

KNOW MORE ABOUT THE TRANSFORMERS

Glossary – Transformers

Ambient temperature – The existing temperature of the atmosphere surrounding a transformer installation.

Ampere – The practical unit of electric current.

Auto-Transformer – A transformer which has only one winding per phase, part of which is common to both primary and secondary circuits.

BIL - Basic Impulse Level is means to express the ability of the insulation system to withstand high voltage surges

Buhholz Relay – A gas operated Relay used in Conservator Mounted Transformer

Core Loss – It is the electric loss in a transformer caused by magnetization of the core. They sometimes are referred to as no-load losses because they exist whenever the primary side of the transformer is energized, regardless of whether there is a load on the transformer. It has two major components – Eddy Current Loss and Hysteresis Loss.

Core Saturation – Condition that occurs when a transformer core has reached maximum magnetic strength.

Current Transformer: A transformer designed have its primary winding connected in the series with the circuit and used for transforming current to a value suitable for measurement or control.

Delta (▲) – It refers to a standard 3-phase connection in which each phase winding is connected in series t form a closed loop

Drain Valve – Fixed normally at the bottom of the tank used mainly for draining of the oil for sampling or filtration

Exciting Current (No-Load Current) – Exciting current is nothing but No load Current that which flows in any winding used to excite the transformer when all other windings are open circuit.

Frequency – Designates the number of times that polarity alternates from positive to Negative such as 50 cycles as per second (50Hz) is the term used to measure AC frequency in cycles per second.

Harmonic Distortion- Non-linear distortion (due to non linear load) in the output current wave from when the input is sinusoidal. Total the square root of the sum of the squares of all harmonic current present in the load, excluding the fundamental frequency (50 or 60Hz). Usually expressed as a percent of the fundamental

Hi Pot Test (Power Frequency Test) – A standard dielectric test to check insulating materials and clearances between winding and ground/neutral

Impedance – Forces, including resistance and capacitive or inductive reactance, which resist current flow in AC circuits. The unit of impedance is Ohm.

Inrush Current – A brief and momentary surge of current through the transformer, due to residual flux, experienced at the instant the transformer is energized.

Linear Loads – Loads where the current waveform conforms to that of the applied voltage, or loads where a change in current is directly proportional to a change in applied voltage. For example: resistance heating, incandescent lighting, water heater

Load Losses – There are the losses in a transformer which are incident to load carrying. Load losses include I^2R loss in the winding due to load current, stray loss due to stray fluxes in the winding, core, clamps, etc.... and to circulating currents (if any), in parallel winding

No-Load Losses – Losses incurred when a transformer is excited but without a load connected to the secondary. These includes core loss & dielectric loss,

Non-Linear Loads – Loads where the current waveform does not conform to that of the applied voltage, or where a change in current is not proportional to change in applied voltage. For example: computer power supplies, motor drive, fluorescent lighting.

OIL Level Gauge – To indicate the oil level in the transformer. It shall be a plain level gauge or magnetic oil level gauge or oil view finder.

OTI - (Normally Top) Oil Temperature Indicator to measure the oil temperature prevailing at the top level

Polarity – A designation of the relative instantaneous direction of the current in a secondary lead as compared with a primary lead.

Power factor – It is the relation of the watts to volt-amps in an electrical circuit

PRV – Pressure Relief Valve a device to release the excess pressure from the transformer tank

Primary Winding- The winding that is directly connected to the input power

Ratio (Voltage Ratio) – a reference to either the primary to secondary winding turn ratio or to the voltage ratio of the transformer

Rated Power - The total output power available from all secondary winding, expressed in Volt amperes (VA) or Kilo volt ampere (KVA). It is load that a transformer can handle indefinitely without exceeding the specified temperature rise.

Reactor – A device for introducing inductive reactance into a circuit.

Rectifier Transformer – A transformer designed to supply AC input to a rectifier to obtain the desired DC output and have the ability to withstand the heating effects caused by rectifier commutation or ripple.

Scott Connection – A transformer connection usually used to get a 2-phase output from the secondary of a transformer with a 3-phase input to the primary or vice versa

Step Down Transformer - A transformer in which the high voltage winding is connected to the input or power source and the low voltage winding is connected to the output load (lower voltage on the output)

Step Up Transformer – A transformer in which the low voltage winding is connected to the input or power source and the low voltage winding is connected to the output load (higher voltage on the output)

Secondary Winding – The winding supplying the output voltage to the load

Silica gel Breather – Natural / Synthetic gel used in the breather to absorb the moisture of incoming air passing through the breather. Used normally in Conservator Mounted Transformer. Used normally in Conservator Mounted Transformer.

