SEPARATION OF LOSSES IN A SINGLE PHASE TRANSFORMER

AIM

To separate the hysteresis and eddy current losses from iron loss in a single phase Transformer at normal voltage and frequency.

APPARATUS REQUIRED

Sl. No:	Apparatus	Specification*	Quantity
1	Voltmeter	0-150 V, MI	1
2	Ammeter	0-1A MC 0-1A, MI	1 1
3	Wattmeter	150V, 5A, LPF	1
4	Rheostat	272 Ω, 1.7A	1
5	Rheostat	100 Ω,5A, 1000 Ω,1A	1
6	Transformer	1Φ,120/240V, 1KVA	1

PRINCIPLE

The components of iron loss consist of hysteresis loss and eddy current loss. Both are functions of frequency and maximum flux density in the core can be separated by finding iron losses at various frequencies and plotting the graphs P_c/N V_s N. Variable supply frequency canbe obtained from an alternator.

There are mainly two types of losses occurs in a transformer. They and iron loss or core loss and copper loss or winding loss. As the name indicates, the loss occurs in core is known as core loss and loss in winding is known as winding loss. The iron loss includes hysteresis losses and eddy current losses, both are functions of frequency and maximum flux density in the core.

The values of these losses are independent of load current. Hence it is assumed as constant from no load to full load and named as constant loss.Hence constant loss in a transformer is given by,

Constant loss (core loss / iron loss) = hysteresis loss + eddy current loss.

$Pc= W_H + W_E$ $W_H = K_H (B_m)^{1.6} f$ $W_E = K_E (B_m)^2 f^2$

Where K_H and K_E are proportionality constants.

Therefore $Pc= K_H (B_m)^{1.6} f + K_E (B_m)^2 f^2$

The hysteresis loss is varying linearly with the frequency while the eddy current loss varies as the square of supply frequency.

The core loss per cycle is given by, $Pc/f = K_H (B_m)^{1.6} + K_E (B_m)^2 f$

This shows that hysteresis loss per cycle is independent of frequency and eddy current per cycle is proportional to the frequency. For the open circuit test V and f are varied together so that V/f is a constant. Since $B_m \alpha V/f$ for a particular value of V/f, the equation for core loss per cycle can be written as, $Pc/f = K_1 + K_2 f$

Where $K_1 = K_H (B_m)^{1.6}$ and $K_2 = K_E (B_m)^2 f$.

Thus the plot of Pc/f versus f results a straight line. From the graph, value of K_1 and K_2 can be determined. Slope of the straight line gives K_2 and intercept gives K_1. Thus core loss can be separated as,

Hysteresis loss, $W_H = K_1 f$ Eddy current loss, $W_E = K_2 f^2$

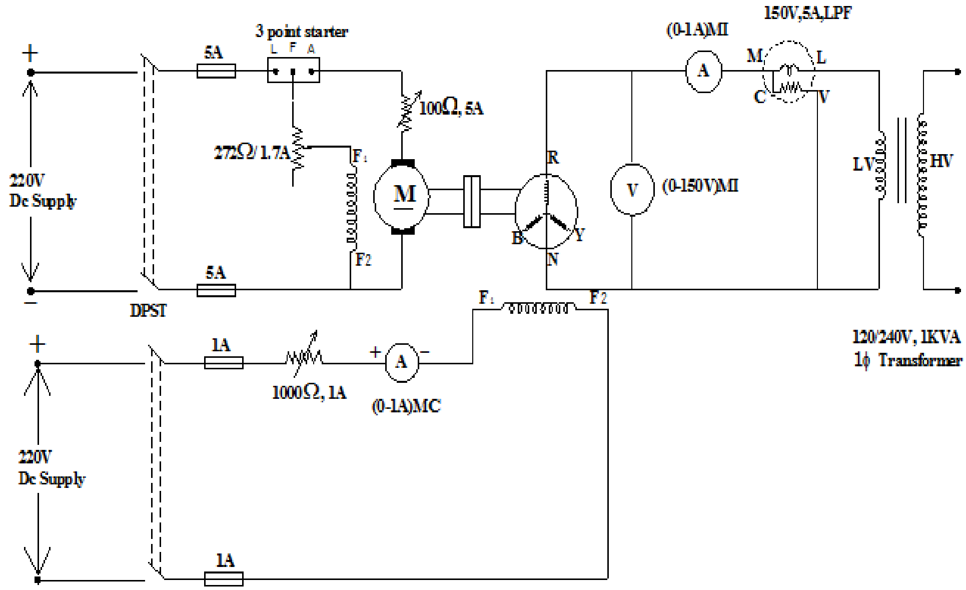
An alternator is a three phase a.c. generator whose speed and frequency are related as N=120f/P.

