

The Method for Measuring Circuit Breaker Overtravel Based on Operating Process

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Abstract: At present, the over-travel measurement of high-voltage circuit breakers is mostly carried out after the circuit breaker is completely dismantled. The disadvantage of the measurement is that it can only be measured when the circuit breaker is dismantled and overhauled. Defects are diagnosed in a timely and effective manner, and capacity causes hidden troubles. This article provides a method for direct measurement of hydraulic circuit breakers without any adjustment or disassembly. The method can be carried out in various situations such as minor repairs, major repairs, and temporary repairs, which not only saves time, but also improves accuracy of the measurement. The comparative test results show that this method can be simple, convenient and effective to measure the overtravel of the high-voltage circuit breaker.

Keywords: Circuit Breaker, Stroke, Over Stroke, Hydraulic Mechanism, Measurement

1 Introduction

With the increasing reliability and automation requirements of the power system, whether it is power generation, transmission, distribution or consumption, the requirements of automation and intelligence in monitoring, control, protection and other aspects are put forward. High-voltage circuit breaker is an important executive component of power system operation, and also an important electrical equipment with more frequency of fault diagnosis, troubleshooting and parameter measurement. The circuit breaker has arc-extinguishing characteristics. When the system is in normal operation, it can cut off and connect the no-load and load current of the lines and various electrical equipment; When a fault occurs in the system, it cooperates with the relay protection to quickly cut off the fault current to prevent expanding the scope of the

accident. No matter what state the power line is in, such as no-load, load or short circuit fault, when the circuit breaker is required to act, it should be able to act reliably to close or cut off the circuit. The circuit breaker can open, close and break the specified abnormal current, such as overload current and short circuit current. Therefore, the high-voltage circuit breaker^[1-3] bears the dual tasks of control and protection in the power system, and its performance is directly related to the safe operation of the power system. With the rapid development of social economy, people put forward higher requirements for power supply quality. To improve the monitoring of power equipment and ensure the stable operation of circuit breakers has become a problem that relevant power workers need to consider and solve.

Generally, the high-voltage circuit breaker should be regularly overhauled according to the regulations

when it is applied in the field. Generally, it is required to carry out 1-2 minor overhauls a year and overhaul once every 2-3 years. The electrical and mechanical properties of the high-voltage circuit breaker should meet the requirements of various operation conditions, repair and maintenance of the power system. The operation experience of the power grid shows that the high voltage circuit breaker equipment has faults, of which mechanical faults account for about 70%~80%. Therefore, when conducting field tests on the circuit breaker equipment, special attention should be paid to the mechanical characteristic test and the measurement of mechanical parameters. Stroke and overstroke^[4-5] are important mechanical parameters of high-voltage circuit breakers. The circuit breaker can give full play to its ability of breaking current only when it ensures proper opening and closing time. It can be predicted that with the rapid development of science and technology, production and life have higher and higher requirements for power grid construction, and the response time for circuit breakers will be more demanding. If the opening time is too long, the arcing time will increase, especially when cutting off the open circuit fault, the long arcing time may cause the contact to burn, or even explode. High voltage circuit breaker will cause mechanical vibration or wear after frequent closing and opening operation; at the same time, the strong burning of the arc in the arc extinguishing chamber will cause serious consequences such as burning and melting of the contact, and the stroke and over-stroke parameters will change. The mechanical or electrical wear degree of the high-voltage circuit breaker can be determined according to the change degree of the stroke and over-stroke.

2 Definition of High-voltage Circuit Breaker Stroke, Overstroke and Opening Distance

2.1 Definition of High-voltage Circuit Breaker Stroke

The stroke of the high-voltage circuit breaker can also be called the total stroke of the high-voltage circuit breaker, which refers to the moving distance of the moving contact from the opening position to the closing end of the high-voltage circuit breaker during the

closing process. The deviation between the stroke of the high-voltage circuit breaker and the factory value is too large, indicating that the transmission part or contact of the high-voltage circuit breaker has mechanical wear or stuck during the movement process or the running trajectory is offset.

