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The Importance of Demagnetizing the Transformer Core

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Why is it important to demagnetize a transformer's core?

"Residual magnetism" is the magnetic flux left behind in ferromagnetic material after an external magnetic field is removed. In a transformer, windings are wound onto the iron core (or magnetic core), to provide a flux path for the voltage induction process. The DC winding resistance test is a very common electrical test that is performed on transformers. During this test, the DC current forces the magnetic dipole moments in the core material to align in one direction, leaving the core magnetized.

Whenever a power or distribution transformer is isolated from the power system, it is possible that some magnetism could be retained by the core (called residual magnetism) due to the phase shift. After conducting a DC winding resistance measurement (for which the core has to be saturated), the transformer core usually retains high levels of residual magnetism. This is also one of the main reasons that DC winding resistance tests are performed after all of the other AC tests have been completed.

1. Effects of residual magnetism

Residual magnetism can lead to very high inrush currents, which place an unnecessary load on the transformer. When a transformer is re-energized, an inrush current occurs that can greatly exceed the nominal current. If the transformer core still contains residual magnetism, the first peak current can even reach the level of the short-circuit current. These high currents can cause undesirable effects, such as mechanical deformation in the windings, faulty triggering in the protection equipment, increased stress on the insulation, etc. If the core is nearly saturated, the transformer's inductance is greatly reduced. The current is now only limited by the winding resistance on the high-voltage side and the impedance of the transmission line that is connected to it.

There are a few routine tests, such as Excitation Current, Magnetic Balance (also referred to as the Core Balance test) or Sweep Frequency Response Analysis (SFRA), that are typically performed as on-site condition assessments for transformers. The results of these tests can be influenced by the effect of residual magnetism, meaning that proper evaluation and assessment could become challenging.

Therefore, it is recommended that the transformer is demagnetized before re-energizing it or performing diagnostic measurements.

2. How to demagnetize

Demagnetization can be done by applying the rated voltage at rated frequency, or a reduced voltage at reduced frequency can be used as an alternative. In the factory, manufacturers can apply nominal voltage at nominal frequency to transformers. By gradually reducing the voltage, the core is being progressively demagnetized (Figure 1). Using reduced voltage and frequency signals is often the only way to demagnetize transformer cores on-site.

OMICRON's TESTRANO 600 and CPC 100 can easily demagnetize transformer cores in a few minutes. This even applies to large power transformers. For example, a 250MVA, 400kV, three-phase transformer was demagnetized in 4 minutes.

Single-phase and three-phase transformers can be demagnetized in a similar way. TESTRANO 600 injects a signal into the center limb of the transformer in order to achieve a higher level of magnetic flux (flux is distributed symmetrically to the two outer limbs). The amplitude is then gradually reduced and brought down closer to zero.

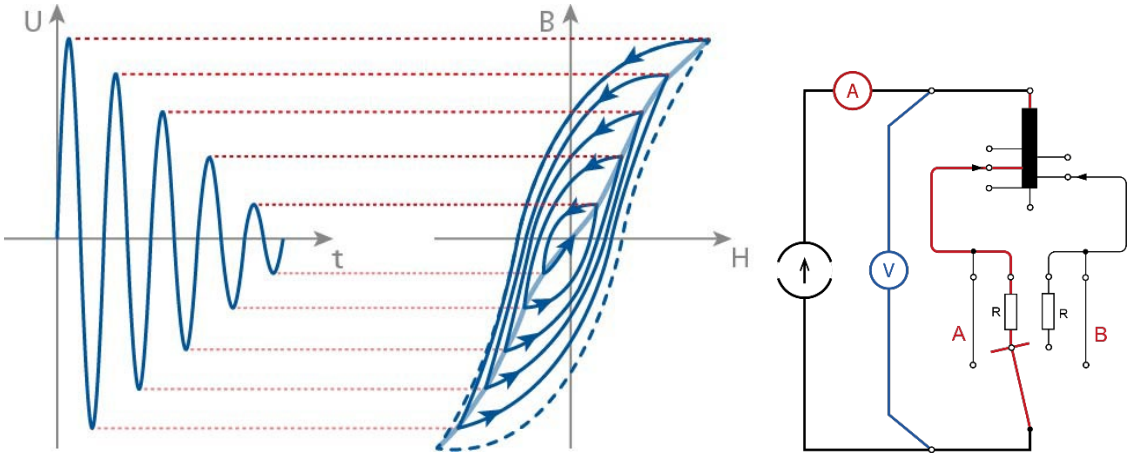

Figure 1: Demagnetizing the transformer core with sinusoidal signal

The process is the same when connecting TESTRANO 600 to the transformer for Turns Ratio, Winding Resistance and Demagnetization tests without having to re-wire anything. See the typical connection set-up below.