Where N- Speed

f- Frequency

P- Number of poles of alternator.

CIRCUIT DIAGRAM



PROCEDURE

1. Connect the circuit as shown in figure.
2. Keep the field rheostat of alternator in maximum position and field rheostat of motorin minimum position. Also keep the armature rheostat of motor in maximum position.
3. Switch ON the power supply.
4. Start the motor using three point starter.
5. Cut off the starting rheostat gradually.
6. Adjust the field rheostat of motor to drive the alternator at its rated speed to getnormal supply frequency (50Hz).
7. Adjust the field rheostat of alternator to supply rated voltage to the transformer.
8. Note the wattmeter reading.
9. Now the frequency is varied to different convenient values by adjusting the speed of the prime mover (motor) and in each case voltage is also adjusted to keep V/f ratio constant.

10. Tabulate the readings.
11. Switch OFF the power supply after bringing all the rheostats to initial positions.

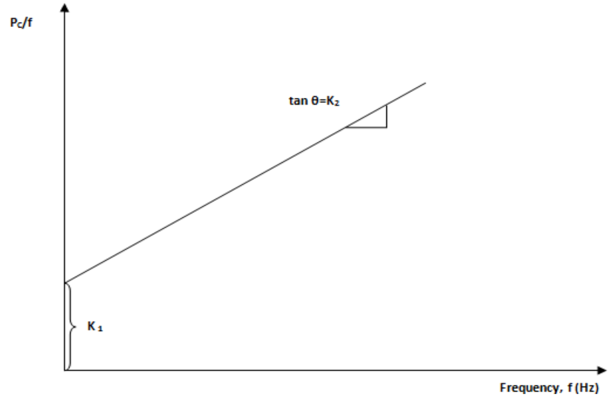
PRECAUTIONS

1. There should not be any loose connection in the circuit.
2. While varying the field rheostat of alternator, care must be taken so that the inducedvoltage does not exceed the rated voltage on LV side of the transformer.
3. In each set of reading, the V/f ratio must be constant.

TABULAR COLUMN

Sl.No	Speed, N (rpm)	Frequency, f (Hz)	Voltage V (V)	Power Pc (W)	Pc/f
1					
2					
3					
4					

SAMPLE GRAPH



SAMPLE CALCULATION

Speed, N=…............... Rpm

N=120f/P

Frequency, f=NP/120=…................ Hz

Power, Pc=… ....W

Pc/f=… .... W/Hz

From graph,

K_1 =… .... W/Hz

K_2= tan θ=… ....W/Hz^2

Sl. No	Speed N (rpm)	Frequency f (Hz)	$W_H = K_1f$ (W)	$W_E=K_2f^2$ (W)	$Pc=W_H+W_E$ (W)
1					
2					
3					
4					
5					
6					

Hysteresis loss, $W_H = K_1f$ =…..............W

Eddy current loss, $W_E = K_2f^2$ =..................W

Total Loss, Pc =$W_H + W_E$=…..... W

RESULT

Thus separated the core loss in a Single phase Transformer into hysteresis loss andeddy current loss at normal voltage and normal frequency.

Hysteresis loss =

Eddy current loss=