2.2 Overtravel of High Voltage Circuit Breakers

The overtravel of the high-voltage circuit breaker is also called overtravel, which refers to the distance from the contact between the moving and static contacts, the moving contacts continue to move beyond the stroke, and the distance to the end of the closing. When measuring overtravel, it should generally start from the opening position and measure through slow closing, rather than starting from the closing position and measuring through slow separation. If the overtravel becomes smaller, it means that the arc contact may have some degree of burnout. The smaller the overtravel, the more serious the burn of the arc contact, and beyond a certain extent, the arc contact needs to be replaced on site. If the overtravel is too large, it means that the dynamic and static contacts are seriously worn and the contact is poor, and the overtravel value must be regularly detected during actual use. Arc extinction is a problem that must be solved for high-voltage circuit breakers. If the contact of the circuit breaker is burnt or seriously worn, it is extremely harmful to the arc extinction of the high-voltage circuit breaker. When the overtravel is less than the value specified by the manufacturer, it is necessary to replace the arc contact in time. The purpose of overtravel is mainly to ensure the pressure of the contact, thereby reducing the contact resistance, various types of high-voltage circuit breakers will give the standard range of overtravel, within this range can ensure the contact pressure of the high-voltage circuit breaker, and can obtain better closing speed. Therefore, in the actual power system, it is of great significance to measure the overtravel distance^[6-8] of the high-voltage circuit breaker. For example, some models of high-voltage circuit breaker arc contacts need to be replaced if they burn out a few millimeters. However, the circuit breaker using hydraulic mechanism in the power system with a voltage level of 220kV and above ac-

counts for the majority, and the closing speed of the high-voltage circuit breaker is very fast, ms-level, and it is difficult to measure the overstroke during operation. At present, the measurement of the stroke and overstroke of the high-voltage circuit breaker can usually only be measured by disintegrating the high-voltage circuit breaker in the case of a major overhaul. Therefore, the measurement interval is long, and it is not easy to detect the mechanical defects of the high-voltage circuit breaker in time. This paper provides a new method to measure the stroke and overstroke of a high-voltage circuit breaker without disassembling it, reducing the difficulty of measuring stroke and overstroke.

2.3 Open Distance of High Voltage Circuit Breaker

The opening distance of the high-voltage circuit breaker refers to the minimum distance between the dynamic and static contacts of the circuit breaker when the circuit breaker is in the open position. As the voltage level of the circuit breaker increases, the circuit breaker opening distance will increase accordingly to meet the insulation requirements of the open state.

3 Experimental Method

In this paper, a new measurement method for overtravel of circuit breaker of hydraulic mechanism is summarized in the experience of power system work site [9-10]. This method can measure the overtravel of the circuit breaker without disintegrating the high-voltage circuit breaker. The basic method is:

(1) The prime minister needs to take the circuit breaker out of operation, let the circuit breaker be in the open position, and open the high-pressure oil drain valve of the hydraulic mechanism at this time. By observing the oil pressure gauge, confirm that the pressure is released to zero, and then close the valve;

(2) Secondly, start the oil pump motor and stop instantly, the main purpose of the process is to establish a small amount of oil pressure. Then force the closing, at this time due to the low oil pressure, the position of the pipe valve can be artificially changed, and the rising speed can be controlled with the oil drain valve;

(3) Finally, the traditional test lamp method is used. The principle is shown in Fig.1, Record the ref-

erence point L1 at the moment when the dynamic and static contacts of the circuit breaker just touch;

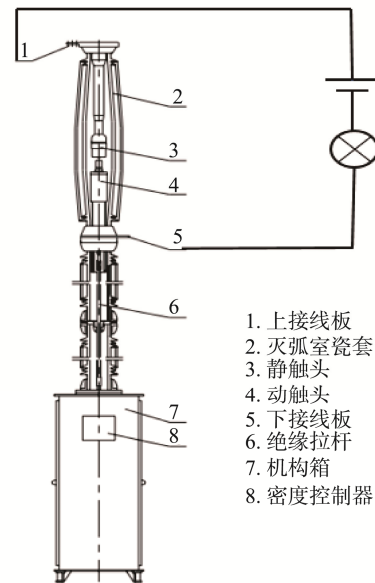


Fig.1 Wiring Diagram of the Light on Test Circuit

(4) Record the reference point L2 where the circuit breaker is closed to the end, as shown in Fig.2, then the circuit breaker override = $L2 - L1$ (Overtravel = total travel of circuit breaker – travel from the closing point to the closing point), and the measurement ends.

