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Application Principle and Fault Maintenance of Thermal Automation Instrument Based on predictive control

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Abstract: Thermal automation instrument plays a very important role in thermal automation system. It is usually composed of three parts: sensor, transmitter and display. The specific analysis of thermal parameters by thermal automation instruments can also timely reflect the operation of thermal equipment and provide the most reliable information and data for the control system of power plant. At the same time, good operation of thermal automation instruments is also an inevitable way to ensure equipment safety, which plays a certain role in economic operation and automation of power plant. Predictive control is a new control algorithm with rapid development, which has obvious advantages, such as its intuitive concept, easy modeling, no need for accurate model and complex control parameter design, and compared with model predictive torque control, it avoids the problem of weight coefficient design. Based on predictive control, this paper expounds the application principle and fault maintenance of thermal automation instruments in detail.

1. Introduction

With the continuous reform and innovation of China's industrial science and technology in recent years, various thermal automation instruments with obvious pertinence have been produced to meet the needs of different industrial production [1]. In the modern society, everyone knows the advantages of thermal automation, such as time-saving, labor-saving, high speed, etc., but they have little knowledge of its basic principles and maintenance, which has hindered the application of thermal automation instruments to some extent [2]. Thermal automation instrument plays a very important role in thermal automation system. It usually consists of three parts: sensor, transmitter and display. It can be said that there are various thermal automation instruments used in China's automatic power plants at present, and the working environments that can be applied are also different [4]. Some common thermal automation instruments are briefly introduced. Thermal automation instruments can analyze the thermal parameters in detail, and can also reflect the operation of thermal equipment in time, providing the most reliable information and data for the power plant control system. At the same time, it is also an inevitable way to ensure the safety of equipment by making thermal automation instruments run well, which plays a certain role in economic operation and power plant automation [5]. There are four typical thermal automation instruments, namely temperature measuring instrument, pressure measuring instrument, flow instrument and material level instrument. This paper makes a specific study on the application principle and fault maintenance of thermal automation instruments

[6].

Predictive control is a new control algorithm with rapid development, which has obvious advantages, such as its intuitive concept, easy modeling, no need for accurate model and complex control parameter design, and compared with model predictive torque control, it avoids the problem of weight coefficient design [7]. However, at this stage, there is still no effective theory to determine the weight coefficient. In practical application, it is necessary to adjust the weight coefficient according to a large number of simulations and experiments. Due to the complicated debugging process, the universality and practicability of this method need to be further improved [8]. Predictive control integrates model prediction, rolling optimization and feedback correction, which is suitable for dealing with multivariable systems, dealing with constraints and time-delay characteristics, and has inherent fault-tolerance and implicit disaster-solving ability. This algorithm is to estimate the running state at the future time according to the current state of the system, then carry out rolling optimization, and apply the optimized value to the state at the next time, so as to better control the system [9]. Predictive control is mainly applied to the application principle and fault of thermal automation instruments. The theoretical research on stability and robustness and the improvement of the algorithm have laid the foundation for successful application in the industrial field [10].

2. Application principle and fault maintenance of thermal automation instrument

2.1 Application principle of Thermal Automation Instrument

China has made great progress in industrial production. At the same time, according to the specific needs of different industrial production, more targeted thermal automation instruments have been produced. It can be said that there are various thermal automation instruments used in China's automatic power plants at present. Automation of thermal engineering has the advantages of fast working speed, time saving and labor saving, but it has little knowledge about its basic composition, working principle, howling and so on. The more common ones are.

① Temperature measuring instrument. Temperature measuring instruments include thermocouple thermometer and thermal resistance thermometer, which can enable thermal automation instruments to assist automatic power plants in temperature measurement. Under certain conditions, there will be a clear functional relationship between the potential generated by the thermocouple and the temperature around the thermocouple, and the value generated by the secondary instrument constituting the thermocouple thermometer is actually the measured temperature near the thermocouple.

② Pressure measuring instrument. This instrument works with micro-pressure meter, pressure gauge and transmitter, which can accurately measure the pressure of automatic power plant system. In terms of bellows micro-pressure meter, it is widely used in pressure measurement of air supply system and pulverizing system of boiler.

③ Flow meter. The instrument is composed of volumetric capacity instrument and differential pressure capacity instrument, and there are many non-stop counting in these instrument bodies to measure the material flow. This is mainly because these rotors themselves have the function of measuring solvent, and the greater the fluid flow, the faster the speed of these rotors.

