Transformers under Open and Short Circuit

1 Aim of the Experiment

The aim of this experiment is to determine the equivalent circuit of a single phase transformer, study the inrush current transients and the form of the BH-Loop.

2 Background

The open circuit and short circuit tests are conducted on a transformer to determine its equivalent circuit parameters. The determination of the equivalent circuit is essential to the determination of the performance of the transformer in a variety of circuits. The open circuit test is used to determine the magnetizing branch values — the core loss and the magnetizing inductance. The short circuit test is used to determine the winding resistance and inductances. The approximate equivalent circuit of the transformer is considered for this purpose. The equivalent circuit is then used for making performance estimates about the equipment.

When a transformer is installed in the field, it has to be connected to the input lines, obviously. It has to be energized with full voltage in one single step. One part of this experiement is to study the current transient that arises at the primary when such an energization is done.

The BH loop of the iron material represents the loss due to hysteresis. A further step in the experiment is to determine this loop approximately.

3 Procedure

3.1 Open Circuit test

The open circuit test is done by exciting the transformer from one side (generally low voltage side), while leaving the other side (generally high voltage) open. The procedure to do the experiment is mentioned below.

Make the appropriate circuit connections and get them checked before energizing any portion. This is to be done in two stages – connect the series circuits first (no voltage measurement circuits first, and then the voltage measurement circuits. The circuit has to be checked at each of these stages.

S.No.	Input Voltage (BNC no.)	Input Current (BNC no.)	Input Power (BNC no.)

Table 1: Open Circuit Test

The test has to be done by varying the input ac voltage from 0 to 1.1 times the rated value. Note down the required measurements at various voltages – at least 10 readings. Remember that LabView has to be set up to take one set of readings at every button press.

The various measurements to be noted down are shown in Table 1.

3.2 Short Circuit Test

The short circuit test is done by shorting the terminals of one side (low voltage side, typically), and exciting the transformer from the other side (high voltage side). The procedure to do the test is mentioned below.

Once the connections have been checked, apply suitable voltage at the exciting end such that rated current (of that side) flows. The input voltage, current and power at the exciting end are to be noted.

3.3 The BH loop

The voltage applied to the input side (when secondary is open) is approximately equal to the induced emf which is related to the flux density in the core (how?). Obtain a representation of the time variation of flux density in the core by suitable signal manipualtions of the applied voltage.

The current flowing in the primary is a representation of the magnetizing field intensity H in the core (why?).

Plot these two quantities (against each other as an x-y plot) to obtain a graph similar to the BH loop. You would have to capture exactly one cycle of data to get one BH

loop.

3.4 Inrush Current

In order to record this phenomenon, the primary alone needs to be connected. Arrange the cicuit so that upon the operation of a switch, rated voltage is applied to the transformer. Both current and voltage need to be measured.

The DAQ card needs to be set up for continuous measurement and writing to a file. Start the vi first, then switch on the voltage to the transformer. Once the current is seen to have settled down in the graph display, stop the vi.

4 Calculations

The test readings under open circuit can be used to determine the magnetizing branch parameters. Since the secondary is open, the effective circuit under operation may be considered to be just the magnetizing branch across the voltage supply. Use the various measurements to inductance to estimate the core loss resistance and the magnetizing inductance at each value of voltage noted.

The test readings under short circuit can be used to determine the winding parameters, viz., the leakage inductances and resistances of the equivalent circuit. Since the applied voltage would have been low, the magnetizing branch currents (and therefore the branch in the equivalent circuit) can be neglected. The currents that have been measured during the test can therefore be assumed to be the current passing through the winding elements of the equivalent circuit. It is common to assume that the winding resistance and leakage inductance of each winding referred to a common side are equal.

What are the factors that must be known in order to convert the "BH loop" to one that really represents B and H?

Plot the inrush current in excel. What is the magnitude of the first peak? How long does it take for the transients to die down? What is the peak of the input current under steady state?

All computations and readings recorded in the computer through LabView must be shown to the TAs for evaluation.

5 Report

In an A4 sheet, write down your name and roll no at the top right corner. Record your readings during OC and SC test. Further, draw the equivalent circuit of the transformer and mark the values of various elements determined. The BH loop obtained should also be plotted with reasonable accuracy. Mention the salient features of the inrush current waveform. Neatness of the report is important.