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Insulation Resistance Test and Oil Test of Distribution Transformer

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ABSTRACT: Transformer is one of the most important part of distribution and transmission process of power. A transformer has to go through different testing procedures in manufacturer's premises to prove that the transformer meets customer's specification and design expectations. Type test of transformer confirms basic criteria of production lot. Moreover, for confirming operational performance of individual unit in a production lot routine test is done. This paper discusses about two different types of distribution transformer testing. A distribution transformer or service transformer is a transformer that provides the final voltage transformation in the electric power distribution system, stepping down the voltage used in the distribution lines to the level used by the customer. Here we have tried to give an overview about the insulation resistance test and transformer oil test conducted in distribution transformer of rating 100KVA.

KEYWORDS: Transformer, Distribution transformer, Type test, Routine test.

I. INTRODUCTION

A transformer is a static device which helps in the transformation of electric power from one circuit to electric power of the same frequency in another circuit. The voltage can be raised or lowered in a circuit, but with a proportional increase or decrease in the current ratings.The principle of operation of a transformer is mutual inductance between two circuits which is linked by a common magnetic flux. A basic transformer consists of two coils that are electrically separate and inductive, but are magnetically linked through a path of reluctance.Various tests are done on a transformer to know its condition. The primary incentive of these tests is to make sure the transformer meet manufacturing specifications. Type test of transformer confirms basic criteria of production lot. For confirming operational performance of individual unit in a production lot routine test is done.In this paper we have discussed in detail about the insulation resistance test and transformer oil test. . This paper did evolve with our practical and theoretical experience gained during our days in power maker industry.

II.TYPES OF TRANSFORMER TESTING

This paper discusses the insulation test and oil tests of a 100 kVA distribution transformer tests done at manufacturing industries:
a) Type Test
b) Routine Test

a) Type Test of Transformer
To prove that the transformer meets customer's specifications and design expectations, the transformer has to go through different testing procedures in manufacturer premises. Some transformer tests are carried out for confirming the basic design expectation of that transformer. These tests are done mainly in a prototype unit not in all manufactured units in a lot. Type test of transformer confirms main and basic design criteria of a production lot.
Type tests of transformer include:
1. Open circuit and short circuit test.
2. Measurement of insulation resistance.

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3. Transformer ratio test
4. Transformer oil testing
5. Transformer winding resistance measurement
6. Magnetic balance test

b) Routine Tests of Transformer

Routine tests of transformer are mainly for confirming operational performance of individual unit in a production lot. Routine tests are carried out on every unit manufactured.

Routine tests of transformer include:

1. Open circuit and short circuit test.
2. Measurement of insulation resistance.
3. Transformer ratio test
4. Transformer oil testing
5. Transformer winding resistance measurement
6. Magnetic balance test

Routine tests of transformer include all the type tests.

Here, in this paper we will broadly discuss about two types of test:

i. Insulation Resistance Test or Megger Test of Transformer
ii. Transformer oil testing

i. **Insulation Resistance Test or Megger Test of Transformer:**

Insulation resistance is the ratio of applied voltage to the resulting current at a specified time after the voltage is applied. Direct voltage are used for measuring insulation resistance values.

Insulation resistance test of transformer is essential type test. This test is carried out to ensure the healthiness of overall insulation system of an electrical power transformer. The insulation resistance (IR) test (also commonly known as a Megger test) is a spot insulation test which uses an applied DC voltage (typically 250Vdc, 500Vdc or 1,000Vdc for low voltage equipment <600V and 2,500V_{dc} and 5,000V_{dc} for high voltage equipment) to measure insulation resistance in either kΩ, MΩ or GΩ. The measured resistance is intended to indicate the condition of the insulation or dielectric between two conductive parts, where the higher the resistance, the better the condition of the insulation. Ideally, the insulation resistance would be infinite, but as no insulators are perfect, leakage currents through the dielectric will ensure that a finite (though high) resistance value is measured.

Because IR testers are portable, the IR test is often used in the field as the final check of equipment insulation and also to confirm the reliability of the circuit and that there are no leakage currents from unintended faults in the wiring (e.g. a shorted connection would be obvious from the test results).

ii. **Transformer Oil Testing:**

Several tests can be performed on transformer oil to determine its condition and many are particularly useful in determining the condition oil that has been in service for a number of years. The most common test performed on oil is the dielectric test. These specifications define the method of preparing a sample, the equipment to be used and the test method.

During factory tests it is useful to take oil samples before testing and again after testing in order to perform a dissolved gas in oil analysis. This is particularly useful for high voltage transformers and in cases when a temperature rise test be performed.

