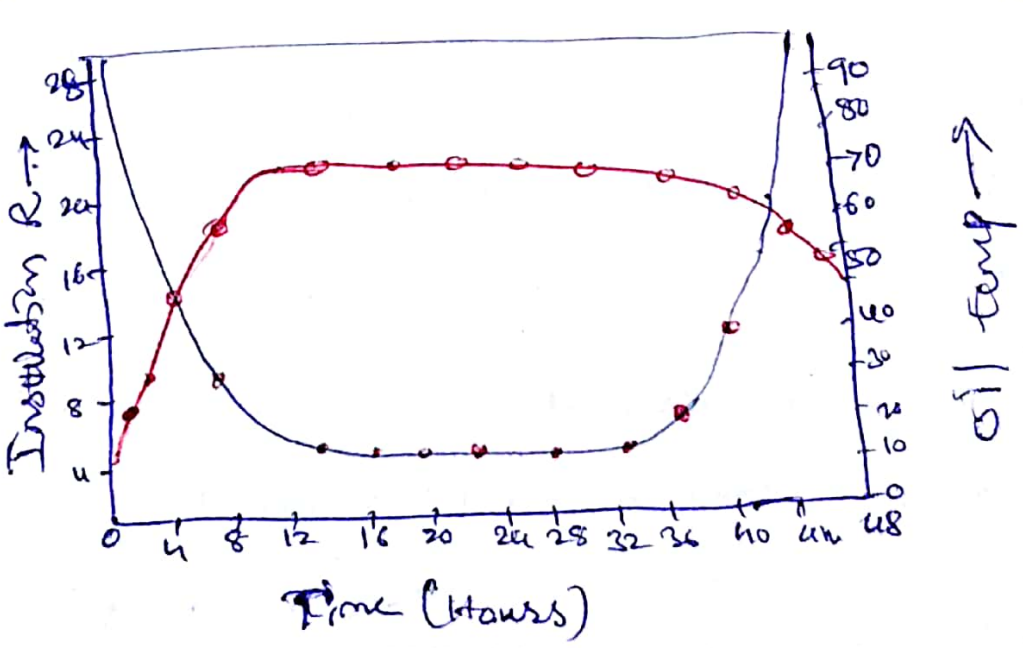
Drying of Windings · IS-10028-1981

The transformer oil & insulation are hygroscopic. When the transformer is idle for a long period, the oil & insulation absorb moisture and drying out is required before commissioning.

When Power transformer is idle for more than a month, drying out is necessary. The main purpose of the drying out is to expell the moisture from the oil, the winding insulation & other internal parts. If the transformer is not dried out properly and leads to premature failure of insulation.

In drying out process the transformer oil or winding is heated for a prolonged period (10 hours to 4 week). Periodic reading of oil/winding temp., Power Input & insulation resistance are taken.

Fig shows variation of insulation resistance with time of drying.



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Drying out has three phases.

i) In the beging the insulation resistance decreases indicating that moisture is getting released with in the insulation.

ii) After few hours the insulation resistance reaches steady value indicating that the moisture content is distributed within the winding. It takes several hours, depends upon size of transformer.

iii) In last phase - insulation resistance value starts increasing indicating that the moisture is expelled.

The drying process is stopped when the insulation resistance, polarization index & dielectric strength of oil meets the specified values.

Different Methods of drying out process.

