Experiment No.(2)

Short Circuit tests of a single-phase Transformer

1-Objective:

The purpose of this experiment is to find the copper losses from short-circuit test and hence estimate the efficiency for different load conditions and to determine the series impedance parameters.

2-Theory:

The purpose of this test is to find the copper losses at full load and to find Req and Xeq of the transformer. For this purpose, one of the windings of the transformer is short-circuited and a suitable small voltage is applied to the other winding so as to circulate full-load currents in the transformer windings.

The applied voltage will be nearly that required to overcome the total impedance voltage drop of the windings and will be generally a few percent of rated value. Normally, the L.V. winding is short-circuited and H.V. winding is excited. Because if the measurements are made on the L.V. side, the voltage would be very low and the ammeter would be very high, it is immaterial which winding the copper losses are measured since they will be the same. The connection diagram for this test is shown in Fig (1) and Fig (2).

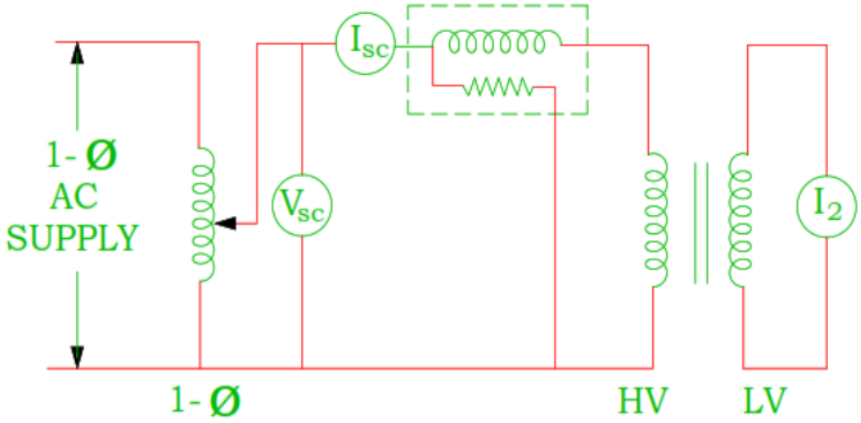

Fig. (1) Short circuit test of single phase transformer

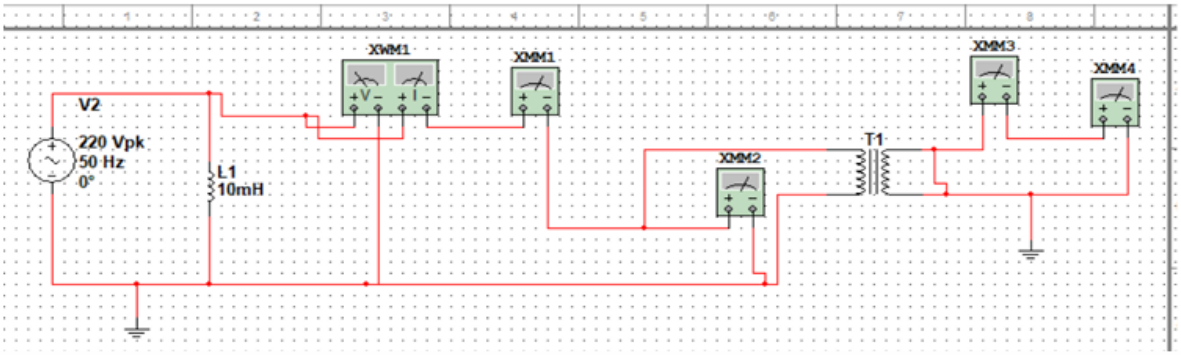

Fig. (2) Short circuit test of single phase transformer (multisum)

Since the applied voltage is small the mutual flux is small and the magnetizing current and the core-losses may be neglected. The wattmeter reading will be equal to the total copper losses in both the windings considering the resistance of the circuit. Since the P.F. of the circuit is low, a low power factor wattmeter is to be used in the circuit. Fig (3.a) and (3.b) shows the eq. circuit of the transformer for the short-circuit condition and Fig (4) show the phasor diagram of Zeq.

Let Vsc, Isc and Psc be the readings of the voltmeter, Ammeter and wattmeter respectively.

$$\text{Then Req} = \text{Psc} / \text{Isc}^2 \; ; \; \text{Zeq} = \text{Vsc} / \text{Isc}$$

$$\text{Xeq} = \sqrt{(\text{Zeq}^2 - \text{Req}^2)}$$

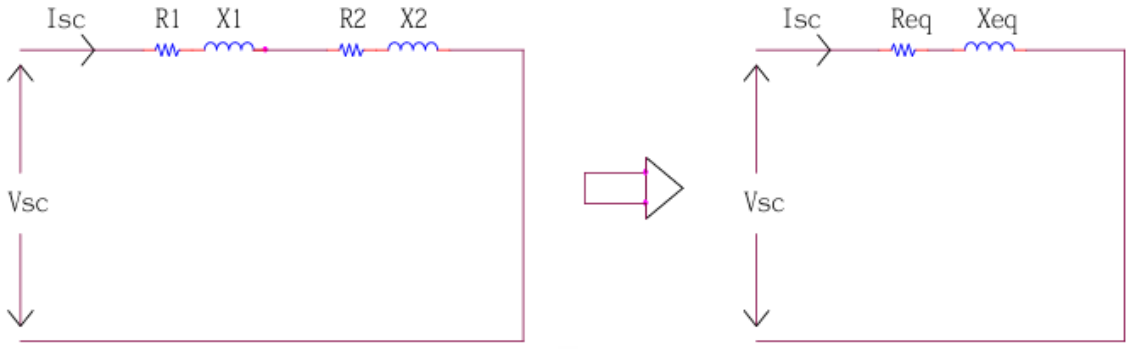

Fig.(3.a) Fig.(3.b)

The above two tests can be used for indirect determination of efficiency and regulation of the transformer:

$$\eta = [1 - (\text{Total Losses})/(\text{output} + \text{Total Losses})]$$

$$\text{Regulation} = (\text{IReq} \cos\varphi + \text{IXeq} \sin\varphi)/\text{Vs0} \times 100\%$$

Where:

I = Secondary load current

Vs0 = Secondary terminal voltage on no-load

φ = P.F. angle of the load

Req = eq. resistance referred to secondary

Xeq = eq. reactance referred to secondary

Req = R1 + R2

Xeq = X1 + X2

$Zeq = \sqrt{(Req^2 + Xeq^2)}$

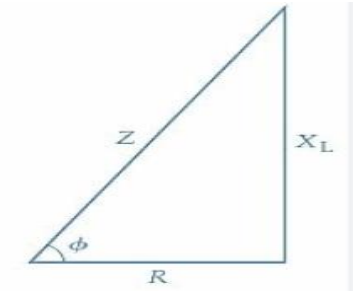

Fig. 4

3-Procedure:

1-Connect the transformer as shown in fig (2).

2-Supply H.V. side through an auto-transformer, increase the voltage in steps till 125% full load current flows on the H.V side, taking the readings at each step.

4-Calculation and Graphs:

1-Find the copper losses at full load.

2- Find Req and Xeq for each current and find average value.

3- Find efficiency at 0.8 pf. Lagging and at u.p.f for full-load condition.

4- Find the max. efficiency and current at 0.8 p.f and u.p.f loads.

5-Discussion:

1-why generally the voltage is applied to H.V side?

2- Draw the exact equivalent circuit of the transformer?