Analysis on Internal Cavity Invasion Moisture of 220kV Oxide Arrester

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Abstract: In view of a flashover discharge accident, it is caused by internal cavity invasion moisture of a metal oxide arrester, various reasons are discussed for moisture ingression of metal oxide arrester through the construction and assembly process of the metal oxide arrester. The test methods for detecting internal cavity invasion moisture of metal oxide arrester are enumerated. Testers are warned, metal oxide arresters with suspected internal invasion moisture or family defects should be shortened and the test data should be comprehensively analyzed and judged to prevent accidents.

1. Introduction

In the 1960s, zinc oxide resistance sheet (valve sheet) was developed. In the 1970s, metal oxide arrester (MOA) was built with valve sheets stacked. Due to its advantages such as fast response to steep waves, large flow capacity, low residual pressure and excellent U-I characteristics, MOA is now widely used at home and abroad, especially in the field of high voltage and ultra-high voltage, and it has been in a monopoly position. Metal oxide arrester is unavoidable because of its design, installation process and atmospheric conditions.

According to the statistics of the two investigation teams in May 1991, the damage rate of seamless metal oxide arresters produced was very high at home and abroad, about 0.2 phase/(100 phase·year). Lightning arrester of damage accident analysis shows that the main reason for the accident, there are two reasons, one is that metal oxide surge arrester is under grid voltage for a long time, sometimes under transient overvoltage (power frequency overvoltage and harmonic overvoltage), it makes the metal oxide surge arrester heat aging and occurs a thermal collapse accident; Second, the metal oxide arrester sealed cavity invasion moisture, resulting in flashover discharge accident. Statistics show that the accident rate of internal cavity invasion moisture is 69% of all metal oxide mine arrester accidents.

2. Examples of flashover discharge accidents caused by internal cavity invasion moisture

2.1 Fault overview

March 16, 2016, 18:39, test personnel made lightning arrester of infrared temperature measurement for a 220kV substation 2 main transformer a phase C, found that difference between upper phase C section under the lightning arrester and normal temperature was about 3K, on the basis of the "DL/T664 charged equipment infrared diagnosis application rules" annex I, type voltage was caused by thermal equipment defect diagnosis criterion of regulation, fault characteristics of zinc oxide valve piece was affected with damp or aging preliminarily, the defects was severe or above, and diagnostic tests were need to carried out arrange outage as soon as possible. The fault arrester model was Y10W1-240/532W, it was produced in July 2013 and put into operate in January 2014.

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2.2 Continuous current test in operation

The next day, before the power failure, the test personnel conducted a continuous current test on the primary arrester of No.2 main transformer during operation. It is shown in Table 1.

Table 1 Continuous current test data for primary arrester of no.2 main transformer in operation

equipment name		voltage(kV)	Total current (uA)	Resistive current (uA)	Ratio of resistive current (%)
No.2 main transformer primary arrester	A	132.8	417	39	9.3
	B	133.1	425	57	13.4
	C	132.7	1026	877	85.4
note	environment temperature 6 "C relative humidity 65%				

As can be seen from Table 1, the resistive current of the C phase arrester accounts for 85.4% of its total current, 20% required attention value was exceeded substantially in the regulation. At the same time, the total current of the C phase arrester exceeded the total current of A and B phases by more than one time. The tester excluded other interfering factors in the field, and the measurement result showed no obvious change, it was preliminarily determined that the valve plate of the C phase arrester was affected by damp.

2.3 Diagnostic test

After the arrester was out of operation, the tester conducted insulation resistance test, DC 1mA voltage and 0. 75u under the leakage current test, the test results are as follows.

Insulation resistance test. The arrester is porcelain insulating, no obvious contamination or cracking was found in the appearance inspect ion, but there were flashover marks. The insulation resistance test data of No.2 main transformer primary arrester are shown in Table 2, and the upper and lower sections do not meet the requirements of the code.

Table 2 lightning arrester insulation resistance test data

equipment name		insulation resistance (MΩ)
No.2 main transformer C phase arrester	upper	1640
	lower	540
note	environment temperature 4"C relative humidity 65%	

DC 1mA voltage and 0.75u lower leakage current test. Test data of No. 2 main transformer primary arrester are shown in table 3. Upper arrester $I_{0.75U1mA}$ is more than the 50uA attention value in the code, lower section arrester U_{1m} and $I_{0.75U1mA}$ do not meet the requirements of the regulations.

Table 3 Arrester $\mathbf{U_{1mA}}$ and $\mathbf{I_{0.75U1mA}}$ test data

equipment name		U_{1mA}(kV)	$I_{0.75U1mA}$(uA)
no.2 main transformer C phase arrester	upper	152.3	77
	lower	114.5	355
note	environment temperature 4"C relative humidity 65%		

Above test data is analyzed, it is concluded that the internal insulation condition of the arrester is bad, the valve characteristics of the zinc oxide arrester are changed, resulting in the increasing the resistance component of AC leakage current and the temperature of the arrester itself.

3. Disintegration inspection

3.1 Appearance inspection

In order to find out the cause of the accident, the appearance of the arrester was first inspected, and it was found that there was water in the flange of the three-phase arrester porcelain bushing, and the water was yellow-brown, so it was judged to contain a lot of rust. Failure phase arrester flange inner fixed steel ring and bolt corrosion is serious, explosion - proof film damage. It is shown in Fig.1. Figure 2 shows the removal of the bottom flange is no.207480T and the removal of the metal oxide valve plates is in the porcelain bushing. The damaged valve plates are scattered.

