Design and Testing Of Power Transformer

[1]Dr.Sweta Shah,[2]Shlok Patel,[3]Karan Prajapati,[4]Jitesh Rathod,[5]Sarthak Shukla
[1]Assistant Professor,[2,3,4,5]B.Tech Student
[1,2,3,4,5]Electrical Engineering,
[1,2,3,4,5]Indus Institute of Technology and Engineering, Ahmedabad,India-382115

Abstract: This paper proposes the processes of transformer designing, manufacturing and testing. In this process, it will cover core construction, insulation, windings, coil manufacturing, coil assembly, insulation winding and testing of transformer. In industries transformer testing is performed to satisfy the need consumer and give them reliable and secure protection from any future faults. This presentation will cover steps of design and all the routine tests that we have performed in the industry.

Index Terms–Design of transformer, Manufacturing, Commissioning, Testing of Transformer.

I. INTRODUCTION

A Transformer is an electric device which is used to transfer the electrical quantity like power from one circuit to another without changing its frequency or phase and without any physical contact. This is one of the oldest inventions in electrical industries. It is very important because it is used in almost every electrical circuitry. It is mainly consist of 2 parts which is called Primary side and Secondary side or LV (Low voltage) and HV (High voltage).

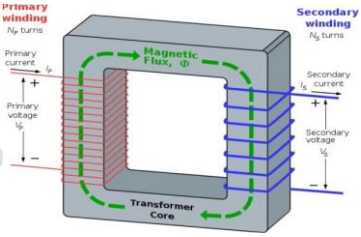


Fig.1 Transformer

1.1 Working principle of transformer

The working of transformer is mainly depend upon Faraday's law of Electromagnetic induction. It is mainly work on principle of mutual induction. According to faraday's law, "The rate of change of flux linkage with respect to time is directly proportional to the EMF induced in the conductor or coil."

$E=Nd\Phi/dt$

Where, E= Induced emf
N= The number of turns
dΦ= Change in flux
dt= change in time

1.2 Type of winding

There are different types of windings for different transformers like as:

- Concentric Winding:
  (1) Cross over winding (2) Continuous winding (3) Helical winding
- Sandwich winding:
  (1) Layer winding (2) Spiral winding

1.2.1. Concentric winding

These type of transformers are use in core type transformer. Each limbs is wound with a group of coils consisting of both primary and secondary turns which may be concentric cylinders. The LV winding is placed next to the core and HV winding on the outside. These windings can be further subdivided as follow:

- **Cross-over windings**

Cross-over windings are used for currents up to 20 A so they are suitable for h.v. winding of small transformers. The conductors are either strips insulated with paper or cotton covered round wires. Cross-over coils are wound over formers and each coil consists of a number of layers with a number of turns per layer. The complete winding consists of a number of coils in series connnected. Two ends of each coil are taken out, one from inside and one from outside. The outside end of a coil is connected to the inside end of the adjacent coil.

- **Helical winding**

Helical winding consists of rectangular strips wound in the shape of a helix. The strips are wound in parallel radially and each turn occupies the total radial depth of winding.

Helical coils are well suited for l.v. windings of large transformers. They can also be used for hv. windings by putting extra insulation between layers in adding up insulation of conductors.

- **Continuous disc winding**

This type of winding consists of a number of flat strips wound spirally from inside (radially) outwards. The conductor is used in such lengths as are sufficient for complete winding or division of winding between tapings. The conductor can either be a single strip or a number of parallel strips, wound on the flat. This gives a robust construction for each disc. The discs are wound on insulating cylinders spaced from it by strips along the length of cylinder. The discs are separated from each other with press board sectors attached to the vertical strips. The horizontal and vertical spacers provide ducts for free circulation of oil which is in contact with every turn.

1.2.2. Sandwich coils

Sandwich coils are in use in transformers of shell type. Both high voltage and low voltage windings are split into a number of sections. Each high voltage section lies between the voltage sections.

The advantages of sandwich coils winding is that their leakage can be easily controlled and so any desired value of leakage reactance can be had by the division of windings.

