

Fast Construction of Bypass System Based on Insulating Rod Type Bypass Switch

Haiyang Liu, Weihao Gao, Yu Cao

State Grid Tonghua Power Supply Company, Tonghua, Jilin, 134000, China

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Abstract: Insulated rod bypass switch, as an indispensable key equipment in modern power system, its performance and reliability are directly related to the safe and stable operation of power grid. In this study, the application and optimization strategy of insulated rod bypass switch in power system are discussed. Faced with the increasing complexity of power system and the high requirement of equipment performance, the flexibility and adaptability of insulated rod bypass switch is particularly important. However, problems such as insulation aging, operation and maintenance difficulties, and system stability and compatibility also emerge. In response to these problems, this study puts forward optimization countermeasures such as strengthening the research and development and application of insulation materials, improving the intelligent level of operation and maintenance, and optimizing system design and compatibility testing. These measures aim to improve the performance of the insulated rod bypass switch, reduce the operation and maintenance cost, and ensure the stable operation of the power grid and the cooperative work of the equipment. Through the combination of theory and practice, this study provides a useful reference for the application and optimization of insulated rod bypass switch in power system.

1. Introduction

With the continuous development of power systems, the requirements for equipment performance are also increasing. Insulated rod bypass switch is the key equipment in power system, its performance directly affects the stable operation of power grid and the cooperative work of equipment. However, in practical applications, insulated rod bypass switches also face many challenges, such as aging insulation materials, operation and maintenance difficulties. These problems not only affect the normal operation of the equipment, but also increase the cost of operation and maintenance. Therefore, optimizing the insulated rod bypass switch to improve its performance and reduce operation and maintenance costs has become an urgent problem in the field of power system. This study will discuss the optimization strategy of insulated rod bypass switch from the aspects of insulation material, intelligence level, system design and compatibility.

2. Characteristics of insulated rod bypass switch

2.1 High insulation performance

The insulated rod bypass switch is famous for its unique high insulation performance in the power system, which not only provides a solid guarantee for the stable operation of the power system, but also further expands its application boundary in the complex and changeable environment. High insulation performance is reflected in many aspects, and its complexity and importance cannot be ignored. The insulating material used in the insulated rod bypass switch has been carefully selected and strictly tested, and has extremely high resistivity and dielectric strength, which can maintain a stable insulation state under high voltage and strong electric field environment, and effectively prevent the occurrence of current leakage and short circuit fault^[1]. This high insulation performance not only ensures the safety and reliability of the switchgear itself, but also provides a strong support for the overall stability of the power system. The insulation design of the insulated rod bypass switch fully considers the impact of environmental factors on the insulation performance, such as temperature, humidity, pollution degree, etc., through optimizing the insulation structure, improving the weatherability of the material and other measures to ensure the continuous stability of the insulation performance under different environmental conditions. High insulation performance is also reflected in the durability of the insulated rod bypass switch, after long-term operation and multiple operations, its insulation performance can still be maintained at a high level, thanks to the excellent performance of the insulation material and the superb level of manufacturing process.

2.2 Fast operation and deployment

The insulated rod bypass switch has become an important tool to deal with emergencies and improve the flexibility of the power grid because of its fast operation and deployment. This feature is not only reflected in the rapid operation of the switch, but also in the simplicity and efficiency of the entire deployment process, which provides strong support for the stable operation and fault recovery of the power system^[2]. The fast operation of the insulated rod bypass switch benefits from its unique design concept and manufacturing process. Through the use of lightweight materials and optimized structural layout, the switch action mechanism is simplified and the operating torque is reduced, so that the switch can complete the opening and closing action in a short time. With advanced control technology and sensor systems, the operation process of the switch can be accurately controlled and real-time monitoring, further improving the accuracy and safety of the operation. In terms of deployment, the insulated rod bypass switch also shows its high efficiency. The traditional bypass switch deployment often requires complex installation and commissioning process, but the insulated rod bypass switch realizes rapid installation and plug and play through the modular design and standardized interface. This not only shortens the deployment time, but also reduces the dependence on professional skills, so that non-professionals can also master the operation method in a short time, providing a more convenient and flexible choice for the emergency response of the power system.

