Research and Application of temperature indicating controller temperature probe replacement tool and test tool frame

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Abstract. In view of the aging and corrosion of temperature probe caused by environmental problems, the traditional replacement method has problems such as long time consumption and difficulty in replacement. It is proposed to make a temperature indicator controller temperature probe replacement tool, which can further improve work efficiency and reduce power failure overhaul time. And in view of the human error in the temperature test of the temperature indicating controller and the technical error caused by the collision of the thermal resistance, combined with the relevant conditions of the electrical laboratory, a multi-functional temperature test tool rack is designed to realize the auxiliary temperature indication controller test and reasonable storage of thermal resistance. Finally, a practical experiment is carried out on the tools and instruments developed, and the results show that the tools and instruments designed and developed in this paper are feasible and practical.

1. Introduction
In the operation of today’s power system, for large power equipment such as transformers and arc suppression coils, thermal effects are the most important factor that causes aging[1]. The temperature indicating controller is commonly known as a thermometer. It is divided into two types: oil surface and winding. It is installed on large power equipment such as transformers and arc suppression coils. It is used to measure and control the oil temperature of other power equipment such as transformers to ensure that the equipment works normally at a qualified temperature, which is of great significance to the reliable operation of the power system[2]. The aging of the sealing rubber gasket of the temperature measuring probe, which causes the temperature probe to rust and damage when entering the water is one of the common faults of the temperature indicating controller[3]. The damage to the thermal resistance during disassembly and testing is an important cause of failure of the transformer temperature measurement system[4]. The installation and disassembly test process of thermal resistance and temperature probe was also considered when analyzing the cause of equipment failure[5].

In view of the above problems, in order to better ensure the stable operation of the power system, this paper proposes to development of temperature indicating controller temperature probe replacement tool and test tool rack.
2. Design and introduction of temperature probe replacement tool

2.1. Structure design of temperature probe replacement tool

Figure 1 shows the structure diagram of the replacement tool. The names of the parts in Figure 1 are as follows: worm 1, worm fixed support 2, worm gear 3, upper steel plate 4, screw rod 5, lower steel plate 6, connecting rod 7, moving steel plate 8, sleeve 9, rolling bearing 10, split body Snap ring clamp 11, crank 12, cavity 13, gap 14, temperature probe 15, screw through hole 16, connecting rod through hole 17, connecting bolt hole 18.

![Figure 1. Structure diagram of temperature probe replacement tool.](image1)

Figure 2 and Figure 3 are respectively a schematic diagram of the upper steel plate plan structure and a schematic diagram of the split snap ring fixture structure.

![Figure 2. Plane structure diagram of upper steel plate.](image2)

![Figure 3. Schematic diagram of snap ring fixture structure.](image3)
2.2. Detailed introduction of tools

As shown in Figure 1, the temperature indicator controller temperature probe replacement tool includes a frame, with a horizontal worm on the frame, with a rocker on the outer end of the worm, and two spaced worm wheels at the front end of the corresponding worm, worm wheel 3 and worm Meshing connection; There are two spaced vertical screw rods in the frame. The upper end of each screw rod is fixed with a worm gear, and the lower end of each screw rod is covered with a rolling bearing, which is used to realize the flexible rotation of the screw rod in place; Each screw is threadedly connected with a moving steel plate, the screw can rotate in place, and the moving steel plate can move up and down along the screw[6].

The frame is composed of four connecting rods between the upper steel plate, the lower steel plate, the upper steel plate and the lower steel plate. There is a cavity between the upper steel plate and the lower steel plate, there is a gap for the temperature probe to pass through on one side of the cavity for the temperature probe to pass through.

There is a hole in the middle of each movable steel plate, and a sleeve with internal thread is inlaid in the hole, which can drive the movable steel plate to move up and down along the screw rod.

The tool is also equipped with a split snap ring clamp connected with the temperature probe. The split snap ring clamp consists of two snap rings with a semicircular inner diameter. The radius is the same as that of the temperature probe, both are 4mm. The two inner diameters are The semicircular snap ring is connected by two horizontally connected bolts in it, and there are connecting bolt holes horizontally.

The worm is fixed above the upper steel plate through the worm fixing support, and it is engaged with the worm wheel at the same time. The center of the worm wheel is above the hexagonal connecting screw, and the lower part of the screw is installed on the lower steel plate. The lower steel plate is connected and fixed with the upper steel plate through four connecting rods. There is a round hole on the left and right sides of the moving steel plate to install a sleeve, and the sleeve is threaded inside, and the sleeve is installed on two screw rods, and the sleeve is fixedly connected in the center hole of the moving steel plate[7]. The connection between the worm and the fixed support of the worm, and the connection between the screw and the lower steel plate are equipped with rolling bearings for easy rotation.

