STUDY OF THE INFLUENCE OF THE MANUFACTURING PROCESS ON THE MAGNETIC BEHAVIOUR IN TOROIDAL TRANSFORMERS

By
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Abstract

Toroidal transformers are manufactured by winding the core material in the form of a continuous strip, to take full advantage by making the direction of preferred orientation coincide with the flux path. However, the manufacturing process influences the magnetic behaviour and affects the quality; quite often leading to a rise in excitation current compared to the design excitation current.

In the study, the factors influencing the magnetic behavior in Toroidal transformers are identified and analyzed. The main factors identified are the "Ratio of drum diameter to toroid inner diameter", "Core lathing", "Stress relief annealing" and "Winding pressure" The factor *"Ratio of drum diameter to toroid inner diameter"* is to study the effect of change of steel drum diameter when making identical toroidal cores to their excitation currents and the *"Core lathing"* is to study the effect of sharpe edge removing by machining to the excitation current while the factor "Stress relief annealing" is to study the effect of oven type to the excitation current and the "Winding pressure" is to study the effect of different steel brands and winding sequence to excitation current.

In order to study the above factors, the sample batch experiments are carried out from the customer orders in a way that production plan is *not* disturbed. The excitation currents and other related measurements are noted down for the analysis which is performed with the help of MS-EXCEL. The statistical graphical method; a box-plot is used to interpret some variations and comparisons.

It is noticed that the excitation currents are high in the initial cores made from a new steel drum and thereby excitation currents are getting reduced. This shows that core making process induces of more irreversible stresses due to plastic deformation at initial cores made from a new steel drum than the later cores. It is also noticed that the excitation currents are increased after machining (core lathing) process. The conclusion is that short circuited steel strips at the lath (or curved) edges cause the

increase of eddy currents and thereby increase of excitation current. Further the high excitation currents are observed in the cores which are annealed in the belt oven which is having forced cooling and they are more sensitive to the winding tightness too. The more consistent excitation currents are observed in the box oven when it compares with the belt ovens. The conclusion is that the cores are re-stressed due to *the* rapid cooling and thereby increase the excitation current.

Finally, it is noticed that excitation currents are increased after conductor winding and the *level* of increase depends on *the steel* brand. Further, the increase of excitation current is more after the first winding on the core. The conclusion is that pressure exerted by conductor winding stresses the core and thereby increases the excitation current. The first winding on the core is dominant in inducing stresses.

Finding the reason for abnormal rise in excitation current (core testing and random test after primary for excitation current are passed *but* final testing for excitation current is failed) and developing a commonly (design, production and quality) acceptable spreadsheet to determine the excitation current are prerequisites to evaluate the governing factors.

Therefore, the abnormal rise in excitation current in the final testing bench is studied and *the* conclusion is that it is caused by the unbalanced turns in the multithread secondary. The decision support system (to perform extra test or not) for engineers is incorporated in the excitation current calculation spreadsheet, which is developed as part of this study. The excitation current calculation spreadsheet is superior to other tools that are used to determine the excitation current as it considers the magnetic field strength at design flux density, resistive part of the excitation current and corrected mean magnetic path length. Later it is extended to generate production testing instruction sheets too.

Declaration

To the best of my knowledge and belief, the work included in this thesis in part or in whole has not been submitted for any other academic qualification at any institution.

Signed by;

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