- **Layer (Barrel) winding**

Layer (Barrel) winding are one of the simplest of all windings in that insulated conductors are wound directly next to each other around the cylinder and spacers. Several layers can be wound on top of one another, with the layers separated by solid insulation, ducts, or a combination. Several strands can be wound in parallel if the current magnitude so dictates.

- **Spiral Windings**

These coils are suitable for windings to carry high currents, which are generally used or currents greater than 100 A. They are almost used for LV windings. Double-layer spiral coils, which are wound on solid insulating former, and hence are mechanically strong.

II. MATHODOLODGY

Transformer design depends upon two main parts, first is core and another is windings. Whenever we are designing a transformer we have to look into ratings of transformer, types of winding, material used for manufacturing core, turn ratio. After designing of winding we have to manufacture coils as per the design of winding. Then after, construct core channel. Now LV and HV winding are manufactured as per the rating of transformer. This winding is going under the process of owning. In this process epoxy resin is coated over the winding for the strength and stability. Now remove core on CCA, and laminate around the limb, and also laminated LV winding than LV winding is set on varnishing paper arena. Than make tapping connection of HV winding after completing this correction. Set LV side and HV side connection. After completing these assembly put these assembly on CCA vacuum chamber. Last process is tanking, in this process CCA is put on the tank and locate bushing on LV side and HV side. After that locate breather, conservator, tank, buchholz relay as per the requirement. It is based on on-load or off-load tap changer. And at last close tank at top side and fill oil in tank and start testing process.

III.STEPS OF DESIGN

1. Calculate voltage per turn using this formula

$$E_t = K\sqrt{Q} \text{ Volts}$$

2. Find net cross sectional area of the core A_i from the equation

$$E_t = 4.4 * f * B_{m*} A_i$$

3. Determine the diameter of the circumscribing circle using these formula

$$d = \sqrt{\frac{Ai}{K}}$$

4. bcFind the width of window $W_w = D - d$
5. Obtain window area from this equation

$$A_w = \frac{Q}{3.3 * f * Bm * \delta * Kw * Ai} * 10^3 \text{ m}^3$$

6. Find the height of window

$$H_w = \frac{Aw}{Kw} \text{ m}^3$$

7. Obtain the depth and height of yoke for the stepped core using the formula

   D_y (Depth of the core)= a

   H (height of the core)=a

   Where, a is width of largest stamping.
8. Obtain the overall height and width of the frame from the following relation.
   i. For three phase core type transformer

   $H=(H_w+2H_y)*mt$; $W=(2D+a)*mt$

   (In case a is not given we assume 0.9d instead of a in the above equation for stepped core, 0.85d for cruciform core and 0.71d for square core)

IV. Testing of Transformer

(1) Insulation Resistance Test:

Test Purpose:

- Insulation resistance test of transformer is indispensable to ensure the good health of whole insulation of an electrical power transformer.

Test Instruments:

- For LV System: Use 500V or 1000V Megger.
- For HV System: Use 2500V or 5000V Megger.

Test Procedure:

- First of all disconnect all the lines and neutral terminals of the transformer.
- Megger checker terminals to be connected to LV bushing and HV bushing studs to measure Insulation Resistance (IR) value in between the LV and HV windings.
- Afterwards, megger checker terminals to be connected to HV bushing studs and transformer tank neutral terminal point to measure Insulation Resistance (IR value) in between the HV windings and neutral terminal point.
- Megger terminals to be connected to LV bushing studs and transformer tank neutral terminal point to measure Insulation Resistance (IR value) in between the LV windings and neutral.
- It is redundant to perform insulation resistance test of transformer per phase wise in three phase transformer. Values of IR will be taken between the windings because all the windings on HV side are internally connected together to form either star or delta and as well all the windings on LV side are also internally connected together to form either star or delta.
- Measurements are to be taken as follows:

Type of Transformer	**Testing-1**	**Testing-2**	**Testing-3**
Auto Transformer	HV-LV to LV	HV-LV to E	LV to E
Two Winding Transformer	HV to LV	HV to E	LV to E
Three Winding Transformers	HV to LV	LV to LV	HV to E & LV to E

- NB: Oil temperature should be noted at the time of insulation resistance test of transformer. Since the IR value of transformer insulating oil may deviate with temperature.
- IR values to be recorded at intervals of 30 seconds, 60 seconds.
- With increased value of IR, duration of application of voltage is also increases. The value of increased IR is an indication of dryness of insulation.
- **PI(Polarization Index) = 10 minutes value / 1 minute value**

Tests can detect:

Weakness of Insulation.

