WARSAW UNIVERSITY OF TECHNOLOGY
INSTITUTE OF ELECTRICAL MACHINES
ELECTRICAL MACHINES LABORATORY

3-PHASE TRANSFORMER TESTS (TR1)

RATING OF THE TRANSFORMER TO BE TESTED

Calculations:

S_N=...
U_N=....
$u_{sc\%}$=....
Group of connections:
Taps terminals:

I_{Nhv}=....
I_{Nlv}=....
$U_{Nph,hv}$=....
$U_{Nph,lv}$=....

Scheme of windings and terminals' symbols (diagram):

1. MEASUREMENT OF INSULATION RESISTANCE AND WINDING RESISTANCE

1.1. Insulation resistance

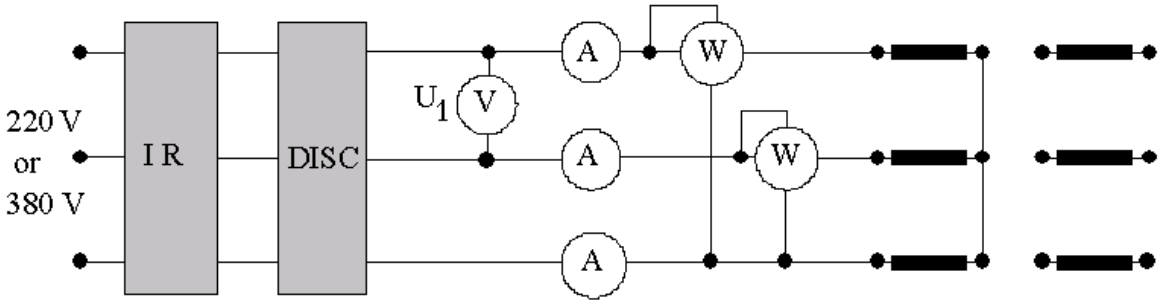
By means of 500 V inductor measure the following resistances:
- between 1A & earth (core) ..... MΩ
- between 1B & earth (core) ..... MΩ
- between 1C & earth (core) ..... MΩ
- between 2A & earth (core) ..... MΩ
- between 2B & earth (core) ..... MΩ
- between 2C & earth (core) ..... MΩ
- between h.v. winding (Y connected) and l.v. winding (y connected)

1.2. Winding resistances

By means of the voltmeter-ammeter method, satisfying the condition that the current shouldn't exceed 20% of winding's rated current, measure the values of h.v. side and l.v. side winding resistances.

2. NO-LOAD TEST (open-circuit test)

The transformer is supplied from its higher voltage side (Y). Secondary winding is open-circuited. Measuring instruments should have their ranges appropriately chosen for the expected values of no-load quantities.



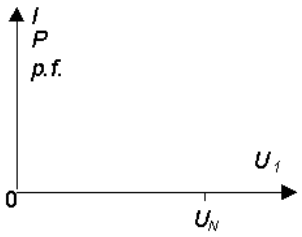
Beginning from $U_1 \approx U_N$, for about 10 values of supplying voltage from the range $(0;U_N)$, realize the following measurements:

ambient temperature t_a=.....^{o}C

No of read.	U_1	I_A	I_B	I_C	P_a	P_b	I_0	P_{10}	p.f.	I_{0w}	I_f	P_{Cu0}	P_{Fe}
	V	A	A	A	W	W	A	W	-	A	A	W	W
1													
2													
3													
...													

$$I_0 = \frac{I_A + I_B + I_C}{3}; \quad I_{0w} = I_0 \cos\varphi_0; \quad I_f = I_0 \sin\varphi_0; \quad P_{Cu0} = 3I_0^2 R_1; \quad P_{Fe} = P_{10} - P_{Cu0}$$

$$P_{10} = P_a + P_b; \quad \cos\varphi_0 = \frac{P_{10}}{\sqrt{3}U_1 I_0}$$



In common coordinates, at a single piece of drawing paper of 1/2 of A4 size, draw the following characteristics:

I_0, I_{0w}, I_f, , $P_{Fe} = f(U_1)$.

