Test on Power Transformer

[1]Dr.Sweta shah, [2]Hardik Patel, [3]Harsh Dixit, [4]Ketul Kachhadiya
[1]Assistant Professor Electrical Engineering, [2, 3] B.Tech Students, [4] AGM Project Department
[1, 2, 3] IITE, Indus University, Rancharda, Ahmedabad-382115
[4] Alfa Transformers

Abstract

Testing of any electrical equipment indicates whether the equipment is able to comply with a customer's requirement. In this paper, testing of transformers is considered. Manufacturers test thousands of transformers at worldwide location each week and every unit. The primary priority is that the transformer meets the manufacturer specification. The tests are part of the manufacturer internal quality assurance program. In this paper, we wish to give an overview of the different pre-commissioning test in transformer rating of 40KVA.

Key Words – Power transformer, commissioning, testing, type tests.

1. INTRODUCTION

The transformer is a static device which is used to step up or step down the voltage, without changing the frequency. The power transformer is generally power system device. In this different tests are undertaken which are performed on the Power transformer. Type test, Routine test, Special test are the different tests. The test is important for the power transformer without testing the transformer the equipment may get damaged. Testing the transformer can find the withstand capacity of current, temperature, etc. Insulation, oil level, windings. All the parameters are tested and after that, it is certified to be operated.

1.1 Pre-Commissioning Test

- Type Test
- Routine Test
- Special Test

Type Test

In this type of test, the confirmation is taken whether the processor services match with the requirements of technical standards, specification, contract, or regulation.

Routine Test

In this routine test is carried out on each and every unit which is manufactured. This is carried out for mainly confirming the operational performance of an individual unit in the production lot.

Special Test

In this special test, the test is carried out as per the customer requirement to obtain information useful to the user during operation or maintenance.

1.2 Routine Test

Different types of Routine Test are given below:

- High Voltage Test
- Transformer Ratio Test
- Open Circuit Test
- Short Circuit Test
- Measurement Of Insulation Resistance Test
- Temperature Rise Test Of Transformer
- Double Voltage Double Frequency Test
- Magnetizing Current Test

1.2.1 High Voltage Test

The high voltage test is generally performed in the laboratory. This high voltage transformer is subjected to transient voltage and surges during their normal operation when the insulation under test breakdown. To withstand this voltage the transformer insulation has to be properly designed.

Method:-

In this test, the high voltage is applied to the testing transformer. In this test, voltage is applied with the help of a step-up transformer, which steps up the high voltage. The HV side of the transformer side is given high voltage and secondary side the reading is taken. If there is any distance between winding and core or in insulation then there will be the fault in the testing unit, and if the manufacturing is of the transformer is perfect then the transformer will withstand the high voltage surges, lightning, etc.
This test is carried out for one minute. The transformer gets heated too quickly so that safety has to be taken.

Applied voltage	Current	Time Taken For Testing
28 KV	0.8 – 0.9 Amp	1 min

Table 1.1

Note:-

If the voltage is high then current will be low, and if current reading is high then there is a fault in the transformer.

1.2.2 Transformer Ratio Test

Transformer turns ratio test is an AC low voltage test. This test determines the high voltage winding to all other winding at no-load. The turns ratio test is performed at all taps of every winding. The transformer turns ratio tester is a device used to measure the turns ratio between the windings. Ratio measurement is conducted on all the tap position. After that, it is calculated in induced voltage reading into an applied voltage value. When the winding ratio increases the voltage decreases, and when the winding ratio decreases the voltage increases. So the ratio of winding should be balanced.

Transformer Rating	Transformer Ratio
11KV/440 V	44.4

Table 1.2

Method:-

Isolate the equipment and apply grounds to all the incoming and outgoing terminals of the transformers. Disconnect cables should have sufficient distance, that it does not touch the other equipment. Connect the high voltage lead to the delta connection side of the transformer. Connect all the three-phase winding with high voltage lead. Another side connects the low voltage lead to the star connection side of the transformer. Connect the all three winding with low voltage lead and the neutral also. Then turn On the transformer turns ratio tester and test for all tap position. Check the readings.

