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Analysis of Common Fault Improvement Strategies of Thermal Control Instruments in Thermal Power Plants

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Abstract: *With the continuous improvement of the level of science and technology, automation technology has been greatly developed. Thermal control instrumentation is an important auxiliary equipment for thermal power plant production. In order to ensure the efficient operation of the production system and achieve the goal of high-efficiency production, it is necessary to equip high-quality and skilled fault maintenance personnel to supervise the operation of the thermal control instrumentation and fault maintenance, which is conducive to the effective monitoring and control of the thermal control instrumentation and the creation of a good production environment. In addition, when installing thermal control instruments, personnel are required to select suitable locations and design feasible installation programmes according to the installation requirements and the purpose of the components themselves.*

Keywords: *Thermal Control Instruments for Power Plants, Malfunctions, Preventive Measures*

1. Introduction

In recent years, with the rapid progress of science and technology, many fields are moving towards an advanced track, including the power industry. Under this process, heat sensors have become an indispensable part of the power system, and they not only provide accurate temperature signals, but also ensure overall safety and reliability, thus playing a crucial role. In order to ensure the smooth running of power production, the supervisory body of the power generation company must strengthen the daily inspection and maintenance of the heat detection device to ensure the smooth running of the whole process. At the same time, it is necessary to take effective measures based on the inspection data to ensure the smooth operation of the whole process.

As one of the infrastructures of the thermal control system, the stability of the distributed control system determines the safety and stability of the thermal control system. The distributed control system consists of the grounding inspection system, the distributed power supply inspection system, the supply sequence control and the safety verification of the power supply route. In actual operation, it is necessary to equip professional personnel to carry out line inspection and maintenance to ensure the safety and accuracy of wiring, striving to receive signals normally without error. The signal data should within the range of functional requirements, which ultimately guarantees that the distributed system can operate normally. In the structural design of the distributed control system, it is essential to meet the characteristics of flexible structure and use, as the DCS control system is based on the network communication system, which can achieve the whole process control.

2. Overview of Thermal Control Instruments

With the leap in technology, most of the current power plants rely on sensors to obtain a variety of information during operation, of which, the thermal control instrumentation is an important tool to establish a link with the operator. In recent years, the thermal control instrumentation has developed rapidly, from just playing a supporting role, to today, it has become an important support to ensure the safety, stability and reliability of power plants. Thermal control technology is an important technology used to detect and manage the inside of a plant and is capable of detecting a wide range of environmental factors within a plant, including air temperature, liquid flow rate, liquid concentration and gas emissions. Thermal control technology uses advanced technology to quickly and accurately detect changes within

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the plant and take appropriate measures to ensure the safety and stability of the plant. When implementing the installation of thermal control instrumentation, it is closely linked to the foundation construction and the installation of other important meta-equipment, and the basic process of the whole construction covers: inspection, selection of meta-equipment, adjustment, connection, manoeuvring, regulation and calibration, as well as the need to use a variety of measurements and displays [1].

3. Role of Thermal Control Instruments in Thermal Power Plants

With the continuous progress of industrial technology, the application of thermal control instrumentation is becoming more and more widespread, especially for the stable operation of thermal power plants is of great significance. The safe and stable operation of thermal power plants is inseparable from the monitoring signals provided by thermal control instruments. Thermal control instruments are mainly used for temperature measurement, pressure measurement and liquid level measurement in the automated operation of thermal power plants. Thermal control instruments are the main monitoring equipment in thermal power plants. To ensure the stable operation of the thermal power plant, the thermal power plant equipment indicators should be monitored and measured. Generally speaking, when a thermal power plant operation process of a certain index is abnormal, thermal control instrument will send an alarm signal, the relevant personnel according to the signal to deal with thermal power plant equipment failure, so as to ensure that the equipment in the operation process due to failure to reduce the efficiency and safety issues. However, once the thermal control instrument fails, it will directly affect the operator's judgement. On the one hand, it will reduce the efficiency; on the other hand, if the real fault is not solved, it will affect the operation of the whole power plant equipment. Therefore, the thermal control instrumentation in the thermal power plant occupies a pivotal position. Once the thermal control instrumentation failures to work, which need to be resolved by the relevant personnel in a timely manner to ensure the safe and stable operation of thermal power plants.