Test Results:

Ambient Temperature: 33°C

		Test Voltage
PRI. Winding to Earth	1.327 T Ω	2500 VOLT
SEC. Winding to Earth	667.7 G Ω	1000 VOLT
PRI. To SEC. Winding	> 2.5 T Ω	2500 VOLT

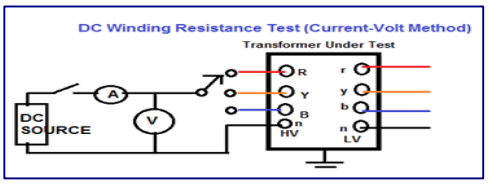
(2) D.C. Resistance or Winding Resistance Test

Test Purpose:

- This test is used to measure transformer winding resistance.
- Test also check status like loose connections, broken strands and High contact resistance in tap changers, etc.
- To Calculation of the loss FormulaI^2R losses in transformer.
- To Calculation of winding temperature (T) at the end of temperature rise test of transformer.

Test Instrument:

- The Resistance of HV winding and LV winding between their terminals are to be measured with accurate milliohm meter, micro ohm meter ,Transformer Ohmmeter ,Wheatstone bridge and DC resistance meter.



Method (current voltage method of measurement of winding resistance)

Test Procedure:

- The resistance of each transformer winding is measured using DC current and recorded at ambient temp.
- In this test resistance of winding is measure by applying a small DC voltage to the winding and measuring the current through the same
- The measured resistance should be corrected to a common temperature such as 75°C using the formula: **RC=RM x ((CF+CT)/(CF+WT))**

  where, RC = the corrected resistance,

  RM = the measured resistance,

  CF i= the correction factor for copper (234.5) or aluminum (225) windings

  CT = the corrected temperature (75°C or 85°C)

  WT i= the winding temperature (°C) at time of test
- NB: Before measurement the transformer should be kept in OFF condition at least for 3 to 4 hours so in this time the winding temperature will become equal to its oil temperature.
- To diminish observation errors, polarity of the core magnetization will be kept constant during all resistance readings.
- Voltmeter terminals shall be independent of the current terminals to protect it from high voltages which may occur during switching on and off the current circuit. +
- The readings will be taken after the electric current and voltage achive steady state values. It takes several minutes depending upon the winding impedance.
- The test current shall not surpassed 15 percentage of the rated current of the winding. Large values cause inaccuracy by heating the winding and in this manner changing its resistance.
- For Calculating resistance, the equivalent temperature of the winding at the time of measurement must be taken with resistance value.

Required Precaution:

- According to IEC 60076-1, in order to decrease measurement errors owing to changes in temperature, some safety measures should be taken before the measurement is made.
- **For Delta connected Winding:** The resistance should be measured for each phase (i.e. R-Y , Y-B & B-R) .Delta is combined of parallel mixture of the winding under test and the series grouping of the remaining winding .It is therefore suggested to create 3 measurements for each phase to phase winding in order obtain the most accurate results.
- Tertiary winding of transformers measurement can be done between pairs of line terminals and resistance per winding calculated as per the formula: Resistance per Winding = 1.5 X Measured Value
- **For Star connected winding:** the neutral terminal brought out, the resistance will be measured between the line and neutral terminal (i.e. R-N, Y-N, B-N) and average of three sets of reading will be the tested value.
- **For Dry type transformers:** the transformer will be at rest in a constant ambient temperature for minimum 3 hours.

Test Acceptance criteria:

[1] DC Resistance Should be<=2% Factory Test.