2.3 Flexibility and adaptability

With its excellent flexibility and adaptability, the insulated rod bypass switch has shown extraordinary potential and value in the diversified needs of power system. This feature is not only reflected in the physical form of the switchgear, but also in its electrical performance, operation mode and application scenario. From the perspective of physical form, the design of insulated rod

bypass switch fully considers the complexity and diversity of the power system, and realizes a wide range of adaptability to different voltage levels, current capacity and installation environment through modular and detachable structural design^[3]. This flexibility allows switchgear to be easily integrated into a variety of power system architectures, whether it is a high-voltage transmission line or a low-voltage distribution network, to find the right application scenario. In terms of electrical performance, the insulated rod bypass switch also shows a high degree of adaptability. The selection of insulation materials and the design of insulation structure have been carefully calculated and optimized to ensure that good electrical performance can be maintained under different working conditions. Whether stable and reliable during normal operation or rapid response under fault conditions, insulated rod bypass switches can meet the needs of power systems with outstanding performance. In addition, in terms of operation mode and application scenarios, the insulated rod bypass switch also shows extraordinary flexibility. Whether it is manual operation or remote control, whether it is temporary fault recovery or long-term power grid transformation, the switchgear can complete the task in an efficient and convenient way, providing a solid guarantee for the stable operation of the power system.

3. The insulation rod type bypass switch problems

3.1 Aging of insulation materials

As an important part of power system, insulated rod bypass switch is directly related to the safe and stable operation of equipment. However, the aging problem of insulation materials has become a potential hidden danger that cannot be ignored. In the long-term operation process, insulation materials will be affected by a variety of factors, such as temperature, humidity, electric field strength, chemical erosion, etc., these factors will lead to a gradual decline in the performance of insulation materials. Among them, temperature is one of the most important influencing factors^[4]. In the high temperature environment, the molecular chain of the insulation material will be broken, resulting in a significant decrease in the mechanical strength and electrical properties of the material. In addition, humidity will also accelerate the aging process of insulation materials, because water will penetrate the inside of the material, forming water molecular chains, which will destroy the insulation structure of the material. The electric field strength directly affects the electrical aging process of the insulating material, and the high intensity electric field will make the charge distribution inside the material uneven, generate partial discharge, and then accelerate the deterioration of the material. In addition to the above factors, chemical erosion is also one of the important reasons for the aging of insulation materials. In the power system, insulation materials may come into contact with various corrosive gases and liquids, and these chemicals will chemically react with the material, resulting in a gradual decline in the performance of the material.

3.2 Difficulty of operation and maintenance

In the application of insulated rod bypass switch in power system, although it provides a strong guarantee for the stable operation of power grid with its unique advantages, its operation and maintenance difficulty has become a double test for power system operation and maintenance personnel. On the one hand, the operation process of the insulated rod bypass switch requires a high degree of professional skills and strict operating specifications. Since switchgear is usually installed in high-voltage transmission lines or complex distribution networks, operators must have rich power knowledge and practical experience to accurately judge the switching state and correctly perform the on-off operation^[5]. In addition, the operation of switchgear is also restricted by environmental factors, such as weather conditions, space constraints, etc., which increase the

complexity and risk of operation. On the other hand, the maintenance of insulated rod bypass switches is equally challenging. Because the switchgear is in operation for a long time, its insulation materials and mechanical components will gradually age or wear out, and it needs to be repaired and replaced regularly. However, because switchgear is usually installed in inaccessible locations, such as high altitude, underground or confined Spaces, it brings great inconvenience to maintenance work. At the same time, the maintenance process also needs to carry out strict testing and calibration of the switchgear to ensure that its performance meets the safety standards, which further increases the difficulty and cost of maintenance.

3.3 System stability and compatibility

The introduction of insulated rod bypass switch in power network aims to improve the flexibility and reliability of power network, but its system stability and compatibility have become a delicate balance problem in the process of power network fusion. On the one hand, the design of insulated rod bypass switch should fully consider the dynamic characteristics of the power system to ensure its stable operation under various working conditions. However, the power system is a highly complex and changeable system, and its operating state is affected by many factors, such as load fluctuation, failure, weather change and so on. These factors will lead to the instability of the power system, and then affect the performance of the insulated rod bypass switch. Therefore, how to ensure the stability of the switchgear itself while effectively dealing with the dynamic changes of the power system has become an urgent problem to be solved. On the other hand, the compatibility of insulated rod bypass switches is also a major challenge in power network convergence. With the continuous progress of power technology and the increasing complexity of power grid structure, the coexistence of different manufacturers and different types of switchgear in the power grid has become the norm. However, due to differences in technical standards, communication protocols and other aspects, the compatibility between these devices is often difficult to ensure. As a newly introduced device, how to seamlessly connect with other devices in the existing power grid to achieve accurate transmission of information and rapid response of instructions has become a topic that needs in-depth research.