4. Failure Analysis of Thermal Control Instruments in Power Plants

4.1 Failure of Seals in Various Parts of the Thermal Control Instrument

Due to the prevalence of sealing failures, it is important for power utilities to strengthen their management and oversight of this issue. If the connecting wires of a thermal control instrument become loose, it may cause outside air, vapour or other substances to penetrate into the interior of the instrument, thus causing damage to metal parts, seriously affecting the normal operation of the equipment, and even causing serious fire and explosion hazards. As manufacturers and suppliers failed to give sufficient attention to the sealing of thermal control instruments, and they failed to give the corresponding technical indicators, this makes it possible for leakage of liquid and air to occur during the testing process, further aggravating the leakage. When the staff handle the interface parts, using appropriate sealing gaskets to ensure the normal operation of the thermal control instrument. It also need to ensure that the thermal control instrument can be firmly fixed, so as to avoid liquid leakage, which can cause a series of damage.

4.2 Deficiency in Thermal Control Instruments

As technology develops, there is a growing demand for the procurement of thermal control instrumentation, and the criteria for these demands have become more stringent. However, due to the insufficient level of professional knowledge and skills of purchasers, they tend to rely solely on the manufacturer's instrument specifications to make judgements, ignoring the actual use of thermal control instruments, which leads to inappropriate purchasing decisions. As some purchasers tried to save money, they did not pay attention to the quality of the thermal control instruments, resulting in their usability being seriously affected and even serious failures [2].

4.3 Corrosion Failure and Circuit Failure

Due to the harsh working environment of most power plants, coupled with the fact that temperature sensors and pressure sensors are susceptible to corrosive substances, when temperature sensors are mixed with corrosive substances, it will cause damage to the temperature sensors and may even lead to the failure of the temperature sensors. In order to ensure the normal operation of the thermal control instrument, the operator must take its daily maintenance and cleaning seriously. In particular, when a short-circuit fault occurs, it may result in a component being connected incorrectly or a component that

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was originally connected, but in reality was not fully connected. Because of the highly automated nature of thermal control instruments, their complex internal structure, and the need for precise installation of interfaces, thermal control instruments are prone to short-circuiting and other problems.

4.4 Common Failures of Temperature Sensors

Temperature sensors are somewhat similar to thermometers applied in life. The application of temperature sensors can be combined with changes in the surrounding temperature, the temperature changes in a timely manner, reflecting the situation to the power plant staff, so that they understand the state of each device during operation. There are two typical temperature sensors in thermal power plants, one of which is a thermocouple, and the other is an RTD, and there are some differences in the working principle of the two. During the application of RTD, if there is a change in temperature, the output resistance will also change. Thermocouples, on the other hand, are a manifestation of the thermoelectric effect. Overall, the temperature sensor is a key component of the temperature measurement instrument. Thermal power plant in the production process, if the sensor operation process, components appear aging damage or loose wiring and other issues, can not accurately and effectively identify, so that the identification results can not guarantee the accuracy of the judgment components aging damage or loose wiring problems, but also for the production of work for the smooth running of the guarantee.

