condition. The implementation of this scheme can effectively control the main steam temperature within a certain range.[3]

When the measured value of main steam temperature is higher than a certain value and the change trend of main steam temperature is rising, a pulse will be triggered and the opening of desuperheating water control valve will increase by 3%. When the temperature continues to be higher than the alarm value for 2 minutes and the change trend of main steam temperature is still rising, the opening of desuperheating water control valve will increase by 3%, and then every 2 minutes the opening of desuperheating water control valve will increase again 3% until the temperature is lower than the alarm value or the main steam temperature shows a downward trend. Low temperature injection trigger logic is shown in Figure 2.

![Figure 2. Low temperature injection trigger logic.](image-url)
When the measured value of the main steam temperature is lower than a certain value, and the change trend of the main steam temperature is a downward trend, a pulse will be triggered, and the opening of the desuperheating water control valve will be reduced by 3%. When the temperature continues to be lower than the fixed value for 2 minutes and the change trend of the main steam temperature is still an upward trend, the opening of the desuperheating water control valve will be reduced by 3%, and then the opening of the desuperheating water control valve will be reduced every 2 minutes 3% until the temperature is lower than the set value or the main steam temperature shows a downward trend. High temperature injection trigger logic is shown in Figure 3.

4 Engineering application

The self-adaptive control logic of the main steam temperature and the auxiliary PID setting value and the desuperheating water injection control scheme to prevent the main steam temperature from overshoot have been applied in a power plant in Inner Mongolia[4]. Through parameter setting and optimization, the operation results show that the auxiliary PID setting value self-adaptive control logic and the desuperheating water injection strategy to prevent the main steam temperature from overshoot in the steady-state and variable load conditions of the unit, the main steam temperature The control index of degree is good, which meets the requirements of regulation dl657 and unit operation. When the unit operates stably and stably, the main steam temperature deviation can be controlled within ± 1.6 °C, and the main steam temperature can be controlled within ± 4 °C in the process of frequent fluctuation of AGC command. Figure 4 shows the constant value disturbance curve of main steam temperature under the condition of frequent action of AGC. The operation range of AGC command is 480mw to 530mw, and the dynamic deviation of main steam temperature is within ± 4 °C in the process of load change.
5 Conclusion

Steam temperature control is an important part to improve the thermal efficiency and ensure the safe operation of the unit, and it is also the control difficulty of the unit. Especially when the AGC command of the power grid fluctuates frequently, the control difficulty of the main steam temperature becomes greater, and the conventional control strategy is difficult to deal with. This paper optimizes the conventional control strategy under the condition of frequent action of the main steam temperature, and puts forward the solutions such as the auxiliary PID set value adaptive control logic and the desuperheating water injection logic to prevent the main steam temperature from overshoot. The successful implementation of the solution in the power plant completely solves the problem of the quality deterioration of the main steam temperature regulation under the condition of frequent fluctuation of AGC instructions in the power grid.

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