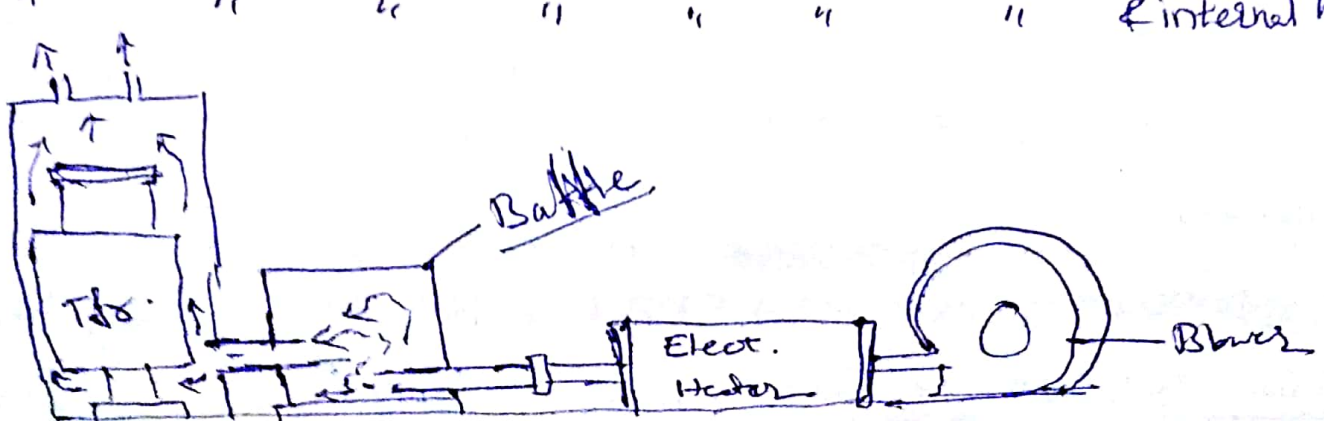
i) Drying of core & coils with oil by oven

ii) " " " " " by S.C Method.

iii) " with oil removed by using external heating.

iv) " " " " " " " & internal heat.

1).



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(ii) Drying by S C Method :- The transformer can be dried by heating the coils by short circuiting the low voltage winding & supplying less voltage at hv terminals. The current should not exceeds 70% of the rated current & oil temp. should not exceeds 75°C. The winding temp. should not exceeds 90°C. This method is more effective in drying at the site.

$$T_2 = \frac{R_2}{R_1}(235 + T_1) - 235^\circ C$$

where $T_2 \rightarrow$ Final average temp. of copper.
$T_1 \rightarrow$ Initial average temp. of copper.
$R_2 \rightarrow$ Final resistance of the windings.
$R_1 \rightarrow$ Initial " " " ".

(iii) & (iv) Drying without oil.

Dryingout of Transformer Duration :- It depends upon the rating & size of transformer.

Voltage Rating	Duration
11 KV	1 - 6 days
220 KV	10 - 30 days
440 KV	15 - 40 days

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General Inspection & Maintenance

If the transformer works long time, trouble free service, it should be given a reasonable amount of inspection & maintence. The main object is to maintain insulation in good condition.

Moisture, dirt & excessive heat are the main causes of insulation failure. With proper inspection and maintaince, the life of transformer is 15 to 25 years.

Maintaince work can be divided in to three catagories.

1) Regular / Routine inspection
2) Medium Repairs (Testing & Reconditioning)
3) Major Repair.

1) Maintaince work does not require the opening of the transformer over. It includes (a) visual inspection, (b) checking of fitments, (c) checking oil level, (d) cooling system, (e) control system, (f) leakages etc. The BDV of oil samples and sample gas from Buchholz's relay are tested.

This includes cleaning of the porcelain surfaces ~~tighting~~ tightening of nut bolts, replacement of silica gel, repair of external fitments & oil filteration. The minor repair is carried out by the person.

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2) Median Repair :- Dismentling of the transformer is taken up for inspection/repair of the core / coil. These sub assemblies are inspected & repaired.

Ex. Repair of conservator tank, tap changer, cooling system, sealing gaskets etc. The defects located in routine inspection & could not be corrected would be taken up here.

3) Major Work :- Major repair work done after 8 to 10 years. This involves complete disentlieng of transformer.

The transformer Maintaince include the following.

a) Routine Daily inspection. — DI
b) " weekly " — WI
c) " Monthly " → MI
d) Quarterly inspection → QI
e) Annual inspection → AI
f) Unsheduled maintaince → US

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Commissioning Tests :-

1. Volt Ratio Test
2. Earth resistance test
3. Oil strength test
4. Insulation test
5. ~~Impedance test~~
6. ~~Impulse~~ test
7. Polarization index
8. Load temp. rise test
9. Performance curve like voltage Regulation & efficiency test.
10. Mech. stress under normal & subnormal tests.