[2] Test Current <10% Rated Current

Test can detect:

- Short Turns
- Loose Connection of bushing
- Loose Connection or High Contact Resistance on Tap Changer/tap links.

Test Results:

Ambient Temperature: 33°C

Tap Changer Position	PRI. Winding Resistance (In Ohms)			SEC. Winding Resistance (In Milli Ohms)		
	1U-1V	1V-1W	1W-1U	2U-2V	2V-2W	2W-2U
NORMAL	1.0486	1.0477	1.0478	1.258	1.263	1.278
Total Wdg Resistance in Ohms/Ph = $\frac{(R1+R2+R3*3/2)}{3}$ 1.572 Ohms/Phase				Total Wdg Resistance = $\frac{(r1+r2+r3)*\frac{1}{2}}{3}$ 0.000633 Ohms/Phase		

(3) Turns Ratio / Voltage Ratio Test:

Test Purpose:

- Turns Ratio Test or Voltage Ratio Test is done in Transformer to find out Open Circuited turns and Short Circuited turns in Transformer winding.
- The voltage ratio in a transformer is equal to the turns ratio in a transformer (V1/V2=N1/N2). Using this principle, the turns ratio is measured with a turns ratio meter. If it is accurate, then the voltage ratio is assumed to be correct.
- This test is performed for any new HV power transformer at the time it is being installed.
- With use of Transformer Turns Ratio meter (TTR), turns Ratio between HV and LV windings at various taps to be measured and recorded.
- The turns ratio is measure of the RMS voltage applied to the primary terminals to the secondary terminals.
- **R= Np / Ns** Where,
- R=Voltage ratio,
- Np=Number of turns at primary winding,
- Ns= Number of turns at secondary Winding,
- The voltage ratio will be measured on all tapping in the no-load condition.

Test Instruments:

- Transformer Turns Ratio (TTR) meter is used to energies the transformer from a LV supply and measure the HV and LV voltages.
- Wheatstone Bridge Circuit

Voltage Ratio Testing:

- This test is performed to check the transformer voltage ratio and tap changer.
- When TTR is not available, Voltage Ratio Test is performed at different tap position by applying 3 phases LT (415V) supply on HT side of Power transformer. To facilitate obtain the required correctness it is usual to use a ratio meter rather than to energies the transformer from a LV supply and measure the HV and LV voltages.
- At Various taps applied voltage and Resultant voltages LV side between various Phases and phases and neutral measured with accurate voltmeter and noted.

Test Procedure:

- Apply 415V on high voltage side, measure the voltage between all phases on the low voltage side for every tap position.
- First of all, the tap changer of transformer is kept in the least position and LV terminals are kept open.
- Then apply three phase 415 V supply on HV terminals. Measure the voltages applied on each phase (Phase to Phase) on HV and induced voltages at LV terminals one after another.
- After measuring the voltages at HV and LV terminals, the tap changer of transformer should be increased by one position and repeat the test.
- Repeat the same procedure for each of the tap position individually.
- At other taps values will be as per the percentage increase or decrease at the respective tap positions.

- In case of Delta/Star transformers the ratio measure between RY-rn, YB-yn and BR-bn.
- For Delta/Star transformers the voltage ratio between HV and LV winding in each phase limb at normal tap position is 33 KV OR 33x√3 = 5.196 ,11 KV / √3 11
- At higher taps (i-e high voltage steps) less number of turns is in circuit than normal. So the ratio values rise by a value equal to 5.196 + {5.196 x (no. of steps above normal) x (percentage rise per each tap position)} 100
- In the same way for lower taps than normal the ratio is equal to 5.196 – [5.196 x (no. of steps above normal) x (percentage rise per each tap position)]*100

Test Acceptance Criteria:

- Range of measured ratio should be equal to the calculated ratio ±0.5%.
- Phase displacement is equal to approved arrangement and transformer's nameplate.
- The IS standard (IS Standard 2026/11171) states that when rated voltage is applied to one winding of the transformer, all other rated voltages at no load should be correct within 1/2 of 1% of the nameplate readings. It also states that all tap voltages should be correct to the closest turn if the volts per turn exceed 1/2 of 1% desired voltage .The ratio test verifies that these conditions are met.
- The IEC60076-1 standard defines the acceptable variation of the actual to declared ratio.
- Principal tapping for a particular first winding pair: the lesser ±0.5% of the declared voltage ratio

Test can detect:

- Turns are shorted or open circuits in the windings.
- Incorrect winding connections & other internal faults or defects in tap changer.