2.2 Maintenance of automatic thermal instrument fault

When the thermal automation instrument is used, there will be various faults and problems, such as wrong maintenance, vibration, sealing, etc., which will directly reduce the reliability of the instrument. In order to ensure that the automatic power plant can operate according to the reasonable demand, it must ensure that these thermal automation instruments will not fail or be damaged. Therefore, corresponding measures should be taken for the cable wiring sealing problems, and the instruments can be strictly inspected during the ordering process. The cable wiring of the automation instrument shall be sealed to ensure that the circuit inside the instrument will not fail due to the immersion of rain or other liquids. Any problem of thermal automation instrument may lead to a problem in one link of the automatic power plant system, which may lead to the paralysis of the operation of the whole automatic power plant, and even form a potential safety hazard. In addition, the factor of man-made damage is also obvious. It is mainly due to various problems caused by improper maintenance. Of course, it also has the responsibility of the staff. The main reason for the failure is that the staff do not do a good job in technical treatment and seriously lack the sense of responsibility. This negligence directly leads to problems in the instrument. Circuit simulation technology can effectively analyze the different characteristics of different circuits at different temperatures, and designers can use the analyzed results as the main basis to improve the overall design of electric power in time. In the process of installation, the sealing joint should be tightened according to certain specifications. Otherwise, if the sealing joint is exposed, it is bound to cause certain potential safety hazards. Therefore, under normal circumstances, if the tightness of thermal automation instrument installation cannot be ensured, the interface can be sealed with silica gel and glass glue to ensure the tightness of the instrument. At the same time, due to inadequate maintenance, it is necessary for these staff to learn more knowledge, improve their relevant professional skills and operational ability, and operate in strict accordance with relevant rules and regulations, so as to realize the work spirit of loving and dedicated posts, which will also greatly help and improve the future development of these staff. Finally, the countermeasures for the vibration problem are put forward. If there is a crack in the instrument, the rubber pad should be used to relieve the vibration, and the problem should be well solved by checking at any time in production.

3. Thermal automation instrument model predictive current control

3.1 Prediction model

In the model predictive current control algorithm, we first need to find a model, which can be used to explain the dynamic process of current in the whole control algorithm, and use the current state of the current period to predict the current trajectory of the next moment, so that the actual current value of the next moment approaches the predicted current, and the closer it is, the more accurate the established model is. The structure diagram of model predictive control is shown in Figure 1.

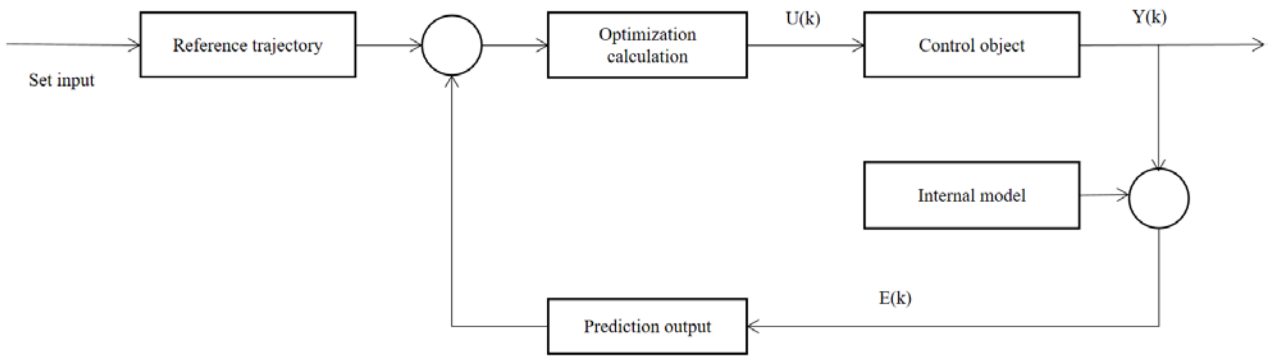

Figure 1: Structure diagram of model predictive control

Model predictive control belongs to closed-loop control. After the model predictive control obtains the future control function through optimization, the predictive control only implements the control function at this time to prevent the control from deviating from the ideal state. At the next sampling time, the model predictive control first detects the actual output of the object, uses this real-time information to correct the prediction of the basic model, and then carries out the next optimization.

Model predictive control is a new type of computer control algorithm, which uses the object model and current input and output measurements to predict the future output. The basic principle of model predictive current control can be shown in Figure 2.