Tap – A connection provided in a transformer winding which has the effect of changing the nominal voltage ratio in the transformer. The taps are usually placed on the high voltage winding to compensate for high or low voltage conditions found on the low voltage output side.

Temperature Rise – The additional maximum heat above ambient temperature that the transformer itself will generate in the normal course of operation.

Top Filling Valve - Fixed at the top cover of the transformer used mainly for oil filling.

Volts - The practical unit of Voltage measured between two terminals

Voltage Regulation – It is the measurement how well a transformer can maintain constant secondary voltage given a constant primary voltage at wide variance in load current. The lower the percentage, the more stable the secondary voltage.

Regulation in Percentage: $\frac{E_{\text{no load}} - E_{\text{full load}}}{E_{\text{full load}}} \times 100$

Voltage Transformer : A transformer that is designed to have its primary winding connected parallel with a circuit and used for transforming voltage to a value suitable for measurement or control.

WTI – Winding Temperature Indicator a device to measure the temperature at the winding

Wye (Star Connection – Y) – A 3-phase connection in which similar ends of each phase winding are connected together at a common point which forms the electrical neutral grounded. It is also called Star Connection.

In Star Connection

Line Current = Phase Current

Line Voltage = $\sqrt{3}$ x Phase Voltage

In Delta Connection

Line Current = $\sqrt{3}$ x Phase Current

Line Voltage = Phase Voltage

Power : $\sqrt{3}$ x Line Voltage x Line Current x Power Factor (for three phases)

Type of Transformer Cooling:

ONAN: Oil Natural Air Natural – Oil inside the transformer tank cooled naturally and Transformer externally cooled by Nature.

ONAF: Oil Natural Air Forced – Oil inside the transformer tank cooled naturally but Transformer externally cooled by the accessories like Fan etc.

OFAF : Oil Forced Air Forced – Oil inside the transformer tank forced cooled by using external heat exchanger and transformer externally cooled by the accessories like Fan ..etc

ODAF: As same of OFAF but with directed oil flow.**OFWE** : Oil Forced Water Forced – Oil inside the transformer tank forced cooled by using external heat exchanger and the heat exchanger is externally cooled by water circulation

Voltage Class in KV	KVA	L mm	W mm	H mm	Weight Kg	OIL Liter	Full Load HV Current	Full Load LV Current	Z% as IEC
11/0.433	25	950	650	1170	325	110	1.31	33	4
	50	1000	720	1250	500	135	2.62	67	
	100	1175	1050	1320	700	185	5.25	133	
	200	1400	1300	1600	1150	300	10.50	267	
	315	1500	1300	1800	1450	365	16.53	420	
	500	2000	1500	2100	2050	450	26.24	667	5
	750	2200	1650	2250	2450	650	39.36	1000	
	1000	2450	1700	2350	3500	980	52.48	1333	
	1250	2550	1800	2400	3800	1100	65.60	1667	6
	1600	2650	1850	2500	4000	1200	83.97	2133	
	2000	2750	2450	2600	4600	1400	104.96	2667	
2500	2850	2550	2700	6500	1850	131.20	3334		
33/0.433	200	1540	1060	1880	1400	500	3.49	267	4
	315	1640	1150	2000	1750	650	5.50	420	
	500	1800	1420	2240	2500	800	8.73	667	
	750	2120	1770	2400	2850	900	13.09	1000	5
	1000	2500	1850	2500	3800	1200	17.45	1333	
	1250	2550	2000	2500	4500	1350	21.81	1667	6
	1600	2650	2200	2650	5000	1500	27.92	2133	
	2000	2700	2800	2700	6000	1600	34.90	2667	
2500	2750	2900	2900	8000	2500	43.63	3334		
33/11 with HV and LV cable box and OCTC	3150	2900	2700	3000	9000	2200	55	165	7
	5000	3150	2800	3200	12500	2800	87.50	262	
	6300	3250	3000	3300	16000	3500	110	331	8
	7500	3350	3300	3500	18500	4500	131	394	
33/11 KV with MR OLTC	10000	4700	4000	2800	26000	6500	175	525	8
	15000	5000	4100	4100	34000	8500	262.50	787	
	20000	6200	4500	4300	41000	10500	350	1050	
11/0.433 KV-DEWA package sub station	500	2250	1625	1750	3250	500	26.24	667	4
	1000	2400	1700	1800	4500	1000	52.49	1333	5
	1500	3200	2300	2000	6000	1200	78.73	2000	6
	2000	3250	2600	2000	6500	1400	104.98	2667	6
*11/0.433 KV package sub station + Housing	500	3900	2500	2400	4500	500	26.24	667	4
	1000	3900	2500	2400	5500	1000	52.49	1333	5
	1500	3900	2500	2400	7500	1200	78.73	2000	6

