Indian Institute of Technology Hyderabad (IITH)

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Experiment-2: Sumpner's (Back-to-Back) Test on 1-ϕ Transformer

1. Aim of this Experiment

An accurate estimation of transformer power loss is necessary to determine the maximum temperature rise in a transformer for various loading conditions. The required level of accuracy may not be achieved for the loss calculation based upon the equivalent circuit representation. On the other hand, a load test may not be feasible for a large transformer. The Sumpner's (also called as Back-to-Back) test is basically a useful way to accurately determine the power loss in a transformer.

2. Circuit Arrangement

The circuit arrangement for the Sumpner's test is shown in Figure 1. The items required here are two identical transformers, two single-phase AC wattmeters, two AC voltmeters and two AC ammeters. The HV sides of the transformers should be connected in parallel with same polarity, whereas the LV sides should be connected in series with inverse polarity. In order to determine the polarity of transformer windings, a polarity test should initially be performed. The circuit arrangement for the transformer polarity test is shown in Figure 2.

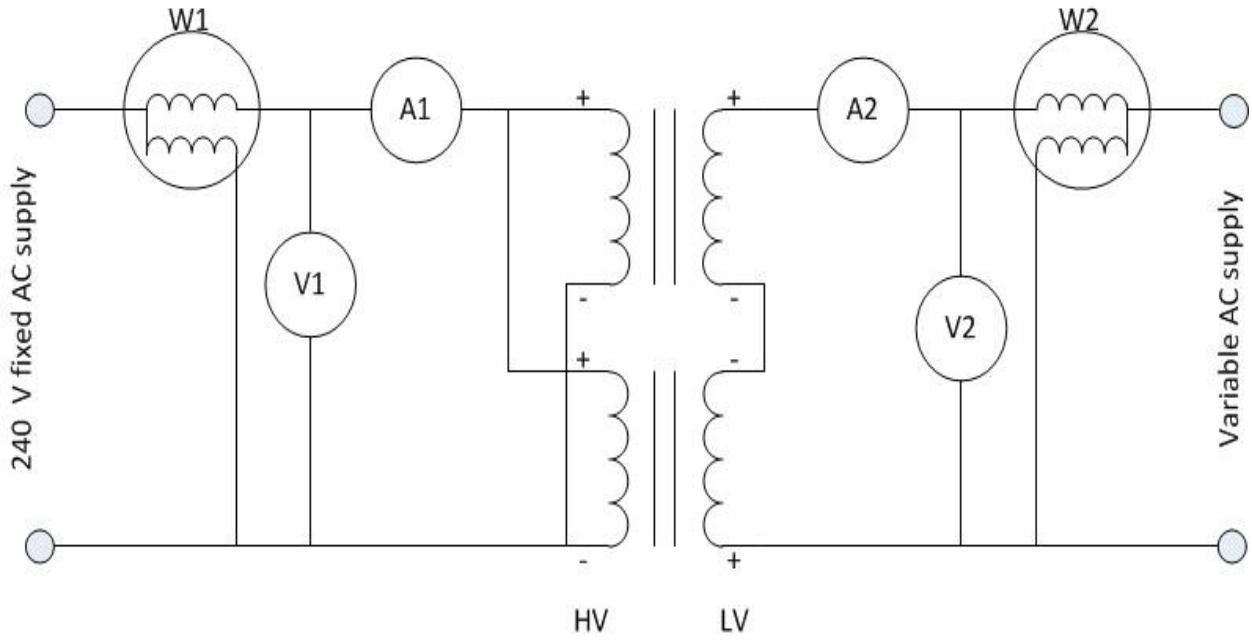

FIG. 1. CIRCUIT ARRANGEMENT FOR SUMPNER'S TEST

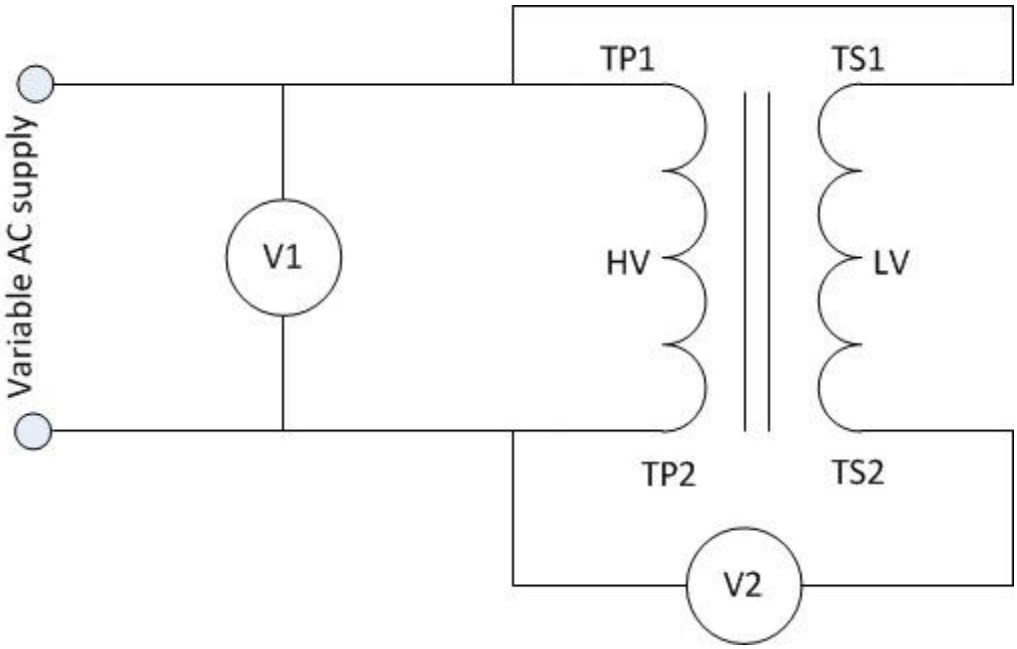

FIG. 2. CIRCUIT ARRANGEMENT FOR TRANSFORMER POLARITY TEST

3. Procedural Details

As mentioned previously, a polarity test should be performed before preparing the circuit arrangement for the Sumpner's test. To perform the polarity test, a voltage (not more than the rated voltage) should be applied across the HV side winding of the transformer and the readings