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50Hz to 60Hz Conversion Factors for Transformer Performance Parameters

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1. Abstract

This session presents the method of development and verification of appropriate frequency conversion factors for no load loss, exciting current, load loss, and noise level of transformers. These factors are needed in order to allow manufacturers to convert measured values from 50Hz to 60Hz and vice versa. Conversion factors are necessary when equipment at a manufacturer's test facility allows direct measurement at one frequency and not the other. These factors are developed using both analytical and actual tested data. Measured data, provided by several manufacturers, was used to confirm the theoretical results. This will be a basis for proposing standard frequency conversion factors in the IEEE test standards for Power and Distribution Transformers. Such a standard will make it possible for manufacturers to use the same frequency conversion factors and hence have a more uniform accuracy of the reported test data at both 50 and 60Hz.

2. Learning Objectives

The presentation will show the development of frequency conversion factors using analytical methods confirmed by measurement for the following items:

- No load loss - Developed using material loss models and magnetic building factor calculations.
- Exciting Current - The exciting force of the material is used to determine the effect of the frequency.
- Load Loss - Finite Element Modeling is used to determine the stray loss in the different structural parts of the transformer and the effect that tank wall shielding has on the flux distribution and hence, on the different components of stray losses.
- Sound Level - Measured data and the impact of items such as core mechanical resonance will be shown.

3. Learning Outcomes

The outcome of the presentation will be an understanding of the effect that the operating power frequency has on no load loss, exciting current, load loss and sound level of power and distribution transformers. There will also be a better knowledge of the analytical tools & methods that can be used to characterize these performance parameters.

4. Presenter's Biographies

Ramis Girgis: Dr. Ramsis S. Girgis (F'93) is presently Manager of the Development Engineering Department in the Power Transformer Division of ABB Power T&D Company located in St. Louis, Missouri, USA. He is also the leader of the global ABB R&D activities in the transformer core performance area. Ramsis received his Ph.D. degree from the University of Saskatchewan, Canada, in Electrical Power Engineering in 1978. Dr. Girgis has over 35 years of R&D experience in the area of power, distribution, and high frequency transformers, rotating machines, and pulsepower components. His main areas of interest are electro-magnetics and noise of electric power equipment. He has published and presented over 60 scientific papers in IEEE, IEE, CIGRE, and other international journals. He is a member of several working groups and subcommittees in the IEEE/PES Transformers Committee and is presently Chairman of the Subcommittee on Performance Characteristics within that organization. He has co-authored chapters in two electrical engineering handbooks on transformer design and transformer noise. He is the past Technical Advisor representing the US National Committee in the IEC Power Transformer Technical Committee 14.

Ed teNyenhuis: Ed G. teNyenhuis (M'97) was born in Barrie, Canada in 1966. Ed received his B.A. Sc. degree from the University of Waterloo, Canada, in 1990 and his M. Eng. degree from North Carolina State University, USA, in 2000; all in electrical engineering. Ed has worked in the power transformer industry for 10 years and is presently a Senior Development Engineer at ABB Transformers in Guelph, Canada. His past experience includes positions at ABB Power Transformers Division in Ludvika, Sweden and ABB Electrical Systems Technology Institute in Raleigh, North Carolina, USA. Ed has published several technical papers in IEEE, SMM and 2DM pertaining to power transformers, magnetics, and electrical steel. He presently chairs the Working Group on Loss Measurement and Tolerances of power and distribution transformers within the IEEE/PES Transformers Committee.