Oil tests are a useful indicator of the condition of the insulation system and the oil and form important elements of any transformer preventative maintenance program. Results taken after periods of service can be compared to baseline measurements taken on the new transformer

The insulation oil of voltage- and current-transformers fulfils the purpose of insulating as well as cooling. Thus, the dielectric quality of transformer oil is a matter of secure operation of a transformer.

As transformer oil deteriorates through aging and moisture ingress, transformer oil should, depending on economics, transformer duty and other factors, be tested periodically. A good transformer oil must have the following Physical, chemical and electrical properties.

1)Physical properties

Oil density

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The maximum value of density of transformer oil at 29.5 ^{o}C must not be more than 0.89 gm/cc.

Flash point
It is the temperature at which oil gets vaporized and when this vapor mixes with air, forms an ignitable mixture and may cause momentary flash. To prevent the risk of fire the transformer oil must have a high flash point. The flash point must be greater than 140^{o}C.
Moisture constant

It is the amount of dissolved present in oil expressed in ppm/kg. the insulating property of the transformer oil will be degraded by the presence of moisture. The maximum allowable moisture constant is 50 ppm.

Pour point
It is the temperature at which oil just commences its flow under prescribed conditions. The specified pour point is -6^{o}C.

2)Chemical Properties
Neutralization value
It is the measure of acidity of oil. It is the measure of organic and inorganic acids present in the oil. It is expressed in terms of milligrams of base required to neutralize the total force acid present in one gram of oil. The recommended maximum value of neutralization is 0.03 mg KOH/gm. Higher the neutralization value, higher the acidity leading to higher sludge formation.
Corrosive Sulphur
The presence of chemicals in the transformer oil will lead to the formation of black deposits over the copper parts of the transformer. Hence the heat dissipation is highly affected. Since transformer oil is derived from petroleum it definitely contains traces of sulphur. The presence corrosive of sulphur in the transformer oil is not recommended.
Oxidation stability
The neutralization value of transformer oil increases on getting oxidized. The neutralization value must not go beyond 0.4 mg KOH/gm after oxidation and total sludge after oxidation must not be more than 0.1% of weight of oil used.

Sediment and perceptible sludge
Sludge is poor conductor of heat. Sludge deposited over the transformer parts leads to poor heat dissipation. It blocks the flow of oil in ducts and impairs cooling. Therefore once sediments or perceptible sludge are detected oil is considered as not usable.

3) Electrical properties
Breakdown voltage (BDV)
It is the voltage is the voltage at which transformer oil losses its dielectric property and starts conducting. It represents the electrical property of transformer oil. The presence of moisture, sludge contaminating agents and sediments decreases the dielectric property of oil. For a new sample of oil the breakdown voltage of transformer oil is 30kV and for a sample after filtration must have BDV of 60kV.

Resistivity
It is one of the most sensitive properties of transformer oil. The resistivity of the oil decreases with increase in temperature. The transformer oil must have a minimum resistivity of 30 x 10^{12} ohm-cm at 90^{o}C and 1500 x 10^{12} ohm-cm at 27^{o}C.
Dielectric dissipation factor (DDF)
It is numerically equal to the sine of loss angle. A High value of DDF refers to poor quality of oil. The maximum recommended value of DDF factor of oil at 90^{o}C is 0.002.

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III. METHODOLOGY

The specification of the transformer under test is as follows:

RATING:	3 Star Losses	Cooling:	ONAN
KVA:	100KVA	Vector Group:	Dyn- 11
Voltage HV:	11000 Volts	Frequency:	50 Hz.
Voltage LV:	433 Volts	Serial No :	PM- 100/840
Current HV:	5.25 Amps.	Mfg. Year:	2016
Current LV:	133.34 Amps.		

Procedure of Insulation Resistance Test of Transformer:

i. Firstly the positive terminal of the megger is connected to primary side and negative terminal to ground.
ii. Then readings are recorded after application of voltage.
iii. Then again positive terminal of megger is connected to secondary side and negative terminal side to ground.
iv. Then we again apply the voltage and readings are recorded.
v. And at last again the positive terminal of mrgger is connected to primary side and negative terminal to secondary side.
vi. Then we record the readings after application of voltage.