Fig. 1 Water accumulation at the lower flange

Fig. 2 Scattered valve plates

3.2 Internal inspection

In order to further ascertain the cause of the accident, the replacement of the three-phase arrester was disassembled for inspection. For example, the lower section 207480T arrester is shown to illustrate the internal situation. After removing the bottom flange, the metal oxide disc inside the arrester is removed. Some of the valve plates have been damaged after failure, and the aluminum gasket with round holes between the valve plates has melted under the action of high temperature. It is shown in Figure 3.

Fig. 3 Flashover of valve disc

3.3 Causes of accident

This type of arrester has been listed as family defect equipment by state grid corporation. The main reason is that the lightning arrester was installed, manufacturer didn’t guide or manufacturer's technical personnel didn’t go to the scene, and the installation personnel didn’t know the structure and principles of arrester, causing each section arrester assembly direction reverse, the nitrogen filling (most people mistaken for flange explosion-proof vent) hole orifice up, and no effective sealing was done, the moisture, water enters the arrester through the hole.

Therefore, the causes of this accident should be as follows: the low business level of the accident

personnel, they don’t know that the small hole filled with nitrogen should be tightly sealed during operation. The long term invasion of moisture will result in serious dampness in the inner cavity, and the internal flashover discharge accident is caused eventually.

3.4 Causes of surge arrester dampness

The leakage of the metal oxide arrester caused the flashover discharge. Through searching, it is found that the causes of moisture inside the metal zinc oxide arrester are generally as follows.

1) The seal gasket of the zinc oxide arrester can't meet the design requirements for permanent compression deformation, after loading the valve plate of the zinc oxide arrester, it is easy to cause seal failure and make moisture or water intrude.

2) The cover plates on both ends of the metal zinc oxide arrester are rough and have burr, it will puncture the explosion-proof plate and lead to the invasion of moisture or water. Both ends cover plate cast iron piece, cast iron piece itself foundry quality is extremely poor, sand hole is much, sealing groove has a gap when processing, and sealing gasket is installed hind and does not have effect, moisture and moisture invade by the gap.

3) During the assembly of the zinc oxide arrester, the sealing gasket is missing or the sealing gasket is moved, resulting in the lax seal and the gradual invasion of moisture.

4) During the construction and installation of the zinc oxide arrester, the desiccant bag was not pressed on the seal ring, and the arrester was assembled upside down without the manufacturer's guidance during the construction and installation, so that the small holes filled with nitrogen (explosion-proof exhaust holes) were installed on the upper part, and no effective sealing was conducted. This article discusses the accident, and it is caused by this reason.

5) The final assembly workshop is in a poor environment, and the valve piece or insulating part is not in the lightning arrester sleeve completely, so that the moisture is blocked in the casing, and the moisture penetrates into the casing during operation, forming "water flow" on the casing inner wall, causing an accident.

3.5 Verifying the method of surge arrester dampness

The leakage of metal oxide arrester will lead to flashover discharge of metal oxide arrester. In order to prevent accidents, the following five test methods can be used to verify whether the lightning arrester is affected by moisture.

3.6 Insulation resistance test

In the case of power failure, the insulation resistance of the arrester can be used to detect the moisture invasion in the inner cavity of the arrester and the aging of the valve sheet. Practice and theory have proved that the measurement of insulation resistance is quite sensitive to the detection of the dampness in the MOA inner cavity and the inertial defects, but due to the low voltage (2500V), it is not sensitive to detect the aging defects of the valve sheet.

3.7 DC leakage current test

DC leakage test was conducted on the arrester in the state of power failure, the U1mA value and the leakage current at 75%U1mA were tested. Because the test voltage applied was very high, all measurements of U1mA and 0. 75U1mA were very sensitive to test the dampness and the inertial defects.

3.8 Infrared temperature measurement

Infrared accurate temperature measurement is carried out under the lightning arrester live state, through the transverse and longitudinal comparison, it can be found that the lightning arrester is in the operation of moisture and the deterioration of the resistance sheet in a certain extent, but the

need for professional testing personnel.

3.9 Charging test

Charging test includes leakage current (full current, resistivity current) test. Charging test can find the dampness of the lightning arrester and the deterioration of the resistance sheet in operation. Therefore, charging test should be carried out in operation. However, due to the influence of external conditions, the test data is highly dispersed, it requires the accumulation of experience. However, charging test is a very important test method, "18 state grid countermeasures" put forward, "for the metal oxide arrester, the operation of charging test in accordance with the requirements of the regulations must be adhered. When abnormal conditions are found, the cause should be ascertained in time. For metal oxide arresters of 35kV or above, charging test can be used instead of periodic power failure test, but for metal oxide arresters of 500kV, power failure test should be conducted once every 3-5 years.

3.10 Online monitoring

Online monitoring is in accordance with the provisions, 110kV and above voltage level, lightning arresters should be installed in AC leakage current online monitoring meter. It is combined with lightning arrester discharge counter generally. Somebody is on duty inspects at least every day, record every half moon, strengthen data analysis, unmanned substation can combine equipment perambulate cycle to undertake perambulate and record, special patrol should be undertaken for weather of strong thunderstorm day.

4. Conclusions

Lightning arrester leakage current online monitoring should be carried out in strict accordance with the cycle, test data should be analyzed by a special person, when the total current increases more than 20%, charging test should be carried out to measure the total current and resistivity current, and analysis and judgment should be made, and power failure DC test should be carried out for necessary.

Charging test should be carried out in strict accordance with the cycle, and the analysis of test data should be strengthened. Repeat test should be conducted for the increase of resistivity current more than 50%, and DC test should be conducted for the power failure of resistivity current more than 100%.

For "familial blemish" arrester, whether somebody is on duty or unmanned station, shortening perambulate and testing cycle should be suggested. When someone is on duty substation, "at least once a day patrol" should be done.

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