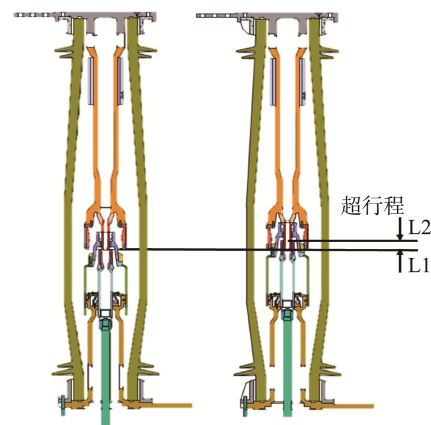


Fig.2 Circuit Breaker Overtravel

4 Measurement Steps

In this paper, LW108-252W/CYT-50 high-pressure circuit breaker of sulfur hexafluoride hydraulic mechanism was used as the experimental object for measurement. LW10B-252/CYT-X SF6 circuit breaker

uses SF₆ gas as arc extinguishing and insulation medium. Single-voltage variable-opening arc extinguishing chamber structure is adopted to cut off rated current and fault current, convert lines, and realize control and protection of high-voltage transmission lines and electrical equipment. Each pole has a set of independent hydraulic system, which can be operated in phases to realize single-phase automatic reclosure; Three-phase linkage operation can also be realized through electrical linkage to realize three-phase automatic reclosing. Table 1 for main technical parameters is shown. The mechanical dimension of the circuit breaker shall be measured by the method of slow opening and closing of the circuit breaker, which shall conform to the following requirements: the stroke is $200\text{mm} \pm 1\text{mm}$, and the over-stroke is $40\text{mm} \pm 4\text{mm}$. When measuring the overtravel, it should generally start from the opening position and measure through slow closing, rather than from the closing position and measure through slow opening.

The specific measurement steps are:

(1) First exit the circuit breaker from operation, so that the circuit breaker is in the open position, open the high-pressure oil drain valve of the hydraulic mechanism, release the pressure to zero, and then close the valve, as shown in Fig.3.

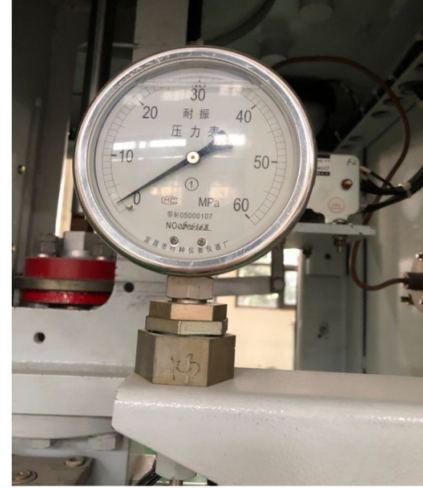


Fig.3 Release Oil Pressure of the Circuit Breaker

(2) Turn on the oil pump power switch and turn it off instantly. Make the oil pump run for no more than one second, so that the hydraulic mechanism establishes a small amount of oil pressure, if the oil pressure is too high, in the future, during the slow closing operation, it will cause the circuit breaker to close directly. If the oil pressure is too low, (experience shows, below 5MPa), it may cause the pipe valve inside the secondary valve of the hydraulic mechanism to move to the middle position, so that the hydraulic mechanism permanently loses pressure.

Table 1 Main Technical Parameters

SN	Item	Unit	Parameter
1	Rated Voltage	kV	252
2	Rated Current	A	4000
3	Rated Frequency	Hz	50
4	Opening speed	m/s	10 ± 1
5	Closing Speed	m/s	4.6 ± 0.5
6	Opening Time	ms	20 ± 3
7	Breaking Time	周波	2
8	When Closing	ms	60 ± 5
9	Pre-filled Nitrogen Pressure of Pressure Accumulator (15°)	MPa	18 ± 1.00
10	Rated Pressure of Oil	MPa	33
11	Rated Pressure of SF ₆ Air (15°)	MPa	0.4
12	Rated Insulation Level (effective Value of Power Frequency Withstand Voltage For 1 min)	Kv	Between Ports (460) Relative Ground (395)

(3) Manually force the closing electromagnet to hit the rod to make the circuit breaker forcibly close, at this time, because the oil pressure is not high, the operating force is very small, and the pipe valve can only be driven to act in place, while the circuit breaker is still in the open position.

