KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

Electric Engineering Department

EE 306 Electric Energy Engineering - Experiment#4

REGULATION AND EFFICIENCY OF A SINGLE PHASE TRANSFORMER

Objectives:

1. To determine the regulation of a transformer
2. To determine the efficiency of a transformer

Apparatus:

1 Single-phase transformer
1 Variable AC power supply
2 Voltmeters
2 Ammeters
2 Wattcmeters
1 Variable load

Theory

The voltage regulation of transformer at rated load is defined as:

$$V_R = (V_{no\ load} - V_{rated}) / V_{rated} \qquad (1)$$

If the approximate equivalent circuit of a transformer is used then for a lagging pf load

$$V_1 = V_{no\ load} = V_{rated} \angle 0^o + I (\cos\theta - j \sin\theta)(R_{eq} \pm j X_{eq})$$
$$= V_{rated} \angle 0^o + (R_{eq} \cos\theta + I X_{eq} \sin\theta) + j(-I R_{eq} \sin\theta + I X_{eq} \cos\theta) \qquad (2)$$

Neglecting the imaginary part on the right hand side,

$$VR = \frac{I\,(R_{eq}\cos\theta + X_{eq}\sin\theta)}{V_{rated}} \qquad (3)$$

The efficiency of the transformer can be written as

$$\eta = \text{Power output / Power input} \qquad (4)$$

Or

$$\eta = \frac{\text{Power Output}}{\text{Power output + Loses}}$$

The losses are,

Core loss = No load power input – No load copper loss
Copper loss = $I_2^2\, R_{eq}$

Procedure :

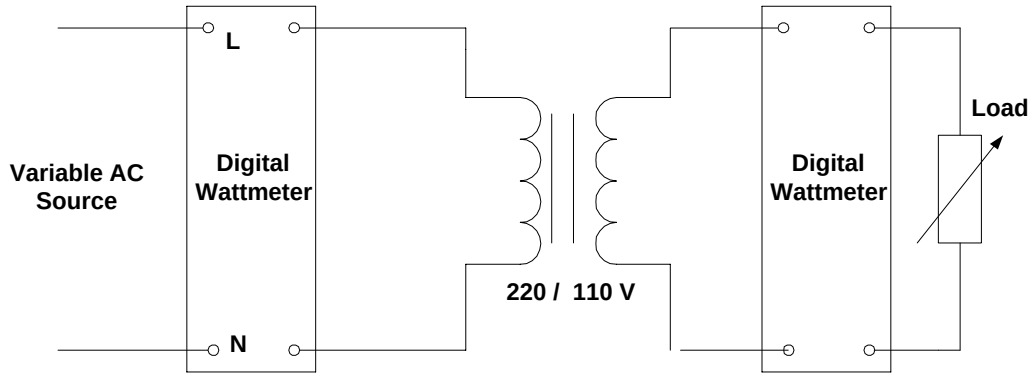

Fig. 1 : A Transformer with Load

1. Record the ratings of the transformer
2. Note down the parameters of the approximate equivalent circuit from the previous experiment. If you are using a different transformer, perform the open circuit and short circuit test again.
3. Connect the circuit as shown in Fig.1.
4. Make a table on the separate page as table.1.
5. Select unity power factor load.
6. Adjust the input voltage so that the load voltage is the rated value for a certain load current. Record P_i, P_o, V_2 and I_2. Switch the load off and record V_2. This is V_2 (no load)
7. Repeat step 6 for various loads until you have reached the rated current. Take about 10 readings. Make sure that you have taken readings at ¼, ½, and ¾ of full load and rated load (8A) condition.

8. Select 0.8-power factor lag. Repeat step 6 for rated current
9. Repeat step 8 for 0.8 p.f . leading.

Table 1

P.f	V_2	I_2	P_i	P_o	V_2 (No load)	$\eta = P_2/P_i$	VR	H (cal)	VR from eq3

Report

1. Calculate efficiency and voltage regulation fro your test results. Enter them in columns 7 and 8 in table 1
2. Plot efficiency as function of load current for the unity power factor load
3. For rated, ½ and ¼ rated load, Calculate the efficiency from the equivalent circuit. Enter them in table 1. Compare with measured values
4. Calculate the voltage regulation for rated load at unity, 0.8 lagging and 0.8 leading power factors using equation 3. Enter them in the table. Compare your results with measured values.
5. State reasons of any discrepancy between the measured and the calculated values