As shown in Figures 1 and 3, the split snap ring clamp is composed of two snap rings with a semicircular inner diameter. In Figure 3, the two halves are separated. The two snap rings are combined as a fixed fixture. Holes are symmetrically drilled on both sides of the snap ring and made into internal threads, which are fixed with the temperature probe by bolts.

2.3. Tool operation method

When using, first place the tool on the temperature measuring probe. The temperature measuring probe is in the center of the circular hole of the lower steel plate through the gap, and then the split snap ring clamp is fixed on the temperature measuring probe. Using the crank to rotate the worm, the worm drives the worm wheel to rotate, the worm wheel drives the screw to rotate, and the screw rotates to lift the moving steel plate with a sleeve (the moving steel plate is stuck at the lower end of the split snap ring clamp), and the moving steel plate drives the split snap ring clamp to lift up, thereby the temperature probe clamped by the split snap ring clamp is taken out from the U-shaped tube.

3. Design and introduction of multifunctional temperature test tool rack

3.1. Structure Design of Multifunctional Temperature Test Tool Rack

First, a temperature and humidity alarm device is installed on the tool rack to detect the temperature and humidity in the laboratory in real time, laying a foundation for better testing. Secondly, there is a movable hook at the front end of the tool rack, which is convenient to ensure that the temperature indicating controller remains in a vertical state during the experiment and simulates the operating state of the equipment in normal operation. The tool rack is also provided with a round hole enough to insert
the thermal resistance, which is convenient for storage of the thermal resistance, and solves the error problem caused by the thermal resistance flat laying and bumping.

At the same time, consider the convenience during the experiment and the reasonable placement of the items after the experiment. The tool rack is also equipped with a movable pull-out storage function and a movable tilt lever.

3.2. Detailed introduction of multifunctional temperature test tool rack

The tool rack structure described in this article is shown in Figure 4. The names of the parts are as follows: white steel frame 1, temperature and humidity alarm 2, hook slide way 3, hook 4, anti-tilting gear lever 5, adjusting screw 6, left side pull-out white steel plate 7, round hole 8, slot Steel slide 9, drawer 10, universal wheel 11, pull-out white steel plate 12 on the right, sliding sleeve 13, front pillar 14.

As shown in Figure 4, the multifunctional temperature test tool frame designed in this paper includes a vertical quadrilateral white steel frame, which is divided into a multi-layer structure from top to bottom. The upper end of the white steel frame is equipped with a temperature and humidity alarm system. The front end of the white steel frame is provided with a hook slide along the width direction. There are several movable hooks in the hook slide. The stainless steel frame at the lower part of the hook slide way is horizontally installed with an anti-tilt gear rod that can move up and down, and the anti-tilt gear rod can be moved. The two ends are connected to the front column of the white steel frame by sliding sleeves. The adjustment lever can be move up and down, and the sliding sleeve has an adjustment screw vertically connected to the front column, which locks the adjustment lever to prevent it from moving up and down[8]. Two pull-out white steel plates are installed on the left and right sides of the middle area of the white steel frame. There are channel steel slides on both sides of the pull-out white steel plate on the left side. There are multiple round holes for inserting thermal resistors on the surface. In figure 4, only one is drawn, and there are actually 24 circular holes, evenly arranged vertically and horizontally, with a diameter of 4cm; Pull-out white steel plate on the right, channel steel slides on both sides of the white steel plate, used to install 220V power sockets and drawers; Four universal wheels are installed at the bottom of the white steel frame. The temperature indicating controller can be hung vertically for temperature test, and the thermal resistance can be stored vertically to prevent the temperature measuring parts from colliding with each other and causing damage[9].

Figure 4. Schematic diagram of the temperature test tool rack.

Figure 5 shows the structure diagram of the hook.
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Figure 5. Schematic diagram of hook structure.

Figure 6 shows a schematic diagram of the top view structure of the anti-tilt gear lever.

4. Conclusion

This paper proposes and designs a temperature indicating controller temperature probe replacement tool and a multifunctional temperature test tool holder used in the field of temperature testing. Through actual operation and application, it can be found that the replacement tool designed in this article has a compact structure and simple operation, which enables a single person to complete the replacement of the temperature probe; at the same time, compared with traditional tools, the replacement time is shorter, the operation difficulty is lower, and the work efficiency is higher, which is beneficial to shorten the power outage time of the equipment. The multi-functional temperature test tool rack designed in this article saves space for the laboratory. Under the premise of enhancing laboratory flexibility, the multi-functional temperature test tool rack realizes the vertical placement of the temperature indicating controller and thermal resistance, as well as the constant monitoring and alarm function of the laboratory temperature. Avoid production problems caused by test errors have improve the accuracy and reliability of test results.

In summary, the special tools and instruments designed in this article are suitable for the actual operation of the electrical test profession, which brings convenience to the operators and helps in safe production. It has strong utilization value and is suitable for popularization and application.

Author introduction

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