(4) Open the high-pressure drain valve again, start the oil pump, and slowly twist the high-pressure drain valve in the closed direction, The circuit breaker begins to close slowly, at this time, due to the low oil pressure, artificially change the position of the pipe valve, use the oil drain valve to control the rising speed, and the closing speed of the circuit breaker can be adjusted by the size of the valve opening.

(5) An external lamp circuit is connected between the upper and lower wiring boards of the circuit breaker arc extinguishing chamber, so as to form a loop, as shown in Fig.2, judging the contact of the dynamic and static contacts of the circuit breaker by the light-on method.

(6) Slow closing circuit breaker, observe the test light in the process of slow closing of the circuit breaker. When the light is on, the dynamic and static contacts just touch the moment, and the position of the transmission rod is recorded. This position is used as the measurement reference point L1, as shown in Fig.4, at this time, the reference point data is read, $L1 = 23.5\text{cm}$.

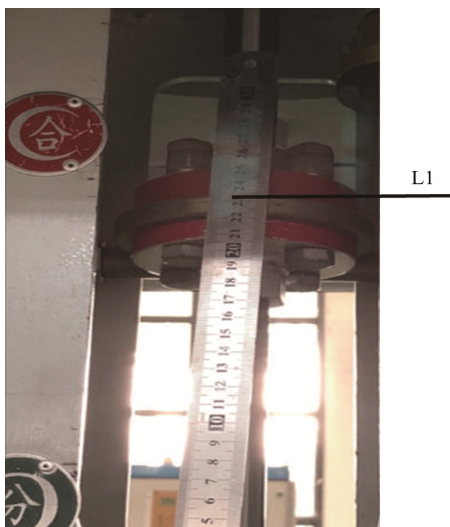


Fig.4 Recording Reference Point L1

(7) Tighten the high-pressure oil drain valve to close the circuit breaker to the end, record the final position L2 of the transmission rod, as shown in Fig.5, at this time $L2=27.5\text{cm}$.

(8) Calculate the distance between the reference point and the final position of the drive lever, the over-stroke of the high-voltage circuit breaker is equal to $L2-L1=27.5-23.5=4\text{cm}$, and the measurement ends.

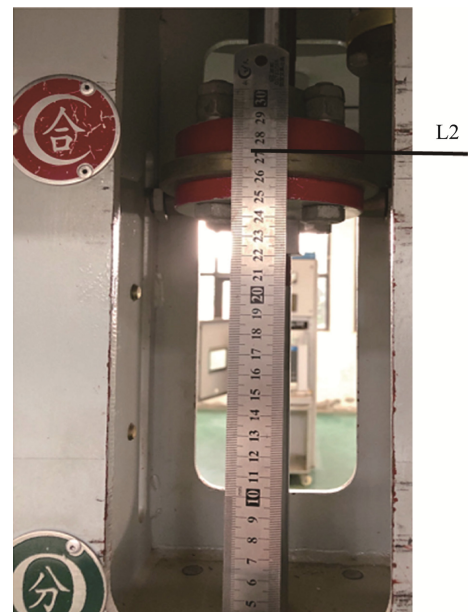


Fig.5 Recording Reference Point L2

5 Conclusions and Recommendations

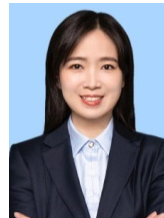
During normal operation of the circuit breaker, the contact will cause wear after continuous disintegration, and after loading or fault disintegration, the contact will be burned. The above problems can be found by measuring the stroke of the high-voltage circuit breaker^[11-12], which provides a basis for evaluating the operating status of the circuit breaker and guiding maintenance. Therefore, the stroke and overstroke of the high-voltage circuit breaker is an extremely important technical parameter and should be measured in strict accordance with the relevant regulations. This measurement method can be used during the operation of the power system without disintegrating the high-voltage circuit breaker. The overtravel of the circuit breaker is measured by controlling the high-pressure drain valve of the hydraulic mechanism, this measurement method is mainly for

the Bellinger hydraulic mechanism, the circuit breaker contact must be in a straight line with the actuator transmission rod, and there are no arms and other components in the middle^[13]. Controlling the speed of the moving contacts is a very important factor in the measurement process. However, in the actual operation of the circuit breaker, the faster the closing speed, the more beneficial it is to extinguish the arc, and it is strictly forbidden to carry out slow closing and slow separation, otherwise it will cause a serious accident of the circuit breaker explosion^[14-15].

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