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Problem Analysis and Solution in Cable Current Carrying Test

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Abstract: This paper analyzes several problems in the current carrying capacity test recently, which are the interference and elimination of external environment, the short circuit of metal layer caused by temperature probe and the contact resistance at the connection. If the above three problems are not considered, the test results will have large errors. This paper discusses the causes and results of the three problems. On this basis, it provides a set of effective solutions for various problems, in order to provide reference for technical personnel in the same industry.

1. Introduction

Current carrying capacity is an important index of cable, which reflects the maximum current value that the cable can bear under certain environmental conditions. If the maximum current carrying capacity is exceeded in long-term operation, the conductor temperature will be too high, the insulation characteristics will be damaged, and the cable insulation level will decline or even fail. This aspect is also clearly stipulated in the industry standard. In practical engineering, if you want to know the real ampacity of the cable in a specific environment, it is generally through the ampacity test method, so the results are more direct and effective. Therefore, in the research of cables, current carrying capacity tests are often carried out on various cables.

In a recent research project, the influence difference of a certain factor on the current carrying capacity of single core cable is compared. Because the project is a comparative study, the control variable method must be used to adjust the external factors such as environment and equipment in order to qualitatively analyze the data. However, from the test process and test results, several test problems have to be paid attention to and considered. If these problems are not studied and solved, it is very likely to lead to data errors and confusion, which will seriously affect the correctness of the results. In this paper, several problems of the test to a certain stage are discussed and solutions are provided, in order to provide reference for the follow-up test and other technicians in the same industry.

2. The Influence of External Factors on the Test and Its Elimination

The cables used in this project are four independent cables, and their current carrying capacity should be tested and compared. Due to the limited equipment, the ampacity test takes a long time,

so each cable can only be tested in turn. Due to the control conditions and room size problems, it is difficult to control the ambient temperature completely, which will have a certain impact on its current carrying capacity. In addition, due to the current ratio error of the equipment, the error caused by pointer reading, other human errors, etc., the final data will be inaccurate. From the two results of the same cable test, the difference between the two data can be 20A for the current carrying capacity of about 300A, while the difference between the two tests with strict control of environmental and human factors is not big, which is within the reasonable range of error. Therefore, external factors have a certain impact on the accuracy of the test, and it is difficult to control. For this study, the current carrying capacity difference between the cables itself is small, and may be less than 20A. The error caused by external factors can lead to the error of the results. Therefore, the influence of external factors must be eliminated as much as possible in the comparative test.

For this problem, the following scheme can be considered. The purpose of this research project is to compare the current carrying capacity between different cables. In order to compare the research project, and the external factors are more complex and difficult to control, the cable series test method can be used. The details are as follows: after the cables are connected in series, the same current is applied, the conductor temperature of each section of cable is read under the same environment, reading and equipment error, and the temperature rise curve is recorded, The faster the temperature rise, the smaller the current carrying capacity and the easiest to reach 90 ℃. After the first cable reaches 90 ℃, continue to increase the applied current value, add each section of cable to 90 ℃ successively, and record the ampacity of each section of cable. Through the data obtained from this test to analyze the differences, the accuracy can be greatly improved, and the influence of external factors on the test can be minimized.

3. Short Connection of Conductor and Metal Layer Caused by Thermocouple Probe

The cable temperature measurement equipment used in this test is thermocouple probe. The probe has a certain specification and size. The front temperature measurement part is aluminum conductor probe with a length of about 3cm. In the test, the cable needs to be drilled to the part to be tested with an electric drill, and then the thermoelectric dipole probe is inserted, and the probe is bound and fixed, Several groups of conductor temperature probes of each section of cable should be set for accuracy comparison. In the process of the test, this test program caused technicians to think about another problem: thermocouple probe may cause conductor and metal layer short circuit, forming a parallel circuit. If only one group of conductor temperature measuring probes is inserted, the problem will not be caused due to the failure to form a path, and multiple groups of probes may cause the metal layer shunt phenomenon, resulting in the test conditions inconsistent with the actual conditions, and the test data is meaningless. The schematic diagram is shown in figure 1. This problem can be confirmed by short circuiting the two ends of the metal layer with wires to simulate the circulating current. The thermocouple probe will indeed cause the connection between the conductor and the metal layer, resulting in shunt. Because the metal layer loop is more unobstructed, the shunt is more obvious, and there is circulating current component, the probe temperature at both ends of the probe increases rapidly, far exceeding the normal heating rate, This problem is obviously due to the large contact resistance at the probe. When a large current flows, a large amount of heat will be generated, resulting in temperature rise. Because the metal layers are all non-magnetic materials, the circulating current generated is very small. It can be basically determined that the current applied by the conductor is led from the probe to the metal layer, and then forms a path.

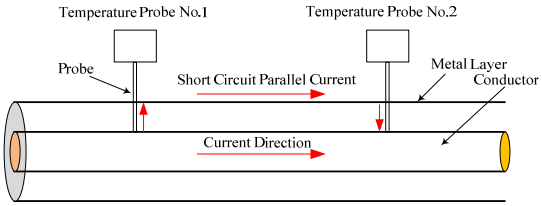

Fig.1 Schematic Diagram of Conductor Metal Layer Parallel Circuit

For this problem, the following scheme can be considered (1) The upper end of the thermocouple probe contacting with the metal layer is pasted with thin insulating paper to prevent the conductor from communicating with the metal layer through the probe (2) The drill hole can be enlarged so that the probe has enough space to isolate from the metal layer. However, this method has some defects. Too much drilling will lead to better heat dissipation and inaccurate measurement of conductor temperature (3) Replacing thermocouple probe with insulated thermocouple wire can solve this problem; And the thermocouple wire is thinner, which can contact with the conductor more closely and measure the temperature more accurately; In addition, the thermocouple wire is easier to fix than the thermocouple probe, and the operation is flexible and convenient, which improves the efficiency; In terms of cost, it also has great advantages. This is also the improved method used in this experiment.

4. Contact Resistance and Connection Method of Each Section of Cable

After connecting four cables in series, five cable joints will be generated when connected to both ends of the equipment. The connection quality of cable joints determines the contact resistance. If the contact resistance is too large, it will cause serious heating at the cable joint. Because of the good thermal conductivity of the conductor, the temperature of the temperature measurement point inside will be affected, and two temperature measuring points near the cable joint may be higher, The phenomenon that the temperature of the temperature measuring point in the middle is lower, and the temperature difference between the temperature measuring points exceeds ±2℃ will cause the measurement results to be invalid; Or three temperature measuring points are very high, which exceeds the data when the temperature is normal. It is found that the closer the end connection is, the less the influence of contact resistance on it is.

For this problem, the following scheme can be considered: (1) According to the investigation results of other organizations, the “U” clamp is used to fasten the conductors at both ends, which can reduce the influence of contact resistance.

(2) In the absence of “U” clamp, the conductor at both ends can be tightened with copper wire. For better effect, stranded conductor can butt each copper wire after it is scattered, and then wrap the loose copper wire tightly to make the conductor fully contact and then tie it tightly with copper wire. The second method is adopted in this test. Through the temperature test of the intermediate joint, it is found that the temperature at the end is not different from other parts, and there is no abnormal heating phenomenon, which solves the problem better.

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