SINGLE PHASE TRANSFORMERS

The purpose of this experiment is to determine the number of turns on the windings, the operating flux density, and the equivalent circuit of the Hampden 1.0 kVA transformer. The performance predicted by the model will also be investigated.

Procedure

1. **Make a visual inspection of the core and coil construction. Note how the iron core is assembled and how the windings are placed on the core.** Make a to scale sketch of it on your data sheet. Make sure you record the dimensions needed to compute the cross-sectional area of the core of the transformer.

2. **RATIO TEST and OPEN CIRCUIT TEST:** To perform the ratio test and open-circuit test on the transformer, construct the circuit shown in figure 1. Use shorting bars to connect X1 to X4 and X3 to X6, connecting the two windings in parallel and giving a 1.0 kVA, 208/120 volt rating. Also supply the "A" circuit with 120/208 3-phase power, even though we will only be using one phase. The test will be performed with the 208 volt winding energized and for the open circuit test, all instrument readings will be "referred" to the 208 volt side. Set the TekMeter up to measure current with the current probe on 100 mV/A, use the Simpson for measuring input voltage, and the Powermeter for measuring input power. All output quantities will be measured with the Electro-Industries meter. These are $V_{ab}$, $I_a$, and $P$. After the instructor approves your circuit:

   Turn the variac down to zero output, then energize the circuit by turning on the power pedestal, the variac circuit breaker, and the input switch $S_s$. All other switches should be open and all instruments should be turned on. Gradually increase the variac output until rated voltage (208 volts) is applied to H1-H4. Record the open-circuit input voltage, current, and power. Then record the output voltage, and CAREFULLY, one at a time, transfer the leads of the Simpson from the input to the test coil. Reduce the meter range to 200 volts and record the test coil voltage. Turn the variac back down to zero and open $S_s$. Return the leads of the Simpson back to their original position, but leave the meter on the 200 volt range.

3. **SHORT CIRCUIT TEST:** With the circuit unchanged, add a shorting bar that connects X4 to X3, which shorts the output.

   After the instructor approves your circuit:

   Turn the variac down to near-zero output, then energize the circuit. Gradually increase the variac output carefully watching the current on the TekMeter, until approximately rated current (4.81 amperes) flows in H1-H4. **Note!** Only a small voltage will be required to drive rated load current when the transformer is short circuited. Record the short-circuit input voltage, current, and power.

   Turn the variac back down to zero and open $S_s$. Remove the shorting bar between X4 and X3. Change the Simpson voltmeter range to 600 volts.

   We now have the data to construct the equivalent circuit of the transformer. To test the accuracy of the equivalent circuit, we will perform a load test and compare predicted to measured performance.

4. **UNITY POWER FACTOR LOAD TEST:** Close the switch $S_L$ and set the load cart to 1050 watts, which is the smallest value we can achieve above rated.

   a. Close Switch $S_s$ to energize the circuit, and adjust the variac to produce rated OUTPUT voltage on the transformer. (120 volts). Record the input power, voltage, and current; record the output power, voltage and current.

   b. Remove the load by opening switch $S_L$. Readjust the variac to produce the same input voltage as in 5a. Record the input and output transformer voltages.
1. From the data collected in parts 1 and 2, determine the number of series turns on the primary and secondary windings and the maximum flux density in the transformer at rated voltage.

2. From the data of parts 2 and 3, determine the approximate equivalent circuits of the transformer referred to both the 208 volt and 120 volt windings.

3. From the data of part 4, determine the experimental unity power factor load efficiency and voltage regulation.

4. Using the equivalent circuit, calculate the voltage regulation and efficiency for the unity power factor load. Use the load of part 4 of the lab procedure for full-load of the transformer. Compare this to the experimental value of 3 above.
Figure 1. Circuit Diagram for Single-Phase Transformer Test.