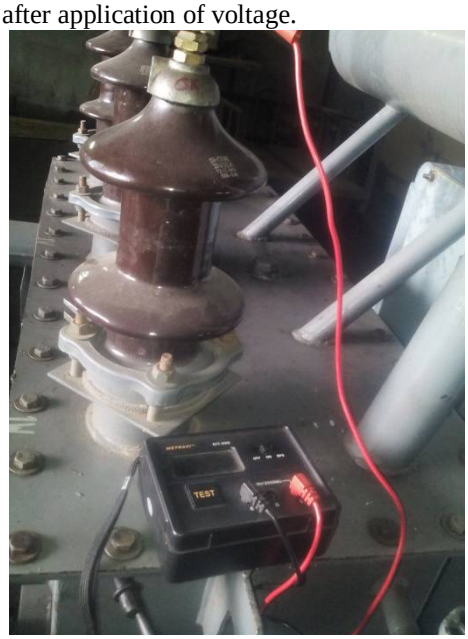

Fig : Megger Test

Procedure of transformer oil test:

To assess the insulating property of dielectric transformer oil, a sample of the transformer oil is taken and its breakdown voltage is measured.

i. The transformer oil is filled in the vessel of the testing device. Two standard-compliant test electrodes with a typical clearance of 2.5 mm are surrounded by the dielectric oil.
ii. A test voltage is applied to the electrodes and is continuously increased up to the breakdown voltage with a constant, standard-compliant slew rate of e.g. 2 kV/s.
iii. At a certain voltage level breakdown occurs in an electric arc, leading to a collapse of the test voltage.
iv. An instant after ignition of the arc, the test voltage is switched off automatically by the testing device. Ultra-fast switch off is highly desirable, as the carbonisation due to the electric arc must be limited to keep the additional pollution as low as possible.

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Fig: Transformer Oil Testing

IV. OBSERVATION

Insulation Resistance Test or Megger Test of Transformer

Table1: Insulation Resistance Test or Megger Test of Transformer

Serial No	Theoretical Resistance(Mega ohms)	Practical Resistance(Mega ohms)
1	HV-Ground>2000(2190)	HV-Ground>2000(2200)
2	LV-Ground>2000(2267)	LV-Ground>2000(2301)
3	HV-LV>2000(2070)	HV-LV>2000(2100)

- Result: We know that when the value of megger resistance is above 1000 ohm the condition of the insulation of the transformer is healthy. It has been found here practically and as well as theoretically that the value of Megger resistance to be above 2000 so we can come to the conclusion that the condition of the transformer is healthy.

4.2 Transformer Oil Test

A. Theoretical Result: Dielectric strength of oil =64kv at 2.5mm gap
B. Practical Result: Dielectric strength of oil =60kv at 2.5mm gap.

Result: Here practically the break down voltage of transformer is 60kv and theoretically it is 64kv. We know that lower the resulting breakdown voltage, the poorer the quality of the transformer oil. Here as it is 64kv and 60kv so the quality of the transformer oil is OK.

V. CONCLUSION

In this paper we have discussed in detail about the insulation resistance test and transformer oil test. As the megger test value is above 2000 ohm so the transformer is healthy. Breakdown voltage of transformer oil is between 60kv and

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60kvboth practically and theoretically so the quality of the transformer oil is OK. This paper did evolve with our practical and theoretical experience gained during our days in power maker industry.

REFERENCES

[1] http://www.electrical4u.com/transformer-testing-type-and-routine-test-of-transfomer/
[2] https://en.m.wikipedia.org/wiki/transformer types
[3]http://www.electrotechnik.net/2010/08/magnetic-balance-test-on-transformers.
[4] Geno Peter P "*A Review about testing of Distribution Transformers*", IJoAT, Vol.2, No.1, January, 2011.
[5] Robert Turcotte"*The locomotive helping customers manage risk and solve operational problems*", Manager, Electrical Loss Control, The Hertford Steam Boiler, Inspection & Insurance Company.
[6] Darshit S. Patel, Abhishek Patel , " *Measurement of winding resistance & insulation Resistance of 3 phase 11kV/433V,16KVA oil cooled type transformer* ," Electrical department , Varodara Institute of Engineering.
[7]Dr. P.S. Bimbhra "*Electrical Machinery*",7th Edition ,27th reprint 2012 , published by Ramesh Chander Khanna for Khanna Publishers
[8]V.K Mehta,Rohit Mehta, "*Principle of Electrical Machines*", First Edition 2002, Published by S.Chand & Company Pvt.Ltd
[9]V.K.Mehta ,Rohit Mehta,'Objective Electrical Technology',First Edition 1939,Published by S.Chand &Company Pvt.Ltd
[10] https://en.m.wikipedia.org/wiki/transformer oil testing.
[11]http://www.avo.co.nz/technical papers/transformers/142-a-guide-to-transformer-insulation-resistance-test
[12]https://electricalnotes.wordpress.com/2015/03/01/various-routine-test-of-power-transformer-part-2/