- Impedance (z) is the minimum value as recommended by IEC 60076-5
- Each Utility has their own specification that makes variations in dimension & weight and impedance etc. Hence for more precious information please get in touch with transformer manufactures.
- Upto 315 KVA, it is considered as pole mounted and 500 & above is ground mounted.
- All transformers are considered as with of circuit tab changer unless mentioned.
- All distribution transformers upto 2000 KVA are hermetically sealed with fin walls.
- 2000 KVA and above are conservator mounted with radiators.
- DEWA – package sub station HV SF6 RMU and LV fuse type panel are in the same side.
- “Other package sub stations HV SF6 RMU and LV panel are in the opposite side with housing.

The IEC standards applicable for Transformers

IEC 60076 – 1 - General
ICE 60076 – 2 – Temperature Rise
IEC 60076 –3- Insulation levels and Dielectric Tests
IEC 60076 –4-Tapping and Connections
IEC 60076 –5-Ability to withstand short circuit level
IEC 60076 –7-Loading guide for oil immersed transformer
IEC 60076 –8-Power Transformer Application guide
IEC 60076 –10- Determination of Sound level
IEC 60076 –14- Design & Application of liquid immersed transformer using high temp insulation
IEC 60085 – Thermal Classification
IEC 60137 - Insulating Bushing for AC Voltage above 1 KV
IEC 60156 - Method of Testing of Electric Strength of Mineral Oil used in the Transformer
IEC 60214 - On Load Tap Changer
IEC 60296 - Specification of Unused Minerals Oil for Transformer & Switchgear
IEC 60330 - Package Sub Station
IEC 60354 - Loading guide for oil immersed Transformer
IEC 60404 - Electrical Steel (core steel)
IEC 60437 - Radio Interference Test on High Voltage Insulators
IEC 60529 - Degree of Protection by enclosures (IP code)
IEC 60599 - Guide to interpretation of dissolved and free gases analysis
IEC 60616 - Terminal Marketing for Power Transformer
IEC 60890 - Specification of Silicon oil for electrical purpose
IEC 60944 - Maintenance of Silicon oil in the transformer
BS 5493 - Protective Coating of Iron & Steel Structure against corrosion
BS 148 - OIL Cooled Transformer & BS 171 – Air Cooled Transformer
BS 381 - Painting
DIN 42500 – Three Phase Oil Immersed Public Transformers

Details of Various Tests on the Transformers

Routine Tests

- Measurement of Winding Resistance
- Measurement of Winding Insulation Resistance (Megger)
- Measurement of Voltage Ratio
- Verification of Vector group (Phase Displacement)
- Measurement of Impedance Voltage
- Measurement of Load Loss
- Measurement of No Load Loss and No Load Current
- Induced Over Voltage Test (Applying double the voltage & Frequency for 60 seconds)
- Separates Source Voltage withstand Test on HV and LV winding for 60 seconds.

Winding Voltage in KV in delta Winding	132	66	33	22	15	11	6.6	3.3	LV Less than 1.1 KV
Test Voltage in KV	230	140	70	50	38	28	20	10	3

Type Test:

- Temperature Rise Test
- Full valve Impulse Voltage withstand Test including Chopped Wave (Dielectric Type Test – IEC 60076-3)

Special Tests:

- Short Circuit withstand Test
- Measurement of sound level
- Measurement of Harmonics of no load current
- Measurement of Zero sequence impedances
- Measurement of power consumption of Auxiliaries like pump, fan etc
- Determination of Winding capacitance
- Measurement of dissipation factor ($\tan \delta$)