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Effect of Changes in Friction of the Circuit Breaker Spring Mechanism on Separating Brake System

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Abstract

High-voltage switch equipment, especially the breaker body has long-term operation without action, this situation will cause friction brake tripping system changes, through ADAMS dynamic simulation and test verification is conducive to improving the reliability of circuit breaker spring mechanism, thereby ensuring safe and reliable operation of the power grid.

Keywords

High-voltage Switch; Circuit Breaker Spring Operating Mechanism; Tripping System; Variation of Friction.

1. Introduction

The main function of the spring operating mechanism of the circuit breaker is to drive the high-voltage switch (the body) to realize closing action, opening action and reclosing action, while playing the role of limit, to ensure that the body is stable in the opening position or the closing position. Circuit breaker spring mechanism in the operation process of the separating brake system is the most critical, when power system failure, require cut-off points brake quickly in dozens of ms, otherwise may cause the whole grid system paralysis. but in actual operation, switch equipment in power station running for a long time without action, will create components of the brake trip system friction changes, may cause the switch can not be split, the safety of the power grid system operation is a great danger. It is very important to optimize the structure to improve the safety of circuit breaker switch by simulating the effect of the friction change of the high-voltage switch breaker spring operation mechanism splitter system on the operation of the split gate.

2. Circuit breaker spring operating mechanism structure and principle of action

The main function of the spring operating mechanism of the circuit breaker is to drive the the body to realize closing action, opening action and reclosing action, while playing the role of limit, to ensure that the body is stable in the opening position or the closing position. The original state of the spring mechanism is in the split gate position, the closing spring is not energy storage state, driving the onto body action principle is as follows: break-brake operations: spring operating mechanism in the closing position and break-brake spring is compressed, when break-brake electromagnet by the electric action, break-brake trip turn to release the main arm of break-brake check a pin, and under the action of break-brake spring, turn the transmission arm by rod driven in turn main arm, turn the arm drives the pull rod assembly and turn the arm upward movement, push the insulation rod, realize the dynamic contact of circuit breaker body assembly and static contact points brake assembly, and by break-brake spring precompression force should be keep to the point gate location.

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3. Simulation and optimization design example

ADAMS dynamic simulation of circuit breaker spring operating mechanism is carried out to analyze the effect of friction changes in the tripping system on the operation of the split gate.

3.1 To reduce the amount of calculation and ensure the accuracy of modeling and simulation, make assumptions about the breaker spring operating mechanism

1) Only the parts involved in the tripping system such as the outer arm, the main arm, the opening latch and the opening latch are considered; Each bearing is equivalent to friction to participate in simulation calculation; The rack is equivalent to the "earth" in the simulation model.

2) Ignoring the flexible deformation of each part, each part is considered as a rigid body.

3) The acting force of the opening brake spring on the outer arm is simplified as a load force acting on the outer arm.

4) The force of the body on the mechanism is simplified as a load force acting on the outer arm.

5) Simplify the force of the reset spring on the opening brake holding valve to a force acting on the opening brake holding valve.

6) The impact force of the electromagnet on the opening gate latch is simplified as a force acting on the opening gate latch.

Under the above assumptions, the ADAMS modeling of the circuit breaker spring operating mechanism is carried out.

3.2 Establish constraints

1) Establish a fixed constraint between the outer arm and the main arm to ensure the coaxial and synchronous rotation of the main arm and the outer arm.

2) Establish a rotation pair restraint between the main crank arm and the earth.

3) Establish a rotation pair constraint between the main roller and the main roller, and increase the friction constraint (as the needle roller bearing is connected between the main roller and the main roller, which is equivalent to the friction force, and set the friction factor of the rotation pair. According to the "Comprehensive Product Catalogue of needle roller Bearing series" published by Japan Dongsheng Co., LTD., the friction factor of needle roller bearing with cage is 0.001-0.003, the upper limit of which is taken in this text 0.003).

4) Establish contact constraint between the main roller and the opening damper (set the friction factor for relative motion between the main roller and the opening damper. It can be seen from "table of friction factors between common materials and objects" that the friction factor between steel and steel is 0 under the condition of no lubrication. 15. The static friction factor in the lubricated state is 0.1 to 0.12. In this paper, the upper limit of static friction factor is 0.12).