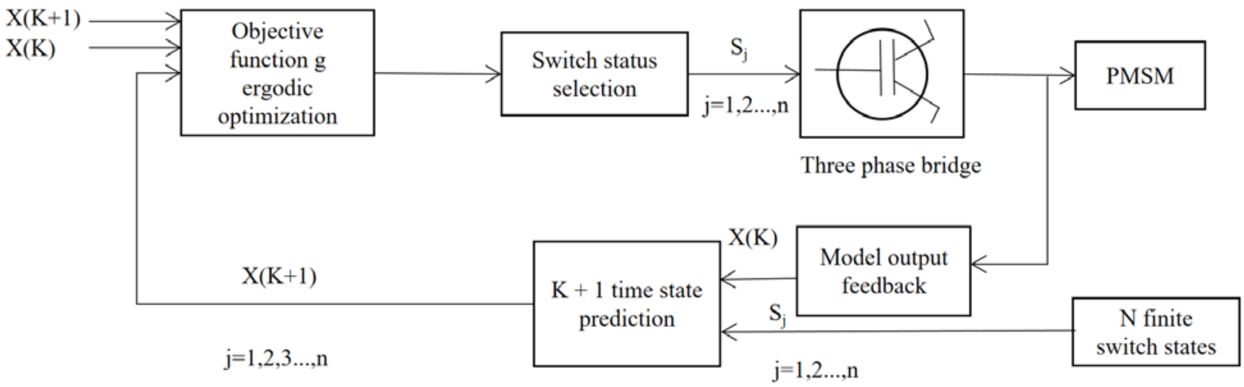

Figure 2: Basic principle diagram of model predictive current control

At each sampling time, the model predictive control uses the objective function to optimize and calculate the control variables to predict the future time according to the current measured values, takes the first column of the optimized value sequence to act on the object, and carries out it again and again in such a control algorithm. If the principle of model predictive current control can be summarized into the above four steps, then the essence of its control lies in three elements, namely predictive model, rolling optimization and value function. It is through these three elements that the model predictive current control establishes a connection with the permanent magnet synchronous motor to achieve the control purpose.

3.2 Value function

In the model predictive current control, in order to make the stator current track the upper reference current, the value function is defined. The voltage vector that minimizes the value function is selected as the optimal voltage vector, and the optimal voltage vector is applied to the permanent magnet synchronous motor control system in the next sampling period. The value function is usually defined as

$$g_i = \left[i_d^* - i_d^p(k+1)\right]^2 + \left[i_q^* - i_q^p(k+1)\right]^2 + g\left[i_d^p(k+1), i_q^p(k+1)\right] \tag{1}$$

The function of value is to make the motor stator current value measured in the circuit follow the reference current value set above. For a commonly used two-level three-phase permanent magnet synchronous motor drive system, there are eight basic voltage vectors. Through traversal optimization, the value that minimizes the objective function gi is found as the optimal voltage vector, and the optimal vector is applied to the sampling control system of the next cycle. The last term in the formula is used to limit the amplitude of stator current, which is expressed by zero or infinity in a certain range and can be expressed by the following formula

$$g\left[i_d(k+1), i_q(k+1)\right]=\begin{cases}0 \left|i_d(k+1)\right| \le i_{d\ \max} \text{And} \left|\mathrm{i}_q(k+1) \le i_{q\ \max}\right| \\ \infty \left|i_d(k+1)\right| > i_{d\ \max} \text{or} \left|\mathrm{i}_q(k+1)\right| > i_{q\ \max}\end{cases} \tag{2}$$

Therefore, the controller cannot select the voltage vector; When the predicted current amplitude generated by a voltage vector exceeds the allowable maximum current amplitude, the value of the value function is infinite, so the controller cannot select the voltage vector.

4. Conclusions

All the above words are a basic exposition of the application principle and fault maintenance of thermal automation instruments. Generally speaking, this industry still has great development potential, and it can drive another qualitative leap of the whole electric power industry. Model predictive controller usually runs well in the early stage of project implementation and has high control performance. However, after running for a period of time, its control performance will gradually deteriorate due to various factors. It is of great practical significance to monitor and evaluate the performance of the model predictive control system in real time. In the future production process, the operation must be strictly in accordance with predictive control, and the problem of fault prevention should be fully done, so as to pay more attention to the thermal automation instruments and make a deeper understanding and analysis of them, which is also the most favorable guarantee to promote the automatic operation. Ensuring the safe and stable operation of production equipment is an important purpose of fault detection and diagnosis technology. At present, there are many batch control processes in chemical production process, and the products of batch process are closely related to modern people's life. Therefore, in order to ensure the safe and reliable operation of batch process, real-time fault monitoring and diagnosis is very necessary.

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