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Research on Buffer Structure of Hydraulic Spring Operating Mechanism

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Abstract: The hydraulic spring operating mechanism is an important part of the high voltage circuit breaker, which determines the speed of separation and the stability of the circuit breaker. The buffer structure plays an indispensable role in the operation of actuators. In order to study and optimize the buffer structure of high voltage circuit breaker, the buffer structure is theoretically analyzed. A simulation model based on AMEsim is built and test is carried out on the gate buffer. Through simulation analysis and experimental research, the dynamic buffering oil pressure and fluid characteristics of the buffer structure are obtained. The five step ladder buffer structure is optimized and improved, which further improves the reliability and applicability of the hydraulic spring operating mechanism

Keywords: buffer structure, co-simulation, buffering characteristics.

1. INTRODUCTION

As a key component of the power grid, high-voltage circuit breakers play a role in protection and control of the entire power system, and their working conditions determine the stability of the system [1]. The buffer structure is an important part of the operating mechanism of the high voltage circuit breaker, and plays a vital role in the normal operation of the operating mechanism. The operating state of the buffer structure affects the working state of the operating mechanism and further affects the working state of the entire circuit breaker [2].

In some special work situations, there is a great impact in the work of high voltage circuit breakers. Hence, adding a buffer structure in circuit breaker operating is essential for ensuring the stability of the system. In field experiments of high voltage circuit breakers, the buffer structure is often subjected to excessive pressure shocks and excessive movement speeds. This will cause the fracture of the organization to fail and seriously threaten the normal operation of the power system [3].

At present, relevant scholars have made targeted research on the buffer structure. However, with the increase of voltage level, the problem of frequent failure of the buffer structure has not been fundamentally solved [4-5]. This paper starts from the practical application of buffer structure, systematically analyzes the dynamic characteristics of the buffer structure, solves the above problems to a certain extent, and optimizes the buffer structure, which provides a theoretical basis for the improvement and application of the buffer structure of the high voltage circuit breaker.

2. WORKING PRINCIPLE OF THE BUFFER STRUCTURE

The cushioning principle of the staircase plunger buffer structure. The flow of hydraulic oil gradually decreases in the buffer hole when the stepped plunger is close to the slow piercing. When the stepped plunger enters the buffer hole, the piston speed will decrease rapidly due to the change of the overcurrent area. This structure is characterized by the short duration of the braking process. During the throttling process, with the continuous change of the throttling area, the corresponding buffer speed and pressure also decrease. When the plunger fully enters the buffer hole, the hydraulic oil is discharged through the adjustable oil outlet controlled by the adjusting screw. The buffer structure is equipped with a one-way valve to ensure that the plunger can fill the piston cavity when reversing. In the initial stage of the buffer, the stepped buffer structure is usually large and has a large impact at the piston, so it is suitable for low speed and large load conditions.

3. DESIGN AND ANALYSIS OF BUFFER STRUCTURE

3.1 piston length

The pressure average value of hydraulic oil is predicted within the allowable pressure range of the buffer structure. According to the law of conservation of energy, the relationship between the work of buffering oil and the amount of kinetic energy change is obtained. The total length of the piston can be roughly calculated to be 240 mm.

3.2 piston and piston rod diameter

The throttling area of the buffer structure is closely related to the diameter of the piston. In order to obtain reasonable throttling area, the diameter of piston and piston rod must be calculated first, so as to achieve the best cushioning effect. The piston diameter of the buffer structure is 55 mm, and the piston rod diameter is 24 mm.

3.3 buffer hole diameter

The diameter of the buffer hole determines the change range of the throttling gap and is the key parameter affecting the cushioning effect. The principle of closing and buffering is similar and the function is different. Therefore, it is necessary to design the buffer holes separately and separately. After calculation, the scoring gate is 25 mm in diameter and 35 mm in the closing hole.