From the diagram, for rated voltage, determine the following parameters:

I_{0N}, , P_{FeN}, I_{0wN}, I_{fN}.

Calculate per-cent values of no-load current and iron loss for rated value of the voltage.

3. SHORT-CIRCUIT TEST

The transformer is supplied from the higher voltage side (Y). Its secondary winding is short-circuited at transformer's terminals. Measuring instruments are connected as in p. 2, but

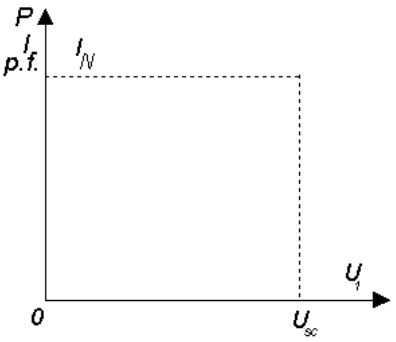
their ranges should be appropriately selected for the expected values of current and voltage during short-circuit test of the transformer.

Beginning from the possible minimum value of supplying voltage make readings for several values of the voltage from the range (min.U_1;U_{sc}):

ambient temperature t_a=.....°C

No of read.	U_1	I_A	I_B	I_C	P_a	P_b	I_{sc}	P_{sc}	p.f.
	V	A	A	A	W	W	A	W	-
1									
2									
3									
...									

$$I_{sc} = \frac{I_A + I_B + I_C}{3}; \quad P_{sc} = P_a + P_b; \quad \cos\varphi_{sc} = \frac{P_{sc}}{\sqrt{3}U_1 I_{sc}}$$



In common coordinates, at a single piece of drawing paper of 1/2 of A4 size, draw the following characteristics:

I_{sc} , P_{sc} , cosφsc = f(U_1)

From the diagram, for I=I_N determine:

U_{sc}; cosφsc; P_{scN}=P_{CuN}

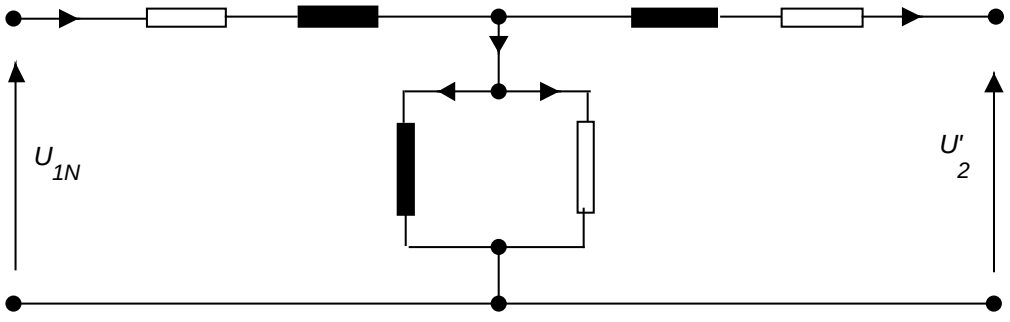
and then calculate:

$u_{sc\%}$; $P_{scN\%}$=$P_{CuN\%}$; Z_{sc} ; $Z_{sc\%}$; X_{sc} ; $X_{sc\%}$;R_{sc} ; $R_{sc\%}$.

From the results obtained calculate the value of short-circuit current at nominal voltage (in per unit)

$$I_{scNr} = \frac{I_{scN}}{I_N}$$

Having results of open-circuit and short-circuit tests as well as measured values of the resistances R_{hv} and R_{lv} determine the parameters of equivalent circuit of the transformer being tested. Draw the circuit scheme assuming the higher voltage side as primary. The currents shown at the diagram should correspond to nominal conditions of the supply and load.



Notice: Assume that the leakage fluxes of both sides' windings are equal each other, i.e. that X_{lhv}=X'_{llv}=1/2X_{sc}.

4. DETERMINATION OF TRANSFORMER`S CHARACTERISTICS FROM THE EQUIVALENT CIRCUIT

Using the MATLAB`s application „Trafo" calculate characteristics of the transformer. Apply the results of calculations in p. 3 (parameters of equivalent circuit) as input data to the "Trafo" program.

BIBLIOGRAPHY

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