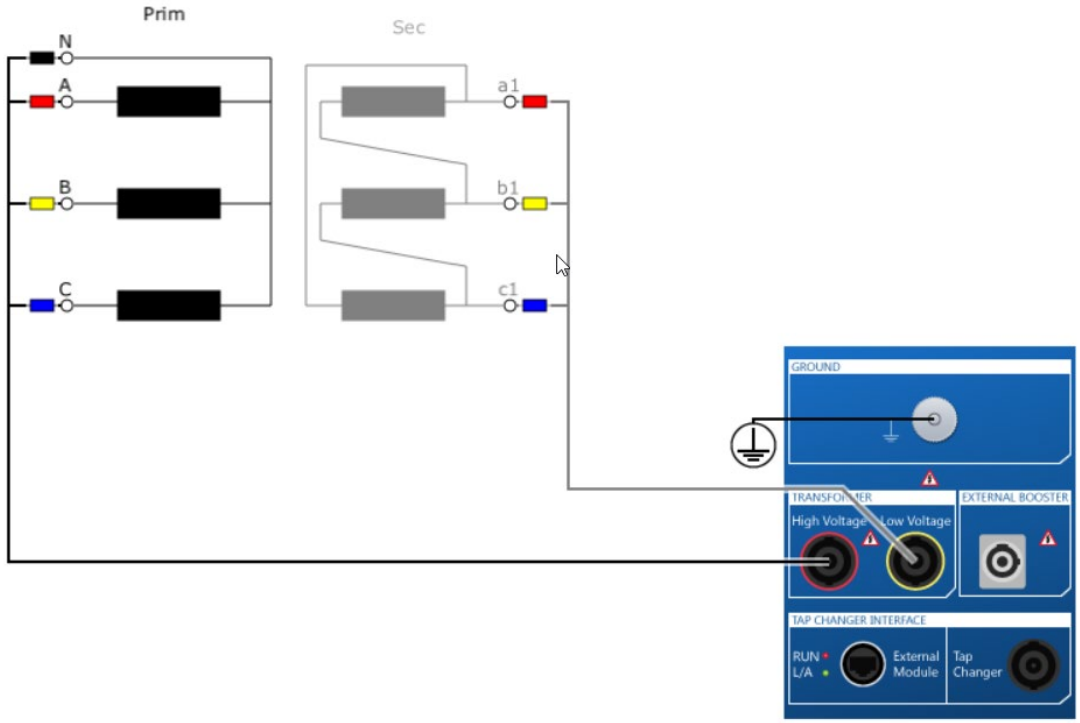

Figure 2: Typical connection set-up for a Star-Delta transformer using TESTRANO 600

The test set typically takes a few minutes to demagnetize the transformer core. The “Initial value” of residual magnetism and the remanence are displayed “after demagnetization has been completed”.

Summary

A few diagnostic tests like SFRA and Excitation Current measurements can be affected if the core is not completely demagnetized. This is why performing these tests at the outset and performing the winding resistance test at the end is the general practice.

However, residual magnetism that is typically left in the core after a DC Winding Resistance measurement, can lead to very high inrush currents. This may cause protective relays to trigger incorrectly.

This is why it’s very important to demagnetize the core before re-energizing the transformer after all of the tests have been performed.

References:

[1] ”Reliable Demagnetization of Transformer Cores” (Markus Putter, Michael Radler and Boris Unterrer, OMICRON electronics GmbH)

Authors

Sridhar Shenoy has been associated with OMICRON India for nearly 15 years as an Application engineer. He has more than 24 years of experience in field testing High Voltage electrical equipment and he specializes in Power Transformer diagnosis.

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