5. Thermal Control Instrumentation in Thermal Power Plants Common Causes of Failure

5.1 Environmental Factor

Possible seal failures can be found through testing and repair. These failures are usually due to loose screws during assembly, different distances between nuts and nuts, and nuts that are not sized to the required standards, thus preventing the proper flow of air and contaminants, which in turn affects the proper functioning of the instrument. Due to the poor airtightness of the thermal control instrument's casing, it is very susceptible to leakage, which can result in the destruction of the temperature sensor. These problems can occur due to loose machine fittings, incorrectly fitted sealing gaskets or other defects in non-mechanical engineering components. Due to the complexity of external factors and other unknowns, many things cannot be fully understood. For example, the presence of lumps of coal can cause damage to the temperature control sensors, which can affect the operation of the coal mill or even prevent it from functioning properly. In addition, the thermal control equipment can also be affected due to the oscillation of the external surroundings. Due to the presence of a large number of hazardous chemicals inside the plant, the connection between the temperature and humidity sensors and the temperature and humidity meter may be loose or unable to be fully opened when the temperature and humidity change, which may lead to the damage of the temperature and humidity sensors [3].

5.2 Human Factor

The human factor is the factor that leads to the highest incidence of failures, and other causes also have an impact. For one, lack of professional knowledge and skills of maintenance personnel leads to lower standards of equipment installation and maintenance, which can lead to failures. In addition, design and installation may also lead to failures. Secondly, the lack of responsibility and professional skills of maintenance and installation personnel, who do not follow the process in their work and are negligent in the maintenance and installation process, leads to equipment failures. Thirdly, some people have illegal behaviours and steal parts of equipment and instruments, which leads to equipment failure. Due to the fact that the design process of instrument installation does not fully take into account the use of the environment, supporting requirements and other performance indicators of the equipment, which leads to improper design and installation of the instrument, thus resulting in incompatibility between the equipment, as well as shortened service life, and ultimately there may be failures.

6. Power Plant Thermal Control Instrumentation Failure Prevention Measures

6.1 Preventive Measures for Sealing Failures of Thermal Control Instruments

In order to enhance the reliability and durability of thermal control instruments, their sealing must be carefully considered, which will ensure their proper operation. In order to achieve this, the right supplier of thermal control instruments must be carefully selected. In addition, it is important to ensure that they

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are designed and manufactured in accordance with standards and that their connections are tight and reliable at the time of installation. For joints that are extremely sensitive to the external environment, effective measures should be taken to ensure that they are effectively sealed, such as the use of silicone, PE, etc. Furthermore, when installing the joints of thermal control instruments, the best gaskets and washers should be precisely selected according to the actual situation to ensure the integrity of the joints. In order to ensure the correctness and reliability of the thermal control instruments, the staff should actively maintain and repair the affected interfaces so that they can be replaced or renewed at any time to maintain their correctness and reliability. In addition, since some thermal control instruments must be exposed to humid environments for long periods of time, their ventilation and cleaning should be enhanced to ensure their proper functioning and to reduce the probability of their failures [4].

6.2 Strengthen the Management of Thermal Control Instruments

In order to ensure the orderly operation of thermal control instruments, active measures should be taken, including: regular operations such as charging and discharging, performance, moisture protection and cleaning, to ensure that they operate safely and reliably under good clean and pollution-free conditions. At the same time, a sound technical file should be established to record all data related to the thermal control instrument, including operation, maintenance and inspection, etc., to ensure its correct and orderly operation, thereby enhancing its reliable availability.

6.3 Improvement of the Instrumentation of the Thermal Control System for Stable Operation

In order to ensure the safety and reliability of thermal power plants, it is necessary to assign an experienced team who will constantly collect, process and analyze various data, as well as comprehensively consider the stability of each part, so as to better guarantee the normal operation of the unit. Through systematic monitoring, real-time monitoring of components, early understanding of the maintenance status, and early tracking of the maintenance process, as well as early measures, the use of big data technology, accurate prioritization and differentiation from other levels, thus avoiding emergencies and improving the safety and reliability of the machine.

