energies

MDPI

Editorial

A Special Issue: Electric Machinery and Transformers

Huseyin R. Hiziroglu

Department of Electrical & Computer Engineering, Kettering University, Flint, MI 48504, USA; hhizirog@kettering.edu

As the demand for electrical energy increases worldwide, engineers and scientists have been investigating new electrical systems and materials to meet this demand economically, having large-scale planning and employing environmentally friendly energy production and energy-efficient systems for consumption to minimize adverse environmental effects. New applications such as renewable energy production, e-mobility, and aerospace technology can be considered within the scope of this perspective. Thus, it is a necessity to establish new paradigms in the design, construction, and selection of new materials and drive systems for electric machines and transformers, where such stringent requirements, as high power density, low weight, compact size, and low cost, should be complied with. Therefore, the objective of this Special Issue is to facilitate a platform for disseminating new findings on any aspect of electric machines and transformers with certain topics of interest, including new materials used in electric machines and transformers, investigations of the performance of electric machines and transformers at dynamic state as well as at steady state, and acoustic analyses of electric machines as well as transformers due to vibrations. In this Special Issue, 11 articles address these subjects of interest.

The Special Issue starts with an article entitled, "FRA Diagnostics Measurement of Winding Deformation in Model Single-Phase Trans-formers Made with Silicon-Steel, Amorphous and Nanocrystalline Magnetic Cores" authored by Maciej Kuniewski [1]. One of the outcomes of this study is that replacing conventional silicon steel with thinner highly permeable magnetic materials can modify the guidelines to interpret the state-of-the-art frequency response analysis (FRA) in single-phase transformers.

The second article is entitled "Performance Assessment of Oil-Immersed Cellulose Insulator Materials Using Time–Domain Spectroscopy under Varying Temperature and Humidity Conditions", authored by Benhui Lai, Shichang Yang, Heng Zhang, Yiyi Zhang, Xianhao Fan, and Jiefeng Liu [2]. In this article, the authors propose a temperature conversion method based on a polarization time-varying current (PTC). One of the conclusions of this study is that the proposed method can be efficiently used in evaluating the aging or the assessment of moisture in cellulose-based insulation immersed in liquid insulating materials in power transformers.

The third article is entitled "On Simplified Calculations of Leakage Inductances of Power Transformers", authored by Tadeusz Sobczyk and Marcin Jaraczewski [3]. The authors present a method that allows the user to find simple formulas for self- and mutual-leakage inductances for an arbitrary pair of windings.

The fourth article is entitled "Effective Simulation Approach for Lightning Impulse Voltage Tests of Reactor and Transformer Windings", authored by Piyapon Tuethong, Peerawut Yutthagowith, and Anantawat Kunakorn [4]. In this article, an effective simulation method is proposed for predicting the behavior of reactor and transformer windings when subjected to lightning impulse voltage. This problem has been a serious issue, especially in transformer windings. Most of the time, the problem is solved using *ad hoc* techniques by the manufacturers. The proposed method in this article could add another brick for a more rigorous approach to this problem.

The fifth article is entitled "Overvoltage Impact on Internal Insulation Systems of Transformers in Electrical Networks with Vacuum Circuit Breakers", authored by Marek

Citation: Hiziroglu, H.R. A Special Issue: Electric Machinery and Transformers. *Energies* **2023**, *16*, 5707. https://doi.org/10.3390/en16155707

Received: 22 December 2022
Accepted: 18 July 2023
Published: 31 July 2023

Florkowski, Jakub Furgał, Maciej Kuniewski, and Piotr Pająk [5]. Vacuum circuit breakers may cause overvoltages in distribution transformers when interrupting a current. In this article, the authors present the analysis of the switching overvoltages measured at the transformer terminals and inside the windings using an experimental system at medium voltage integrated with a vacuum circuit breaker.

The sixth article is entitled "Influence of Molecule Structure on Lightning Impulse Breakdown of Ester Liquids", authored by Huaqiang Li, Linfeng Xia, Shengwei Cai, Zhiqiang Huang, Jiaqi Li, and Lisheng Zhong [6]. Mineral oil is one of the most important insulating materials that is used in a wide variety of transformers for electrical insulation as well as for cooling. Management of mineral oil is critical due to its environmental issues. Ester oil, on the other hand, is a more environmentally friendly oil. Thus, there could be a potential to replace mineral oil with ester oil in transformers. In this article, the authors experimentally investigate the breakdown behavior of ester oil when subjected to lightning impulse voltages.

The seventh article is entitled "Analysis and Pareto Frontier Based Tradeoff Design of an Integrated Magnetic Structure for a CLLC Resonant Converter", authored by Gang Wang, Qiyu Hu, Chunyu Xu, Bin Zhao, and Xiaobao Su [7]. Bidirectional dc–dc converters have a wide variety of applications, from uninterrupted power supplies (UPS) to electric vehicles, energy storage systems, and smart grid power systems. In this article, the authors propose an integrated magnetic structure for a CLLC resonant converter in conjunction with a Pareto optimization procedure to achieve both high efficiency and high power density in the operation.

