IEEE/PES Transformers Committee
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"Electrical Steel and Core Performance"

-- Technical Presentation --
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1. Abstract

A number of performance parameters of power and distribution transformers are determined by the magnetic, surface, and mechanical parameters of the electrical steel used in the core of these transformers. This tutorial has three parts. First, the process of manufacturing the different grades of grain – oriented electrical steel will be explained. This will be followed by a presentation of the parameters of electrical steel that determines the core loss, exciting current, noise level, and other performance parameters of power and distribution transformers. This part of the tutorial will also include quality requirements of electrical steel that are critical to transformers. Finally, the history of development of electrical steel will be presented along with an overview of possible future directions of new developments for improved performance electrical steels in transformers.

2. Learning Objectives

This tutorial is planned to:

- Provide background to what performance parameters of electrical steel influence performance of power and distribution transformers
- Explain the process of manufacturing the different grades of grain-oriented electrical steel
- Explain the measurements made on electrical steel before it is shipped to transformer plants
- Explain the relationship between performance parameters of electrical Steel and performance of transformers
- Explain quality requirements of electrical steel that are critical to transformers
- Present the history of development of electrical steel
- Give an overview of possible future directions of new developments for improved performance electrical steels in transformers

3. Learning Outcomes

As a result of attending this tutorial session, members will gain an understanding of the following:

- What performance parameters of electrical steel influence performance of power and distribution transformers
- The process of manufacturing the different grades of grain-oriented electrical steel
- Measurements made on electrical steel before it is shipped to transformer plants
- Relationship between performance parameters of electrical Steel and performance of transformers

- Quality requirements of electrical steel that are critical to transformers
- History of development of electrical steel
- Possible future directions of new developments for improved performance electrical steels in transformers

4. Presenters' Biographies

Dr. Ramsis Girgis: Ramsis is the R&D Manager at the ABB Power Transformer Division, St. Louis, Missouri. He is also the leader of the ABB's global R&D activities in the area of "Transformer Core Performance" and the co-leader of the global R&D activities in the area of "Transformer Noise & Vibrations". Most recently, he has been the project leader for developing the ABB technology for designing, manufacturing, and noise testing of ultra-low noise power transformers. Ramsis received his Ph.D. degree from the University of Saskatchewan, Canada, in Electrical Power Engineering in 1978. He has over 40 years of R&D experience in the area of power, distribution, pulse power, high-frequency transformers, and rotating machines. He has published and presented over 70 scientific papers in IEEE, IEE, CIGRE, and other international journals. He was awarded the IEEE Fellow Grade in 1986. Until recently, he was the Chairman of the Transformers Committee's Subcommittee on "Performance Characteristics". Dr. Girgis 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).

Dr. Michael Hastenrath: Michael is Head of Customer Service of ThyssenKrupp Electrical Steel in Gelsenkirchen, Germany. He is responsible for the technical support of customers in using grain-oriented electrical steel in transformers and other electromagnetic devices. Michael joined the company in 1982 starting in the R&D department, where he worked in different projects on development of electrical steel in thinner gauges, domain-refinement by laser scribing and improvement of insulation properties. In 1991, he became Head of the quality department of Gelsenkirchen plant until 2001, when he changed to Customer Service. Michael had studied physics at the Technical University of Aachen, Germany, where he graduated in 1976 in solid state physics. In 1981, he received his Ph.D. with a thesis on micro characterization of materials for electrical engineering at the University of Duisburg, Germany. Dr. Hastenrath has published several technical papers mainly related to grain-oriented electrical steel.

J. W. Schoen: Jerry is a Principal Engineer in the Specialty Product Research & Applications Engineering Department at AK Steel's Research Center in Middletown, OH. He has over 30 years of experience in product R&D, engineering and applications working exclusively in electrical steels, primarily in grain-oriented types and, secondarily, non-grain oriented types. From 2000 to 2003, he was assigned to the Business Development department at AK Steel's headquarters. Prior to 2000, Jerry was a Principal Research Engineer, during which time he contributed to over 20 U.S. patents in the field of electrical steel, as well as a number of technical papers. Jerry received his BS degree (1977) in Metallurgical Engineering from the University of Pittsburgh, Pittsburgh, PA, the M.Sc. degree (1987) in Materials Science & Engineering from the University of Cincinnati, OH and is a member of ASM & AIST. In 1988, Jerry received the AIST's John Chipman medal for his technical publication on research into the physical mechanism of abnormal grain growth in silicon steels.