4. Optimization strategy of insulated rod bypass switch

4.1 Strengthen the research and development and application of insulation materials

Insulated rod bypass switch is the key equipment in power system, its performance and reliability are directly related to the safe and stable operation of the whole power grid. In view of the key problems such as aging insulation materials, strengthening the research and development and application of insulation materials has become an important countermeasure to optimize the performance of insulated rod bypass switch and improve the safety line of power system. On the one hand, the research and development of insulating materials should pay attention to the aging resistance of materials, and improve the anti-aging ability of materials and extend the service life of insulating materials by introducing advanced technologies such as new polymer materials and nanocomposite materials. At the same time, it is also necessary to further study the relationship between the microstructure and properties of materials, reveal the internal mechanism of material aging, and provide theoretical support for the development of higher performance insulation materials. On the other hand, the application of insulation materials also needs to consider the actual needs of the power system, such as voltage level, operating environment, maintenance costs and other factors. By optimizing the formula and process of the insulation material, the electrical properties and mechanical strength of the material are improved to meet the application needs under

different working conditions. In addition, it is necessary to strengthen the detection and evaluation of insulating materials, establish a perfect material performance database, and provide a scientific basis for the selection and application of insulating materials.

4.2 Improve the intelligent level of operation and maintenance

As the key equipment in power system, the intelligent level of operation and maintenance of insulated rod bypass switch is directly related to the safe and stable operation and operation and maintenance efficiency of power system. Under the background of the new era of power operation and maintenance, improving the intelligent level of operation and maintenance of insulated rod bypass switch has become the only way to optimize equipment performance and reduce operation and maintenance costs. On the one hand, through the introduction of advanced sensor technology and Internet of Things technology, the real-time monitoring and data analysis of the operating state of the insulated rod bypass switch are realized. By utilizing big data and artificial intelligence technology, deep mining and analysis of equipment operation data can be conducted to promptly identify potential faults and safety hazards, providing accurate warning information and decision support for operation and maintenance personnel. On the other hand, the development and application of intelligent operation and maintenance systems have been promoted, achieving remote control and automatic maintenance of 1 insulation rod bypass switch. Through the construction of intelligent operation interface and interactive platform, the operation process is simplified, the operation difficulty is reduced, and the operation efficiency and safety are improved. At the same time, the automatic maintenance system is used to carry out regular inspection and maintenance of the equipment, discover and deal with equipment faults in time, extend the service life of the equipment, and reduce the operation and maintenance cost.

4.3 Optimize system design and compatibility test

Insulated rod bypass switch is a very important equipment in power system, its system design and compatibility play a very important role in the stable operation of power grid and the cooperative work of equipment. In order to cope with the increasingly complex grid environment and diverse equipment requirements, optimizing system design and strengthening compatibility testing have become the key measures to ensure that devices work together in grid convergence. On the one hand, at the beginning of the system design, it is necessary to fully consider the dynamic characteristics and future development trends of the power system, and adopt the modular and expandable design concept to ensure that the insulated rod bypass switch can flexibly adapt to the changes of the power grid structure and the growth of the load. At the same time, it is also necessary to deeply study the electrical performance, mechanical strength and environmental adaptability of the equipment to ensure that it can operate stably under various working conditions. On the other hand, compatibility testing is an important part of ensuring that devices work together. Because there are a large number of different manufacturers and different models of equipment in the power system, strict compatibility testing, including electromagnetic compatibility testing and communication protocol compatibility testing, is required in the design and production process of the insulated rod bypass switch to ensure that the equipment can seamlessly connect with other equipment in the existing power grid to achieve accurate transmission of information and rapid response to instructions.

5. Conclusions

Through in-depth discussion on the optimization strategy of insulated rod bypass switch in

power system, this study reveals the key path to improve equipment performance, reduce operation and maintenance costs, and ensure the stable operation of power grid. First, we need to strengthen the research, development and application of insulation materials to improve the anti-aging performance of equipment; The second is to improve the level of intelligent operation and maintenance, simplify the operation process, and enhance the efficiency of operation and maintenance; The third is to optimize system design, strengthen compatibility testing, and ensure seamless integration and collaborative work between devices. The implementation of these optimization measures not only helps to extend the service life of insulated rod bypass switch, reduce operation and maintenance costs, but also provides a strong guarantee for the safe and stable operation of power system. In the future, with the continuous progress of technology and the continuous optimization of the power grid structure, the performance of the insulated rod bypass switch will be further improved, contributing to the reliable operation of the power system.

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