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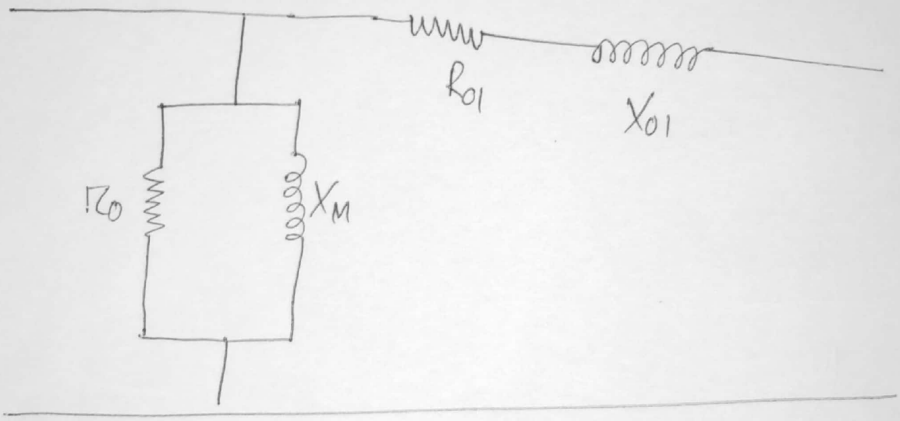
Objective

The purpose of this experiment is to study the equivalent circuit parameters of a transformer and calculate it's efficiency and regulation.

Introduction:

The equivalent circuit of a tranformer



The various parameters of this ~~ex~~ circuit can be determined by open circuit test and short circuit test. Various performance characteristics e.g. efficiency, regulation can be determined without actually loading the transformer.

In this experiment, the transformer was loaded with a ~~ce~~ certain RL load and regulation and efficiency were experimentally measured. The obtained results

were then compared with those from theoritical calculations.

Instruments:

1. One AC voltmeter (0-300V)
2. Two AC ammeters (0-10A, 0-30A)
3. Two 1-φ wattmeters
4. One 1-φ variac
5. One 12Ω resistance bank
6. One inductance bank

Circuit Diagrams:

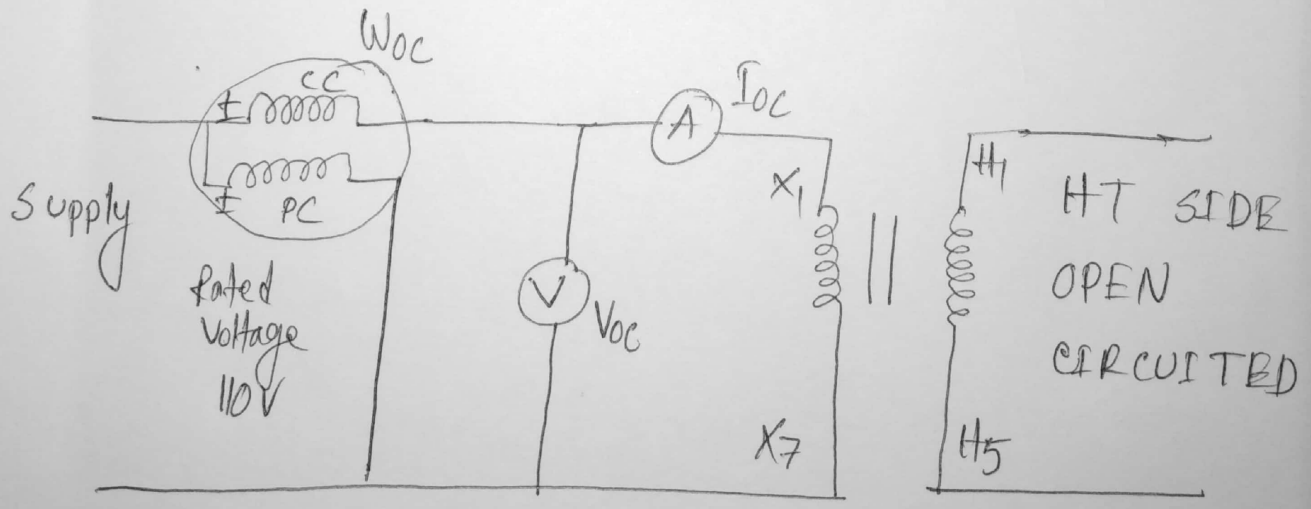


Fig1: OPEN CIRCUIT TEST

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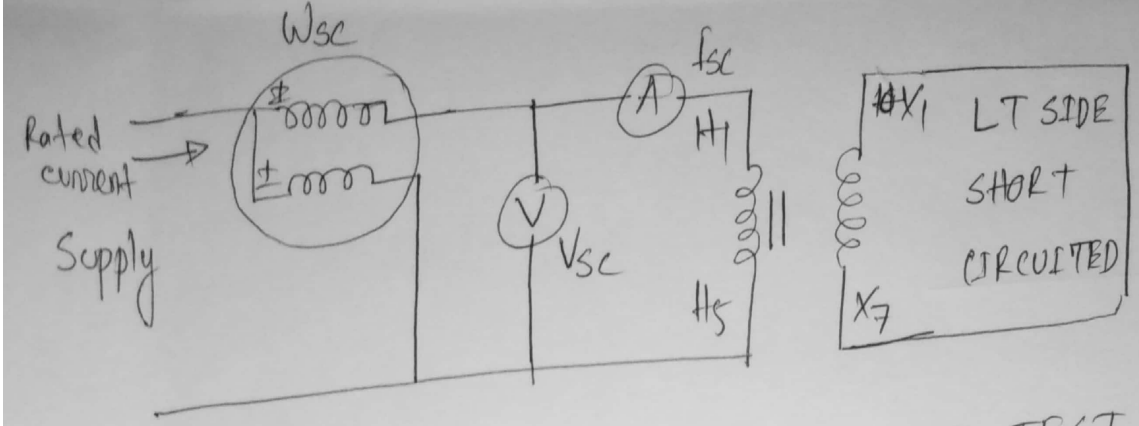

FIG-2: SHORT CIRCUIT TEST

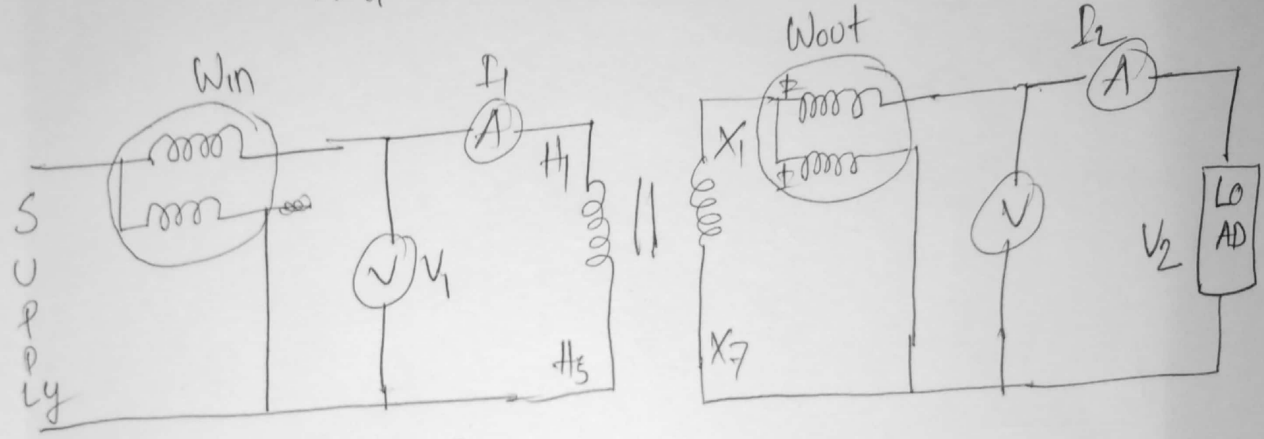

Fig3: LOADING TEST

DATA:

For open circuit test (reffered to LT side):

Input power, $W_{oc} = 20W$

Input current, $I_{oc} = 0.17A$

Input voltage, $V_{oc} = 202V$

for short circuit test (reffered to H.T. side):

Input power $W_{sc} = 20W$

Input current, $I_{sc} = 2A$

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Input voltage, $V_{SC} = 11.9\,V$

For loading test (referred to LT side):

Input power, $W_{IN} = 120\,W$

Output power, $W_{out} = 120\,W$

Output current, $I_2 = 1.3\,A$

Output voltage, $V_2 = 108.4\,V$

Reports:

(I) Determine the equivalent circuit parameters of the transformer from the data.