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Polarization Index : Polarization index gives the true idea about — ① Quality of insulation.

② Extent of dryness.

~~As the dryness~~ As the insulation draws capacitive charging currents in the beginning the current is more. Hence 15 sec insulation resistance reading is to be taken ie the generator is driven for 15 sec & the reading of the megger is noted. Repeat the same for 60 sec. & note down the reading. The ratio of I_0R_{60} to I_0R_{15} gives the polarization index.

$$\text{ie} \quad \frac{I_0R_{60}}{I_0R_{15}} > 1.$$

The polarization index is depends upon the temp. at which insulation resistance measured. The polarization index at 50°C is more than that at 30°C.

Reason for low insulation resistance value as follows.

a) Dust & dirt sticking on the surface of insulation:- The carbon particles, metallic particles & sludge have a tendency to align along the direction of the electric field on internal & external surface of the insulator

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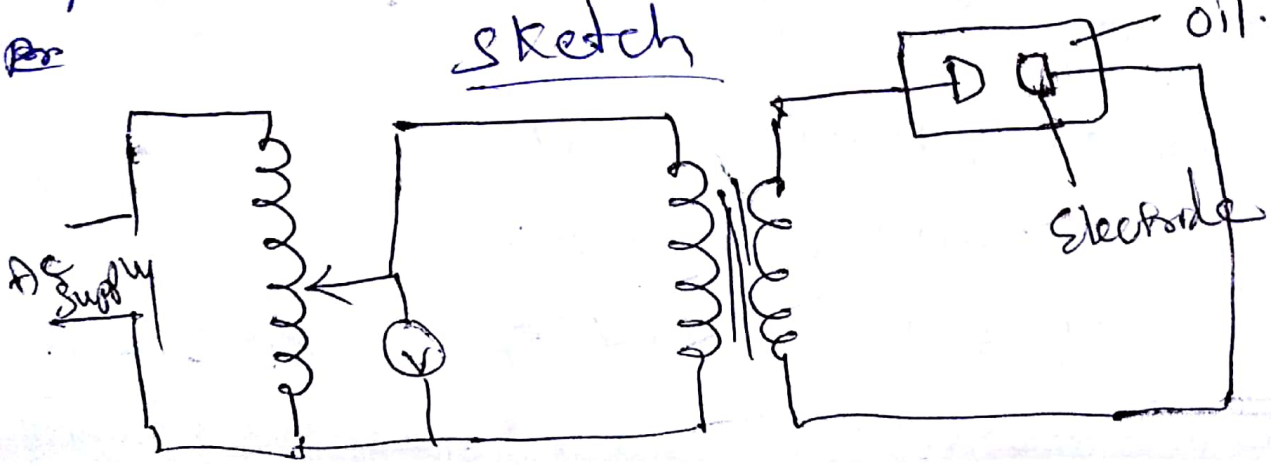
and in presence of moisture the tracking is accelerated & reduces the insulation resistance.

b) Absorption of moisture by insulation & the insulating oil results in low insulation resistance value.

Testing of oil strength (BDV test)

The transformer oil should be checked during periodic maintenance. The fresh transformed oil has pale yellow in colour. A dark colour or cloudy appearance indicate deterioration. Impurities have a bad effect on the properties of the oil. The oil sample is taken in a standard oil test cell [80 x 60 mm cross section area x 100 mm high] Electrodes are polished brass spheres 12.7 mm dia mounted horizontally. The gap spacing is 4mm ± 0.02mm. Dielectric strength of oil is very important.

Sketch



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A sample of insulating oil is taken from the bottom of the tank. Dark & brown clouds indicate deterioration oil in good condition has pale yellowish uniform colour. It is tested by means of portable oil testing set which consists of a auto transformer, voltmeter, tripping ckt device etc. The vltage can be gradually increased. Oil in good condition should withstand 45KV rms for one minute in a standard oil testing cup with 4mm gap electrodes. A gap of 2.5 mm should have break-down value above 45 KV.

~~5, 10, 12, 17, 22, 25, 29, 31, 33, 35, 39,~~

Impulse Testing on T/fr.