3.4 buffer steps

The stepped plunger is located on both sides of the piston, and the working performance of the buffer structure can be changed flexibly according to the change of the diameter of the multi plunger. The number of steps in the ladder shaped buffer structure is determined by the diameter of the piston, and the diameter of each step affects the performance of the buffer structure. In order to match the step column and the diameter of the piston, the 5 step plunger and the ladder shape buffer structure diagram of the piston rod were initially determined by Figure 1.

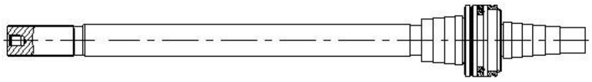


Fig. 1 The structure diagram of piston rod

4. SIMULATION ANALYSIS OF BUFFER STRUCTURE

Based on the Adams simulation model of the five step step buffer structure, the hydraulic system model of buffer structure is constructed by AMEsim simulation software. The model obtained is shown in Figure 2. In Figure 2, when the speed is reduced to 0, when the simulation ends, the buffer characteristic curve of the buffer stage can be obtained.

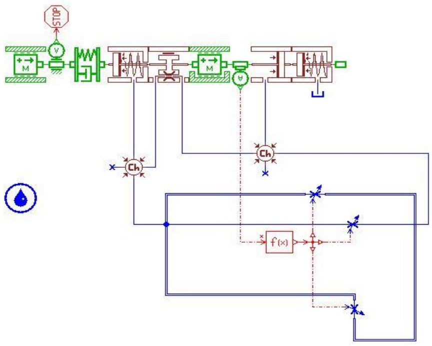
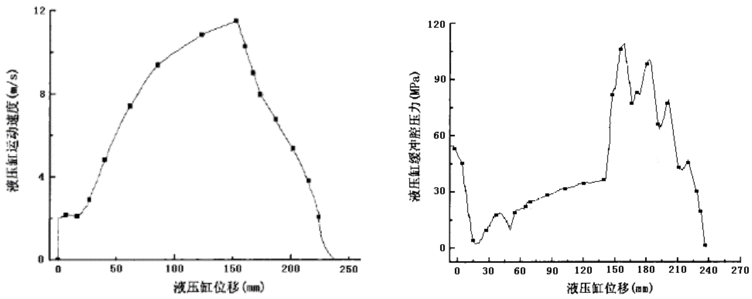


Fig. 2 Simulation model in AMEsim

The speed, pressure and displacement characteristics of the piston during the brake buffer stage are shown in Figure 3. In Figure 3(a), the speed and displacement curve of the gate has a tendency to rise first and then decrease. When the speed reaches the peak value of 11.2m/s, the ladder shaped column is inserted into the buffer port. The sudden decrease of the overcurrent area makes the pressure increase rapidly and produce a greater impact. The piston speed continues to decrease with the plunger depth, and the piston speed drops to 1.0m/s at the end of the brake buffer stage. From Figure 3(b), it is found that the pressure displacement curve is opposite to the velocity displacement curve because the hydraulic oil provides braking resistance during the buffer process. As the piston begins to accelerate, the pressure decreases rapidly as the displacement increases, and the acceleration of the piston increases the oil pressure. When the buffer stage starts, the peak pressure is 111.98MPa, and different extremes are generated at the beginning of different buffer steps.



(a)The opening velocity-displacement curve (b)The opening pressure-displacement curve

Fig. 3 The opening and closing curve

When the buffer process is completed, the pressure or speed over the assembly will cause serious rigid impact on the mechanism, resulting in damage to the buffer structure. The simulation results show that the pressure and terminal velocity of the buffer chamber are low, which can reduce the impact problem to a certain extent and improve the reliability of the system.

5. CONCLUSION

The buffer structure of the hydraulic spring operating mechanism is simulated and tested, and the displacement curve and the buffer oil pressure curve of the brake buffer are obtained. The simulation results show that the greater the gap between the steps of the stepped plunger and the buffer hole, the greater the pressure impact, and on the contrary, the reduction of the gap can help to improve the pressure impact. Through the test verification, through the reasonable arrangement of the step diameter of the stepped plunger, the peak pressure of the buffer structure can be reduced, the buffer oil pressure curve is smoother and the pressure fluctuation of the buffer structure is greatly improved.

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