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Metal fault analysis and preventive measures for grounding accessories of 110kV cable outdoor terminal

Y Xie^{1*}, L Yang², W Li³ and Y L Liu¹

¹ State Grid Hunan Electric Power Corporation Research Institute, Changsha, Hunan, 410007, China

² State Grid Xiangtan Power Supply Company, Xiangtan, Hunan, 411104, China

³ State Grid Hengyang Power Supply Company, Hengyang, Hunan, 421000, China

Corresponding author and e-mail: Y Xie, yxie001@126.com

Abstract. There were three grounding metal faults of the 110 kV outdoor cable terminals, i.e., cracked weld between grounding copper block and the cable tail pipe, no fastened grounding copper block connecting bolt and no fixed grounding wire connected to the grounding copper block, respectively. Precautionary measures were proposed from three stages of design, including installation, operation and maintenance. It was recommended to improve the welding design during the design phase. In the installation stage, it was necessary to strictly control the construction quality control, attach importance to the connection of bolts and gaskets, and improve the fixing of the grounding wire. For the operation and maintenance phase, it was important to strengthen the targeted inspection of the grounding point of the cable terminal and the grounding wire, and to non-destructively test the quality of the weld during the power failure maintenance, which was an effective measure to ensure the safe operation of the grounded metal.

1. Introduction

With the development of urban power grids, the proportion of power cables in power lines is increasing, and the corresponding cable terminals are also increasing [1-2]. In order to ensure the safety of the electrical equipment and the staff under special circumstances such as breakdown or high current flow, the cable terminal is generally equipped with a grounding device, and a grounding copper block with a screw hole is welded to the tail pipe [3-4]. The wire is connected to the grounding copper block by bolts, and the other end of the grounding wire is connected to the grounding protector in the substation.

In recent years, several cable terminals in a certain urban power grid have ground faults and are closely related to grounded metals. This paper analyzes the cause of the fault in the grounding metal of the cable terminal, finds the lack of work in design and installation, and provides experience and reference for technical supervision.

2. Typical fault

Through the analysis of the ground faults of multiple cable terminals, it was found that there were three types of typical grounding metal faults, namely, the grounding copper block and the cable tail pipe weld were disconnected, the grounding copper block connecting bolt was not fastened, and the



grounding wire connected to the grounding copper block was not fixed. All three cases would cause grounding metal defects, which would endanger the safe operation of the cable.

The grounding copper block and the cable tail pipe are generally connected by brazing. The weld is cracked due to stress or its own defects and gradually disengages from the tail pipe. During the gradual cracking of the weld, it is possible that the grounded copper block is completely separated from the tail pipe copper material. For example, the surface of a 110 kV cable terminal A-phase tail pipe leaves a clear trace of welding along the rectangular copper block, as shown in Figure 1(a). The grounding copper joint weld cracking chamber may also break the copper body of the tail pipe to form a hole. For example, and the terminal internal silicone oil leaks from the hole of a 110 kV cable terminal C-phase tail pipe, as shown in Figure 1(b).



Figure 1. (a) Ground copper block and tail pipe copper are completely separated; (b) Cable terminal tail pipe copper weld zone is cracked.

The grounding copper block and the grounding wire are connected by fasteners. Because the installation process control is not in place, only a spring washer is installed on both sides of a 110 kV cable terminal A phase grounding copper block, and no flat pad is installed, as shown in Figure 2.



Figure 2. No fastened connection bolts.



Figure 3. No fixed ground wire connected to the grounding copper block.

The grounding wire connection method of the grounding copper block connection is not specified in the standard regulations and installation documents. Some grounding wires are not fixed by any measures, such as the phase B of a 110 kV cable terminal, as shown in Figure 3.

3. Analysis and discussion

The metallographic test was carried out on the grounding copper block and the weld. The bright color interval is copper matrix and the metallographic structure is normal. The gray interval is the weld structure. Inside the weld, a hole larger than 0.5 mm in size can be seen, and there are also pores of the order of 100 μ m. Since the copper material is not melted and there is no weld transition zone, the interface between the copper base and the weld is clear, which is a typical brazing feature, as shown in Fig. 4.