This test is necessary for all indoor & outdoor transformers. Standard impulse wave of specified amplitude is applied twice in succession. If there is no flash over or puncture of the insulators, then the transformer is considered to have passed the test. If there is puncture, is considered to have failed the test.

During test, one wave should be applied with reversal of polarity. The peak value & wave shape of the test vltage is recorded by means of storage oscilloscope.

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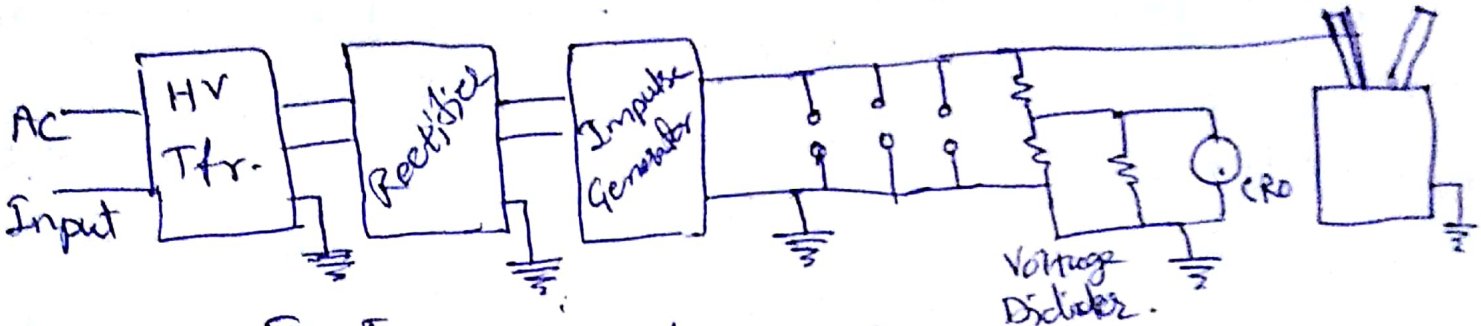

Fig-I: Setup for Impulse voltage test.

Lightning is probably the most common cause of flash over on overhead transmission line. Two mechanism can be occuses. 1. The lightning stroke makes direct contact with phase conductor producing a voltage on lines in excess of the impulse voltage level.

2. The stroke makes contact with an earth wire or tower and the combination of ~~tower~~ current & tower impedence produces a voltage near the tower top to produce back flashover.

Switching impulses can occur during all kinds of switching operations in the system. The magnitude & form of impulses generated differ from case to case. The magnitude of switching impulses is proportional to system voltage. The max. voltage can be about 3.5 times the servi voltage.

The system disturbances may be represented by 3 basic wave shapes shown in fig.

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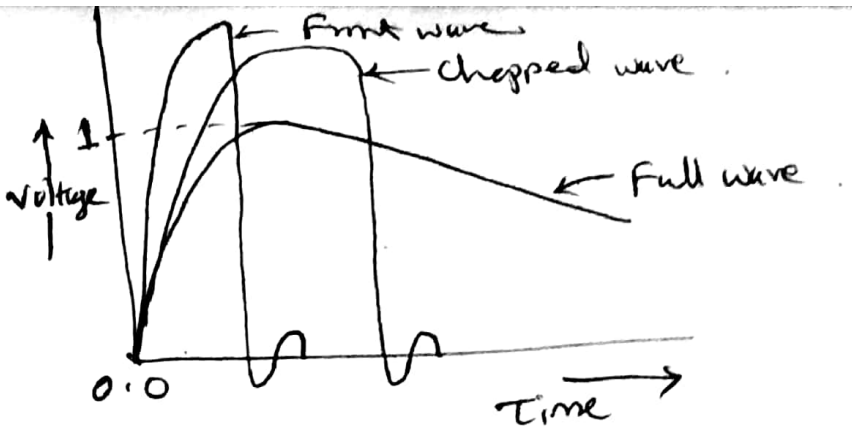
a) Full wave
b) Chopped waves.
c) Front waves.