Note:-

Confirm that measured ratio is between 0.5% of the calculated ratios.

1.2.3 Open circuit Test

The purpose of this test is to determine the no-load current and losses of the transformer because of which the no-load parameters of the transformer are determined. This test is carried out on the primary side of the transformer.

Method:-

In this test, the secondary of the transformer is left open. A wattmeter is connected in the primary side and ammeter is connected in series with the primary winding. The voltmeter is optional as the applied voltage is the same as the voltmeter reading. The rated voltage is applied at the primary side of the transformer. The applied voltage is normal voltage then the normal flux will be produced. Hence, due to this, the iron loss will be produced. The eddy current and hysteresis loss also produced in this test. The hysteresis loss is less than the eddy current loss, it is not negligible. Since the secondary of the transformer is open the primary draws only no-load current, which has some copper loss, and it is no-load on the secondary side of the transformer. There is no secondary current so there will be no copper loss. Eddy current is induced in iron due to alternating flux.

Transformer rating	Voltage	Current	Power Factor	Losses	Frequency
11KV/440 V	251.5 V	2.145 A	0.119	193.3 Watt	50.05 Hz

Table 1.3

Note:-

LT side current should not exceed than 2%.

1.2.4 Short Circuit Test

In this test is conducted on the high voltage side of the transformer. The low voltage side of the secondary is short-circuited. A wattmeter is connected to the primary side of the transformer.
The ammeter is connected in the series with the primary winding. A voltmeter is optional as the applied voltage is the same as the voltmeter reading.

Method:-

Isolate the transformer, and remove the HV/LV jumps and disconnect the neutral from Earth/ground. After that short, the LV phases and connect the short circuit terminals to neutral. Energize the HV side by giving supply from the LV side. Measure the current in neutral, HV Voltage and HV line current. Take the reading of the meters and the wattmeter shows the total copper loss of the transformer. The iron losses in the transformer are taken as negligible here.

Transformer rating	Voltage	Current	Power Factor	Losses	Frequency
11KV/440 V	219.5 V	2.192 A	0.565	816.9 Watt	50.05 Hz

Table 1.4

Note:-

If temperature increases the losses will be increased.

1.2.5 Measurement of insulation Resistance Test

In this test, the insulation resistance is measured under the test object, while phase and neutral are short-circuited together. Its objective is to measure the ohmic value of the insulation under a direct voltage of great stability, generally 50,100,250,500 or 1000 V DC. The ohmic value of resistance is measured in megaohm.

Method:-

In this insulation resistance test if direct-indicating ohmmeter with hand driven dc generator then it is called hand driven megger. If there is direct-indicating ohmmeter with motor driven dc generator then it is called the motorized meter. In this measurement of insulation resistance can be conducted by external dc supply. In this voltage and current reading is taken with the help of dc voltmeter and micro ranged dc ammeter. In this microammeter ranged meter is used because a tiny current flow in the insulation and current is in that range only. The microammeter has to withstand the initial capacitive charging current and as well as absorption current. The voltmeter, ammeter, and source have to withstand the short circuit current in the case of insulation failure. The leads of the instruments are connected to the insulation which has to be tested. After running the instrument, the value of insulation resistance is taken from the meter. The reading is taken after a standard time to get more accurate and error free result. For distribution Transformer minimum value is 500 Megaohms,And for the power transformer, it is 1500 Megaohm.

Test Done Between	Transformer Rating	Ohm Value
LT to Earth	5000 V	6.78 KΩ
HV to LT	5000 V	11 KΩ
HV to Earth	5000 V	7 KΩ

Table 1.5

Notes:-

Check the continuity of the Test leads by shorting them together and verify that instrument measure the resistance value less than 1 ohm.

