Abstract

This work extends and contributes to the current understanding of the dynamic short circuit forces in power transformers. A transient, three-dimensional coupled magneto-mechanical finite-element method model of the transformer windings is developed to describe and accurately predict the dynamic magnetic and mechanical behaviour of transformer windings under short circuit conditions that previously described methods. The work explores the interactions between two physics in great details in regard to the short circuit withstand capability of power transformers. Specifically, the interactive dynamic effects that have not been previously described or calculated. Previously unknown interactions and mechanisms of mechanical stress generation are described and quantified. The model demonstrates that due to the interactions between the magnetic and mechanical domains, the areas of the transformer windings where the Lorentz forces density is the highest, are not the only areas with the highest mechanical stress in a winding. In fact, the transient mechanical reaction of each individual winding to the Lorentz forces creates reactive mechanical forces which in certain areas of the winding geometry satisfy the superposition principle and results in higher forces and stresses than previously calculated. The results of this thesis have significant design implications for short-circuit proof design of power transformers.

***Keywords* —transformer, FEM, short circuit, multiphysics**