Ans:

(i) Core loss resistance, $r_o = \frac{V_{oc}^{\vee}\, a^{\vee}}{W_{oc}} = \frac{202^{\vee}}{20} = 2040\,\Omega$

(ii) Core loss, $W_{core} = W_{oc} = 20\,W$

(iii) Magnetizing resistance, $X_M = \frac{V_{oc}\, a^{\vee}}{I_{oc} \sin\phi_o}$

Here, $\phi_o = \cos^{-1}\frac{W_{oc}}{V_{oc} I_{oc}} = \cos^{-1}\frac{20}{202 \times 0.17} = 54.38°$

$$X_M = \frac{202}{0.17 \times \sin 54.38°} = 1461.73\,\Omega$$

(iv) Copper loss, $W_{cu} = W_{sc} = 20W$

(v) Equivalent resistance, $R_1 = \frac{W_{sc}}{I_{sc}^2} = \frac{20}{2^2} = 5\Omega$

(vi) Equivalent reactance, $X_1 = \sqrt{\left(\frac{V_{sc}}{I_{sc}}\right)^2 - R_1^2} = 3.225\Omega$

(vii) Power factor of R_L Load, $\cos\theta = \frac{W_{out}}{V_2 I_2} = \frac{120}{1.3 \times 108.4}$

$= 0.852$

(2) Determine efficiency and regulation of the transformer for the given RL load.

Ans:

$$\text{Efficiency} = \frac{W_{out}}{W_{IN}} = \frac{V_2 I_2 \cos\theta}{V_2 I_2 \cos\theta + W_{core} + W_{IN}} \times 100\%$$

$$= \frac{108.4 \times 1.3 \times 0.852}{108.4 \times 1.3 \times 0.852 + 20 + 20} \times 100\%$$

$$= 75.01\%$$

$$\text{Voltage Regulation} = \frac{E_2 - V_2}{V_2} \times 100\%$$

$$E_2 = \left(V_2 \cos\theta + I_2 \frac{R_1}{a^2}\right) + j\left(V_2 \sin\theta + I_2 \frac{X_1}{a^2}\right)$$

$$= (108.4 \times 0.85 + 1.3 \times 1.25) + j(108.4 \times 0.527 + 1.3 \times 0.806)$$

$= 93.765 + j58.1746$ V

$= 110.34$V $\angle 31.81°$ V

$$\text{Regulation} = \frac{110.345 - 108.4}{108.4} \times 100\%$$

$= 1.79\%$

(3) What are the approximation of the short circuit and open circuit tests?

Ans

With short circuit tests, the equivalent impedance, leakage reactance and total resistance can be approximated. Also, the copper loss at full load can be determined which is used in calculating the efficiency of the transformer.

With open circuit tests the no load loss or core loss and no load current can be approximated which are helpful in determining the core resistance and reactance.

④ Why open circuit test is performed in the high tension side whereas short circuit test is performed in the low tension side?

Ans:

The reasons why the open circuit test is performed in the high tension side is that, in order to apply full voltage to the high tension side, a larger power source is required. Hence the high tension side is usually kept open where the voltage is essentially applied to the low tension side.

The reasons for short circuit test to be performed in the low tension side are as follows:-

(i) the rated current on the high tension side of a transformer is less than that of the low tension side. And this current can easily be measured with the help of available lab ammeters.

(ii) Also, since if the high tension side is shorted, voltage of this side would essentially fall to zero and as VI^2 constant, the current would be very high which could

possibly burn the windings.