Test Results:

Tap Changer Position	Measured Voltage Ratio			Required Voltage Ratio = =(Rated HV Voltage * 1.732)/LV Volt		
	1U PHASE	1V PHASE	1W PHASE	Minimum	Std. Ratio	Maximum
1 (+ 5%)	46.22	43.33	46.33	45.97	46.20	46.43
2 (+2.5%)	45.15	45.20	45.20	44.87	45.10	45.33
3 NORMAL	44.03	44.07	44.08	43.78	44.00	44.22
4 (-2.5%)	42.90	42.95	42.95	42.69	42.90	43.11
5 (- 5%)	41.77	41.82	41.82	41.59	41.80	42.01

(4) Polarity / Vector group Test

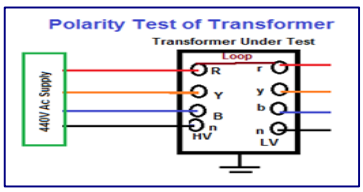
Purpose of Test:

- The vector group of transformer is an necessary characteristics for successful parallel operation of transformers. Hence all electrical power transformer must experience through vector group test of transformer at factory site for ensuring the customer particular vector group of transformer.

Test Instruments:

- Ratio meter.
- Volt Meter.
- A Ratio meter not always be accessible and this is frequently the case on site so that the polarity checked by voltmeter.

Test Circuit Diagram:



Test Procedure:

- The primary and secondary windings are connected together at 1 point.
- Connect neutral point of star connected winding with neutral.
- Low voltage 3 phase supply (415 V) is then applied to the HighVoltage terminals.

- Voltage measurements are then taken between various pairs of terminals as indicated in the diagram and the readings obtained should be the phasor sum of the separate voltages of each winding under consideration.

Condition:

(HV side R-Y-B-N and LV Side r-y-b-n)

- R and r should be shorted.
- Apply 415 Volt to R-Y-B
- Measure Voltage between phase and Satisfy Following Condition

Vector Group	Satisfied Following Condition
Dyn1	Rb = Rn+Bn
	Bb=By
	Yy<Yb
Dyn11	Ry=Rn+Yn
	Yb=Yy
	Bb<By
Ynd1	RN=Ry+Yn
	By=Yy
	Yy<Yb
Ynyn0	Bb=Yy
	Bn=Yn
	RN=Rn+Nn

(5) Short Circuit Test

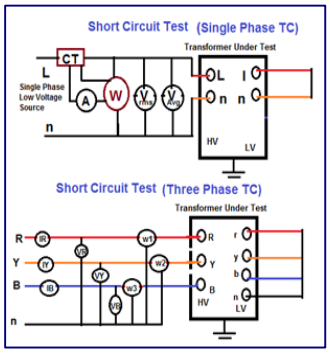
Test Purpose:

- The value of the short circuit impedance Z percentage and the load (copper) losses (I^2R) are obtained.
- Before the impulse test this test should be performed. In order to avoid readings errors the later will be performed as a routine test.

Test Instrument:

(1)Megger (2)Multi meter (3)CT, PT

Test Procedure:



- Appropriate Low Voltage (3-phase 415V, 50 Hz) can be applied to the terminals of 1 winding (usually the H.V.) with the other winding short circuited with Copper cable(Usually the L.V.).
- The applied voltage is adjusted to pass the required current in the primary or secondary. In order to simulate conditions closet to full load, it is usual to pass 100%, 50% or at least 25% of full load current.
- Voltage to be increased steadily till the current in the energized winding reaches the compulsory value (50% to 100% rated current).
- Measure the three phase line currents at all tap position. If the tap-switch is an Off-Circuit tap-switch, the supply has to be disconnected before changing the tap. A steady trend in the boost or diminish of current, as the case may be, confirms the healthiness of the transformer.
- At normal tap position 3 phase LT supply is applied on HV side of power transformer with rated current on the HV side of the power transformer and also currents measured in all the phases on HV side and phases and neutral on Low Voltage side values noted.
- Readings to be taken as quickly as possible as the windings hot up and the winding resistance increases. Thus, the losses value will increase consequently.
- Using suitable instruments (conventional 3 watt meter method / digital watt meter with ammeters and voltmeters) measurements of voltage, currents and power can be recorded.