6.4 Analyzing Faulty Parameters of Thermal Instrumentation

When measurements and analyses are carried out using thermal instruments, there are some minor variations in the parameters associated with them. Therefore, it is important to ensure that some fixed patterns are adhered to, so that latent problems can be recognized at an early stage. Measurements and analyses have to be carried out carefully and responsibly to ensure accuracy and precision of the results. If there is a large variation in the data, it may lead to malfunctioning of the thermal instrumentation, which requires the thermal power plant to take measures to ensure the normal use of the equipment. Special attention needs to be paid to the correct operation of the DSC and other sensors during overhaul and diagnosis to ensure the safety and reliability of the equipment. In the event of a malfunction, the measured value and the possible cause should determine its category.The category should be ensured based on the measured values and the possible causes of the malfunction. Especially in the case of severe vibrations of the temperature measuring device, the PID calibration should be carried out by a specialized technical engineer.

6.5 Improvement of Installation Techniques

In the installation process, in order to ensure the normal operation of the thermal control instrument, the characteristics and functions of each component should be carefully considered, and the best installation position should be precisely selected to ensure the measurement accuracy. In addition, in the installation process, the actual situation of the power plant should be fully considered, and in accordance with certain steps and norms, carefully choreographed each step of the operation to ensure the accuracy and stability of the measurement. In the installation of the thermal control system, its complexity, tediousness and accuracy requirements, any error in any one place will lead to the overall operation status being hindered. Therefore, it is necessary to establish a set of perfect and effective installation design to ensure the smooth operation of the system [5].

6.6 Improve the Logic Design of the Thermal Control System

Initially, flaws in the system logic prevented the thermal control signals from being recognized

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correctly, which led to the stoppage of the unit. Lessons should be learnt from this, and the logic of the thermal control system should be improved at a deeper level. Through comprehensive discussion and analysis, as well as communication with superiors, the defects should be remedied as soon as possible, so as to ultimately achieve the purpose of optimization and enhancement. By comprehensively improving and perfecting the thermal control system, it can meet all the safety requirements and adopt advanced technical means to realize precise temperature regulation.

6.7 Regular Functional Tests

Since thermal control instruments belong to high-precision instrumentation, they need to be calibrated regularly in order to avoid errors caused by prolonged use. Specifically, during routine maintenance, professional calibrators should be selected to regularly check and determine the current instrument error. When the error reaches the standard error range, it is a normal value. When the error is out of range, professional calibrators are required to use special calibration instruments for calibration to ensure the accuracy of the calibration results.

6.8 Strengthening Talent Development and Management

By adopting the latest advanced fault-tolerant logic technology, it can not only check and evaluate the operation status of thermal equipment in real time, but also effectively detect abnormalities in the system, so as to formulate effective solutions based on the checking results, thus ensuring the safety, effectiveness and economy of the thermal equipment. With the development of science and technology, more and more high-tech is transferred to the modern engineering field, and the success of high-tech depends on advanced operators. Therefore, all kinds of high-tech enterprises must pay attention to high-tech technology research and development, and with the support of high-tech enterprises, actively carry out the co-operation between high-tech enterprises, and jointly promote the co-operation between high-tech enterprises, and make joint efforts to improve the research and development level of high-tech products of high-tech enterprises, and improve the overall competitiveness of high-tech enterprises. The stability of the thermal control system has been greatly improved by introducing an expert management team to re-examine and improve the current management mode according to the characteristics of the current thermal control system and to give them higher standards so that they can better implement the relevant regulations and check all kinds of potential faults in a more refined way, such as collecting, analyzing and disposing of continuous signals.

7. Conclusions

To achieve economic development and better foothold in the market, thermal power plants should pay attention to the application of thermal control instrumentation and troubleshooting. Thermal control instrumentation can effectively detect the state, determine whether the thermal power plant production system is in a safe state or not and conducive to the discovery of the problem in a timely manner, thus avoiding the failure of thermal control instrumentation and an adverse impact to the production system of the thermal power plant. Staff should be aware of the important use of thermal control instrumentation in the enterprise. To understand the various types of different instrumentation failures, staff should set up lifelong learning goals, and constantly improve their professionalism to ensure that in the event of a failure, they can be the first time to effectively deal with all kinds of failures and create a good environment for the production of thermal power plant operations, maintaining the stability, safety and standardized production order of the thermal power plant.

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