of Voltmeter 1 and Voltmeter 2 are to be observed. In the case the reading of Voltmeter 2 is found to be lower than the reading of Voltmeter 1, terminals TP1 and TS1 (as well as TP2 and TS2) are of same polarity. Otherwise, terminals TP1 and TS2 (as well as TP2 and TS1) should be of same polarity.

For the Sumpner's test, establish $x\%$ of the rated current on the LV side by softly tuning the LV side input voltage. Note down all the meter readings. The copper loss in each of the transformers for a particular load current is given by half of the power measured Wattmeter 2. Similarly, the iron loss in each of the transformers is given by half of the power measured by Wattmeter 1. Observe the transformer losses for 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100% of the rated current. Compare the observed power losses with the power losses calculated from the equivalent circuit representation.

4. Results and Discussion

R (referred to the LV side) = G_i (referred to the HV side) =

HV side voltmeter reading	HV side ammeter reading	LV side voltmeter reading	LV side ammeter reading	HV side wattmeter reading	LV side wattmeter reading	Observed power loss in each transformer	Calculated power loss in each transformer

5. Conclusions

1 Comment on the inaccuracy of loss calculation by means of equivalent circuit representation (1st Experiment).
2 Calculate the efficiency & regulation at various loads. Compare the same with 1st Experiment at any one particular load value.
3 Comment on the usage of Sumpner's test as "Heat Run Test".
4 Plot the variation of
   a. Efficiency with load (load current or load kW)
   b. Regulation with load (load current or load kW)

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