1.2.6 Temperature Rise Test

In this temperature rise test whether the temperature rising limit of the transformer winding and transformer oil as specified by the manufacturer

Method:-

In this LV winding of the transformer is short-circuited. One thermometer is placed at the pocket of the transformer top cover and other two placed at inlet and outlet of the cooler bank respectively. The voltage to such value is applied to the HV side and temperature is maintained at 75°C. The total loss is measured by the three wattmeter methods. During test hourly top cover temperature and inlet and outlet cooler bank temperature is also taken. The test would be continued until the temperature increment of the top oil becomes less than 3°C in one hour. The LV winding is short-circuited and HV winding side supply is given, so for full load rated current flows in the transformer the supply rated voltage required much less than the rated voltage of the transformer. In this, the transformer is operated on full load. The equipment is tested for 24 Hr.

Transformer Rating	Heating Temperature	Heater Capacity	Time Taken to Heat
11KV/440 V	70°C To 75°C	8000 Watt	24 Hr

Table 1.6

Note:-

When the temperature increases in the transformer losses also increase.

1.2.7 Double Voltage Double Frequency Test

This test is also called an induced overvoltage test. This test is performed to check the turn insulation winding.

Method:-

In this test, the voltage is doubled and the frequency is also doubled which is applied to the transformer, and it is for 1min. In this usually HV Side is open circuited, and LV side this test is performed There is no restriction on the frequency, as it can be more than doubled rated frequency, but the frequency should not be less than the double rated frequency. The test will be successful if all the three winding shows the equal current. In this test booster transformer and slip ring, motor set and the dimmer is used to boost up the voltage and frequency. It helps to double the frequency also. If there is a faulty transformer than the voltage will decrease and the current will increase. If there is any damaged in the winding then by this test it can be known.

Rated Frequency	Applied Frequency	Rated Voltage	Applied Voltage
50.05 Hz	100.10 Hz	440 V	883 V

Table 1.7

Note:-

If there is an equal voltage in the three windings then there is a fault in the winding, check the windings.

1.2.8 Winding Resistance Test

The purpose of this test is to check the gross differences between windings and open in the connection of the transformer. by measuring the transformer winding it is assured that each circuit of the transformer is wired properly and all the connections are tightened properly. Winding resistance in the transformer will change if there are shorted turns, loose connection, or deteriorating contacts in tap changers.

Method:-

In this test, if the winding is star connected than the resistance will be measured between a line and a neutral terminal. On the other hand in a delta connection, measurement of winding resistance is done between pairs of line terminals.as in delta connection resistance of individual winding cannot be measured separately, as resistance per winding is calculated by

Resistance per winding = 1.5 * Measured value

The resistance of the transformer is measured at the temperature and then converted to resistance at 75°C for all the practical purpose of comparison with specified design values, previous design value, and diagnostics. The resistance shall be measured by a simple ammeter voltmeter method, kelvin bridge meter or automatic winding resistance measurement kit.

Transformer Rating	Transformer In KVA	HV Side Ohm	LV Side Ohm
11 KV/440 V	16 KVA	165 Ω	170 Ω
11 KV/440 V	25KVA	123 Ω	131 Ω
11 KV/440 V	63 KVA	40 Ω	31 Ω
11 KV/440 V	100 KVA	24 Ω	21 Ω

Table 1.8

Note:-

In this test, the current should not exceed more than 15% of the rated current of the winding. A large value may cause inaccuracy due to heating the winding and temperature changes and resistance

2. Conclusion:-

From this Test, we have concluded that by testing the transformer winding, insulation, transformer withstand capacity all the parameters are tested which are important to check before commissioning. Testing results show all parameters satisfy the standards of the transformer and it shows that the transformer is ready for commissioning.

3. Reference:-

- IEC 60076 -1, “Power Transformer”_ Part 1: General,2000
- ABB, “Testing Of Power Transformer”, Zurich.2003
- IEC 60060-1, “High Voltage Test Techniques ”_Part 1: General,1989