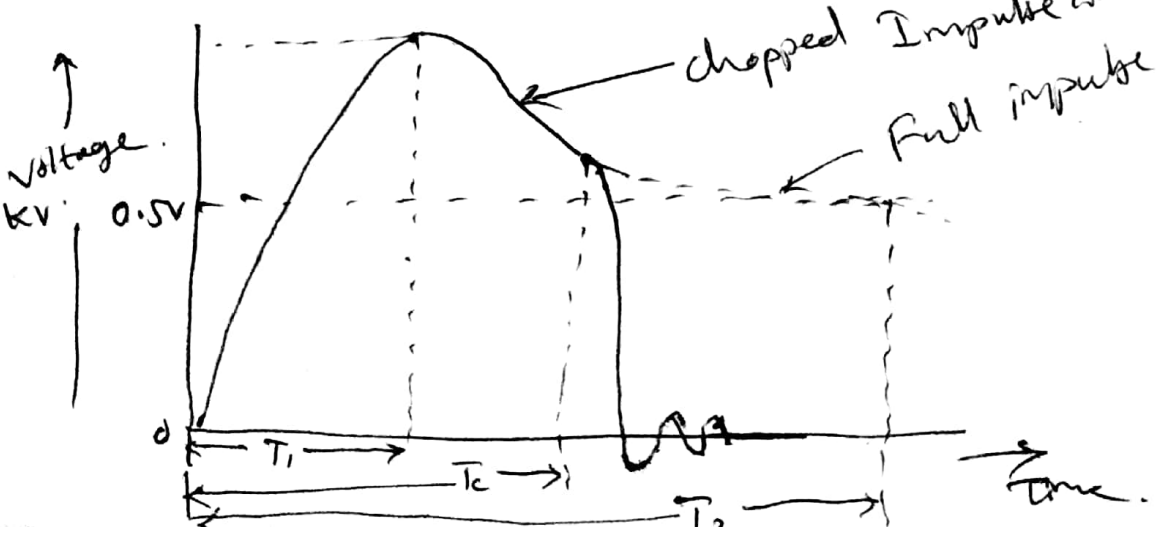
the standard impulse voltage is by.

a) polarity
b) Peak value
c) Virtual front (T_1)
d) Virtual half time (T_2)
e) Virtual time chopping (T_c).

Standard impulse can be classified three types:

1) Lightning Impulse : 1.2/50 μs (wave front/wave tail)
2) Switching Impulse wave: 250/2500 μs
3) Chopped impulse wave : 12/50 μs.

Below fig shows std. Impulse wave



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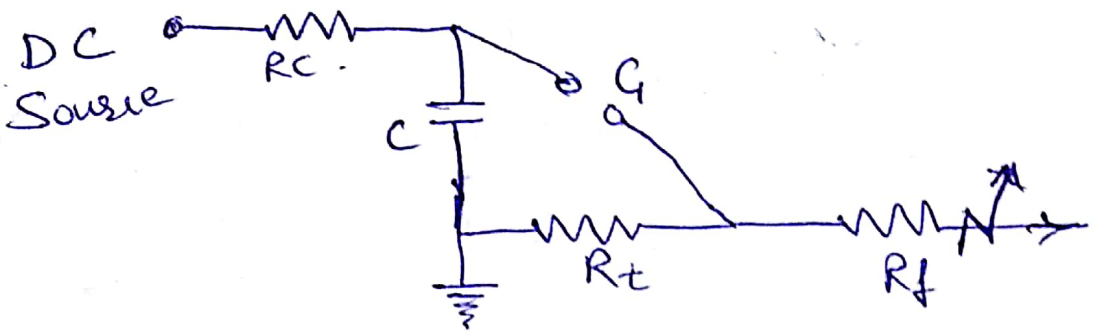
Impulse test setup on Power Transformer

The impulse voltage is produced by the discharge of a capacitor or no of capacitors into wave generators & so produced impulse voltage is applied to the object under test.

For HV impulse test a multistage impulse generator which is modified. This consists of number of capacitors initially charged in parallel & discharged in series by the sequential firing of the interstage gaps



where Rc - charging resistor
Rf - Series resistor controlling wave front
Rt - Discharging resistor controlling wave tail
G - Wave gap.

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