Acceptance Criteria:

II. Measured impedance to be within nameplate value.
III. Load losses to be contained by definite values.

Test can detect:

- Winding deformation.
- Deviation in name plate value.

Test Results:

Ambient temperature : 33℃ (Guaranteed Losses : 9800 Watts @ 75℃)

Impedance Voltage (V) $V_{avg.}$	Load Loss Measured (Watts) 33ºC	(%z) = (Imp.volt*100)/ Primary voltage	Current (Amp.) $I_{avg.}$	Losses Measured(Watts) @75ºC
583.03	8885	5.30	52.51	9934

(6) Open Circuit / No Load Test

Test Purpose:

- In open circuit test, the value of No-Load power (Po) and the No-Load current (Io) are measured at rated voltage & frequency.

Test Instruments:

- Watt meters.
- Ammeter , Voltmeter or
- Power analyses

Test Procedure:

- Test is performed at rated frequency.
- Three phase LT Voltage of 415 V applied on HV side of Power transformer keeping LV side open.
- Two voltmeters are connected to the energized winding, 1 winding is measuring the voltage mean value and the other is for the Voltage R.M.S value.
- Voltage applied to winding (usually to High Voltage windings).It will be in a range from 90% of winding rated voltage to 110% of the same in steps, each of 5% (i.e. for a 33/11kV transformer, applied voltage guaranteed values shall be 29.7kV, 31.35kV,36.3kV)
- All the readings of watt meters, Voltmeters & Ammeters are recorded to obtain the values of (Vr .m.s), Vmean, Po and Io at each voltage step.
- Test results are measured satisfactory if the readings of the 2 are equal within 3%. If it's more than 3%, the validity of the test is subjected to agreement.
- From the following formula we can measure value of power loss in correct manner :
- Pc=Pm (1+d)
- D= (Vmean – Vrms) / Vmean
- Measure the loss in all the three phases with the help of three watt meter method. Total no load loss or iron loss of the tranformer = W1 + W2 +W3.

Test Caution:

- This test should be performed before the impulse test-if the later will be performed as a routine test- in order to avoid readings errors

Acceptance Criteria:

- No Load losses to be within values.

Test Results:

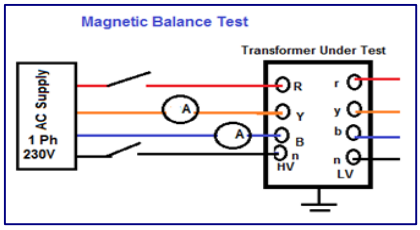
Applied Voltage (V) $V_{avg.}$	Current (Amp.) $I_{avg.}$	Frequency (HZ)	Losses Measured (Watts)
433.9	12.5	49.95	2532

(7) Magnetic Balance Test

Test Purpose:

- To check the imbalance in the magnetic circuit this test of transformer is conducted only on 3 phase transformers.

Test Circuit Diagram:



Test Instrument:

- Multi meter.
- Mill Ammeter

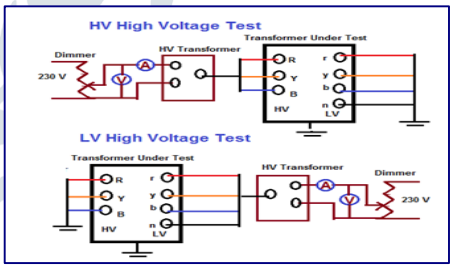
Test Procedure:

- First of all in normal position remain the tap changer of transformer.
- Now disconnect the transformer neutral from ground.
- Then apply 1 phase 230V AC supply across the HV winding and neutral terminals.
- In two other HV terminals in respect of neutral terminals measure the voltages.
- Repeat the test for each of the 3 phases.
- There are 3 limbs equal in a core of transformer. One phase winding is wound in one limb. The voltage induce in dissimilar phases depends upon the individual position of the limb in the core.
- The voltage induced in dissimilar phases of transformer in respect to neutral terminals is given below.
- Two phase supply (415 V) is to be applied to any two phases terminals on HV side of power transformer and voltages are measure with LT open.
- Sum of the ensuing two values should be equal to the voltage applied.

Applied Voltage (415V)	Measured Voltage(V1)	Measured Voltage(V2)	Result
RY	YB	BR	V=V1+V2
YB	RY	BR	V=V1+V2
BR	YB	RY	V=V1+V2

(8) High Voltage tests on HV & LV Winding:

Test Circuit Diagram:



Test Purpose:

- To checks the insulation characteristics between Primary to neutral, Secondary to neutral terminal and between Primary terminal& Secondary terminal.

Test Instrument:

- High Voltage tester (100KV & 3KV)

Test Procedure:

- HV high voltage test: LV winding connected together and neutral. HV winding is connected together and given HV Supply for one minute.
- LV high Voltage test: HV winding connected together and neutral. LV winding is connected together and given HV Supply for one minute.
- 433V Winding =3KV High Voltage
- 11KV Winding =28KV High Voltage
- 22KV Winding =50KV High Voltage
- 33KV Winding =70KV High Voltage.

(9)Induced over voltage test of transformer

Induced over voltage test of transformer is one of transformer testing that carry out at manufacture factory and this test classified under routine test of transformer & type test of transformer.

Test Purpose:

To secure that the insulation between the phase windings, turns, coils, tapping leads and terminals. For non-uniformity insulated windings the insulation between these parts and earth. Withstand the temporary over voltages and switching over voltages to which over voltages and switching over voltages subject to the transformer during its lifetime. Ensure that the transformer is not cut into one of the electrical supply lines. This causes the resonant effect to occur, causing high vibration voltage waves that may damage the transformer if there is a weak isolation. Discovering the air gaps between the layers of the windings to find out the efficiency of insulation between these layers and other layers and high voltage high-frequency we use will detect these air gaps.

Precautions before do this test:

- Disconnect the electrical current from the transformer.
- Clean the terminals of the transformer.

Steps of Induced over voltage test of transformer:

- Apply the excitation voltage to the terminals of the low voltage winding.
- Left the other windings open circuited.
- Normally, we use high frequency voltage source (the test frequency is typical 180 HZ) to prevent (magnetic flux saturation, and the test voltage is twice rated voltage.
- Select the tapping of the off-circuit tap changer.
- So, in all windings the voltage during the test is as near as possible to the rated test voltage.
- We can calculate the duration of the test from this relation:
- T test = [rated frequency / test frequency] x 120 seconds = 40 s (min 15 sec, max 60 sec)
- Repeat the test at each tap changer point of transformer.
- The test is successful if no collapse of the test occurs.

Test Results:

Test	Applied Voltage (V)	Applied Frequency(Hz)	Duration (Sec)	Remarks
Applied to Secondary Winding and primary winding open.	866	100	60	OK

V. CONCLUSION

- From this test we have concluded that for different type of transformer we use different type of winding i.e. spiral winding, cylindrical winding, cross over winding etc.
- We have also conclude that for reliable working of transformer, we run some test on transformer i.e. power withstand test, insulation winding resistance test, over-voltage test etc. By this tests we can study about withstand capacity of transformer, resistance of winding insulation and voltage capacity of the transformer respectively.
- Testing result show all parameters satisfy the standard of transformer and it shows that transformer is ready for commissioning.

REFERENCES

Books:-

- " **Design of Transformer** "
- By: - Indrajit Dasgupta
- Pub: - Tata Mcgraw Hill Publication.
- " **A course in electrical machine Design**

  By Dhanpat rai (A K Sawhney)