5) Establish a rotating pair constraint between the opening brake retaining valve and the earth, and increase the friction constraint (since the opening brake retaining valve is connected with the frame through a bearing, its equal effect is regarded as friction force, and set the friction factor of the rotating pair. According to the "Comprehensive Product Catalogue of needle roller Bearing series" published by Japan Dongsheng Co., LTD., the friction factor of needle roller bearing with cage is 0. 001-0. 003, and we're going to take 0 as the upper limit. 003).

6) Establish contact constraint between the opening roller and the opening latch (set the friction factor for relative motion between the opening roller and the opening latch. It can be seen from "table of friction factors between common materials and objects" that the static friction factor between steel and steel is 0 under the condition of no lubrication. 15, the static friction factor in the slippery state is 0.1 to 0.12. In this paper, the upper limit of the static friction factor in the state of lubrication is 0.12).

7) Establish a pair of rotation constraints between the release latch and the earth.

8) The load force F1 is set on the outer turn arm, and its value is the equivalent acting force of the opening spring (take the spring force 26753 N when the opening spring is at the position of P2).

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9) Load force F2 is set on the outer turn arm, and its value is the equivalent body force.

10) Load force F3 is set on the opening brake retaining valve, and its value is equivalent reset spring.
11) The load force F4 is set at the opening lock latch to ensure the reliable rotation of the opening lock latch.

3.3 Carry out simulation analysis according to the model

Modeling of theoretical dimensions: modeling the dimensions of each part calculated according to the lower limit of theoretical dimensions required by the drawings, and setting the simulation analysis time to 0. 007 s, simulation step set to 500.When the load force F4 acts on the opening lock latch, the opening lock latch rotates reliably.

When the parts are at the lower limit of the theoretical size, when the opening lock is rotated reliably under the action of the electromagnet, the opening keep valve can not keep self-balance, and automatically disengage the main turn arm to realize the opening operation.

The dimensions of each part calculated in reference are modeled according to the upper limit of theoretical dimensions required by the drawings. When the load force F4 acts on the opening lock, the opening lock can rotate reliably and the opening trip system can also operate reliably.

It can be seen from the above analysis that under normal condition, when the unlocking latch is rotated reliably, the mechanism will not appear the phenomenon of "rejection".

The mechanism keeps the closing state for a long time, without operation, etc., and the friction factor between the parts of the mechanism will gradually increase due to a long time of no action (such as a long time of no action, resulting in the consolidation of lubricating oil, pollutants in the air attached to the surface of the parts, sufficient deformation between the parts, etc.).Therefore, the simulation is carried out from the perspective of increasing the friction factor between components analysis.

Tripping system for the analysis of relative movement between parts, except the Lord turn arm stone child with break-brake keep rolling friction between the pawl is outside, the rest of the parts, such as points between the brake pawl and frame, and turn the main arm between frame and so on, are connected by bearing, axis bearing friction factor less affected by the outside world, therefore this article mainly from turn increase the arm roll and child with break-brake keep the Angle of the friction factor between the latch for simulation and analysis. Based on the original model, the friction factor between the main roller and the opening damper is changed from 0. 12 increments to 0. 3. Institutions began to reject scores. When the load force F4 acts on the opening lock latch, it makes the opening lock latch reliable the rotation.

The above analysis shows that under normal circumstances, institutions will not happen "rejected" phenomenon, the breaker spring mechanism in the scene without moving for a long time "points" phenomenon, when the machine structure for a long time no movement, consolidation, lubricating oil pollutants in the air table surface attached to the parts, parts between deformation, etc., fully turn leads to the main arm stone roller with break-brake pawl increases the coefficient of friction between the above normal (friction factor between components is gradually increasing because of long time no action). After the opening lock is rotated, the mechanism may appear the phenomenon of "rejection". The maintenance department of the power station should not keep the breaker spring structure stationary for a long time as far as possible, and the switch manufacturer should adopt good anti-aging performance, not solidifying and lubricating grease, and keep enough strength margin and corrosion resistance of the parts.

4. Conclusion

In this paper, a dynamic simulation software is introduced to simulate and analyze the effect of friction force variation on the tripping system of high voltage switch circuit breaker spring operating mechanism, which has guiding significance for the research and improvement of the tripping system of high voltage switch.

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