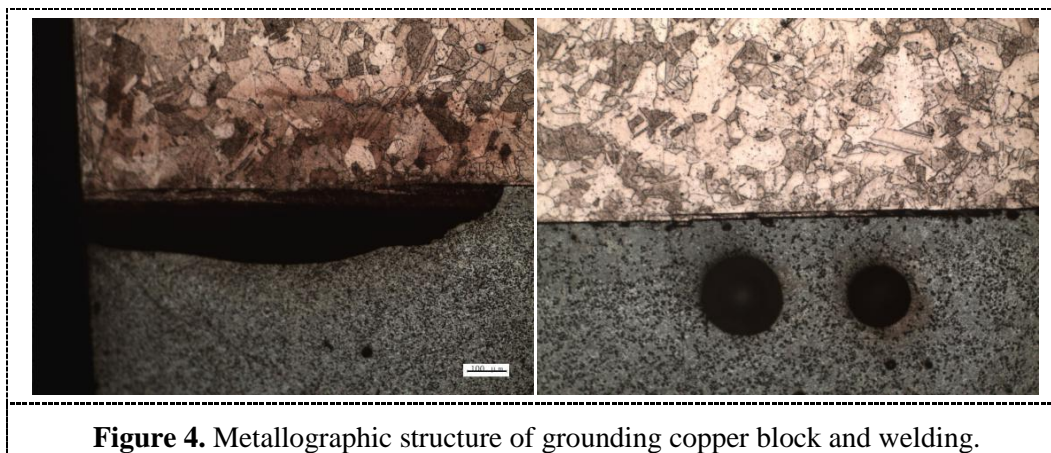


Figure 4. Metallographic structure of grounding copper block and welding.

The metallographic test shows that there is a significant weld quality defect in the brazing of the grounded copper block and the tail pipe. At the same time, according to HGJ223-1992 "Technical Regulations for Welding and Brazing of Copper and Copper Alloys", the flux should be brushed on the surface of the welding during brazing [5], and the entire welded end face of the grounded copper block should be covered with flux. From the traces of the weld crack in Figure 1, it can be seen that the grounded copper block is only partially brazed around. More importantly, the brazed weld itself has poor bearing capacity and is generally not brazed at the bearing [6]. Since the grounding copper block is brazed and welded only locally around the grounded copper block, the brazed welded joint has large holes and many pores, so its bearing capacity is poor. It is easy to detach from the tail pipe under the action of the ground wire self-weight, the external wind load installation additional torque and the corrosion stress, so that the contact failure occurs.

The connecting bolt of the grounding copper block and the grounding wire is an important node in the grounding flow guiding circuit. Flat washers and spring washers are required for bolt mounting. Gaskets and gaskets ensure good bolt contact by increasing the contact surface and preventing loose bolts. Once the bolt is missing, the bolt connection will be loose, and the contact resistance between the grounding copper block and the grounding wire will be too large. There is a safety risk in cable breakdown and high current.

Although there are no relevant standard procedures and installation specifications to clarify the way the grounding wire is fixed, it is necessary to consider the influence of the grounding wire fixing method on the service condition of the grounding copper bead weld. From the field situation, when the grounding wire is not fixed, the grounding copper block will bear the self-weight of the grounding wire and the load of the environment acting on the grounding wire, and directly promote the cracking of the welded portion of the grounding copper block.

4. Precautions

In view of the above-mentioned metal faults existing in the cable terminal, it is recommended to take measures to prevent the operation of the cable terminal from the three stages of design, installation and operation and maintenance.

(1) It is recommended to fully consider the stress of the weld between the tail pipe of the grounding copper cable end, and select the appropriate welding method and welding material.

(2) The installation requirements and standards should be strictly installed during the welding to ensure the welding quality. It is necessary to pay attention to the gasket assembly of the connecting bolts and tighten the bolts with a torque wrench. At the same time, the fixing of the grounding wire is improved to avoid additional torque to the grounded copper block weld.

(3) The operation and maintenance personnel should regularly inspect the cable terminal, and specifically detect the grounding point of the cable terminal and the grounding wire. When the power failure is overhauled, the non-destructive testing of the grounding wire welding site can be carried out, and the crack is found to be scheduled for power failure maintenance as soon as possible.

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