2-D Static Magnetic Simulation of Flux Density Distribution in Transformer Cores by ANSYS

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The hole in transformer core sheets is a necessity to tailor the core design without serious deterioration in the magnetic properties. With using spark eroding, specimens were pierced as a circle-shape at certain locations and diameters to compare their effects on magnetic properties by means of hysteresis curves and finite element method (FEM). Herewith we made an attempt to simulate the effect of microstructural deformation to the flux density distribution as well as power losses by means of ANSYS Multiphysics pack, electromagnetic section. In this simulation and FEM studies, we have chosen more convenient 2-D magnetic solid model with 8-Nodes, namely PLANE53. It models two-dimensional axisymmetric magnetic fields, flux density, magnetic force and energy distribution. The element is defined by component of the magnetic vector potential (AZ), time-integrated electric scalar potential (VOLT), electric current (CURR), and electromotive force (EMF). PLANE53 is based on the magnetic vector potential formulation and is applicable to the following low-frequency magnetic field analyses: magnetostatics, eddy currents, voltage forced magnetic fields (static and AC time harmonic) and electromagnetic-circuit coupled. The element has also nonlinear magnetic capability for modeling B-H curves and related magnetic properties. Coil cross-sectional area, total number of coil turns and length in the z-direction with its fill factor were able to be input the system to generate sharper flux density throughout the ferromagnetic media.

Regular piercing in the middle and at the corners of sheets lead to a drop of maximum permeability in the range of 20% - 70% with respect to non-pierced sample. Additionally, significant increment in the power losses was able to measure by 0,8 W/kg to 2,54 W/kg depending upon increasing hole diameter. Furthermore, for all possible scenarios based on the hole diameter and location, sheets were also simulated in terms of distributions of flux lines, flux density, nodal magnetic forces and magnetic energy by using of 2-D static magnetic analysis. Certain region was also observed by Magneto-optical Kerr microscopy. The diagrams from simulation results and Kerr images were properly compared to be sure how flux distribution is influenced by the physical properties of a hole.

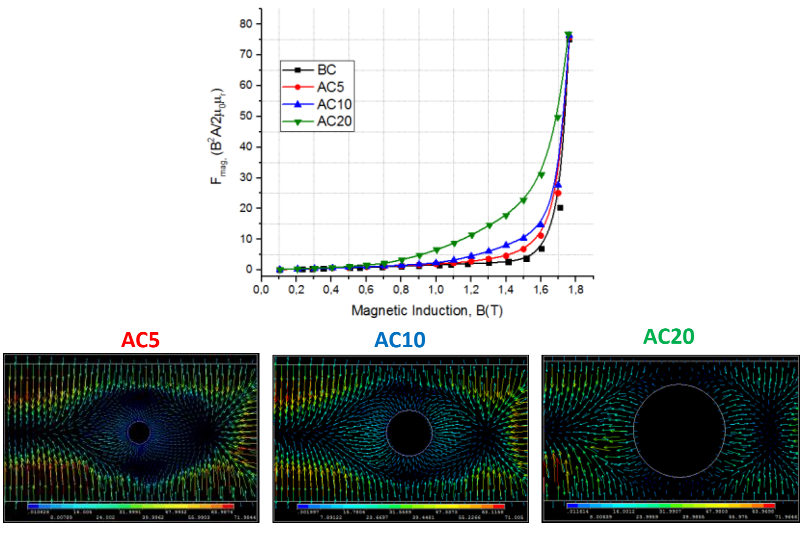

Figure 1. Magnetic Force Distributions (Fmag) in the vicinity of hole (5-, 10-, 20-mm diameter).