The eighth article is entitled "Magneto-Thermo-Structural Analysis of Power Transformers under Inrush and Short Circuit Conditions", authored by Antonio Roniel Marques de Sousa, Marcus Vinicius Alves Nunes, Wellington da Silva Fonseca, Ramon Cristian Fernandes Araujo, and Diorge de Souza Lima [8]. The authors present a study of electromagnetic, thermal, and structural analysis of power transformers to provide the operator with information on the ideal moment to perform predictive maintenance to avoid unplanned shutdowns.

The ninth article is entitled "High-Frequency Modeling of a Three-Winding Power Transformer Using Sweep Frequency Response Analysis", authored by Yeunggurl Yoon, Yongju Son, Jintae Cho, SuHyeong Jang, Young-Geun Kim, and Sungyun Choi [9]. In this article, actual single-phase, three-winding transformer model parameters have been estimated based on field sweep frequency response analysis (SFRA) data, showing that SFRA curves simulated from the estimated model are consistent with the measured data.

The tenth article is entitled "Evaluation of Methodology for Lightning Impulse Voltage Distribution Over High-Voltage Windings of Inductive Voltage Transformers", authored by Bojan Trkulja, Ana Drandić, Viktor Milardić, and Igor Žiger [10]. The authors present a complete methodology for the lightning impulse (LI) voltage distribution of inductive voltage transformers, which can be used by engineers for a transformer winding insulation design based on the lumped parameter approach and made more efficient with the implementation of the adaptive cross-approximation (ACA) algorithm.

The eleventh article is entitled "Acoustic Signature Analysis and Sound Source Localization for a Three-Phase AC Induction Motor", authored by Anand Krishnasarma, Seyed Jamaleddin Mostafavi Yazdi, Allan Taylor, Daniel Ludwigsen, and Javad Baqersad [11]. With the development of new technologies and materials, the internal combustion engine (ICE) has been replaced by an electric motor in e-mobility. The transition to an electrified drivetrain poses new challenges due to noise, vibration, and harshness (NVH) related to electric motors. In this paper, the authors investigate the acoustic signature of an electric motor to better understand the sound generated by these motors.

Many of the topics presented in this Special Issue have been the problems for practicing engineers, and we hope that the authors have contributed to solving some of these problems by proposing new methods for performance predictions, new materials for size reduction and improved efficiency, and new materials to minimize environmental pollution.

Finally, we would like to thank the many volunteer reviewers who thoroughly evaluated each article before a final decision was made. Without the efforts of these expert volunteer reviewers, it would have been very difficult to complete this Special Issue.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Kuniewski, M. FRA Diagnostics Measurement of Winding Deformation in Model Single-Phase Transformers Made with Silicon-Steel, Amorphous and Nanocrystalline Magnetic Cores. *Energies* **2020**, *13*, 2424. [CrossRef]
2. Lai, L.; Yang, S.; Zhang, H.; Zhang, Y.; Fan, X.; Liu, J. Performance Assessment of Oil-Immersed Cellulose Insulator Materials Using Time–Domain Spectroscopy under Varying Temperature and Humidity Conditions. *Energies* **2020**, *13*, 4426. [CrossRef]
3. Sobczyk, T.; Jaraczewski, M. On Simplified Calculations of Leakage Inductances of Power Transformers. *Energies* **2020**, *13*, 4952. [CrossRef]
4. Tuethong, P.; Yutthagowith, P.; Kunakorn, A. Effective Simulation Approach for Lightning Impulse Voltage Tests of Reactor and Transformer Windings. *Energies* **2020**, *13*, 5399. [CrossRef]
5. Florkowski, M.; Furgał, J.; Kuniewski, M.; Pająk, P. Overvoltage Impact on Internal Insulation Systems of Transformers in Electrical Networks with Vacuum Circuit Breakers. *Energies* **2020**, *13*, 6380. [CrossRef]
6. Li, H.; Xia, L.; Cai, S.; Huang, Z.; Li, J.; Zhong, L. Influence of Molecule Structure on Lightning Impulse Breakdown of Ester Liquids. *Energies* **2021**, *14*, 1061. [CrossRef]
7. Wang, G.; Hu, Q.; Xu, C.; Zhao, B.; Su, X. Analysis and Pareto Frontier Based Tradeoff Design of an Integrated Magnetic Structure for a CLLC Resonant Converter. *Energies* **2021**, *14*, 1756. [CrossRef]
8. Marques de Sousa, A.R.; Nunes, M.V.A.; Fonseca, W.S.; Araujo, R.C.F.; Lima, D.S. Magneto-Thermo-Structural Analysis of Power Transformers under Inrush and Short Circuit Conditions. *Energies* **2021**, *14*, 3266. [CrossRef]
9. Yoon, Y.; Son, Y.; Cho, J.; Jang, S.H.; Kim, Y.G.; Choi, S. High-Frequency Modeling of a Three-Winding Power Transformer Using Sweep Frequency Response Analysis. *Energies* **2021**, *14*, 4009. [CrossRef]
10. Trkulja, B.; Drandić, A.; Milardić, V.; Žiger, I. Evaluation of Methodology for Lightning Impulse Voltage Distribution over High-Voltage Windings of Inductive Voltage Transformers. *Energies* **2021**, *14*, 5144. [CrossRef]
11. Krishnasarma, A.; Yazdi, S.J.M.; Taylor, A.; Ludwigsen, D.; Baqersad, J. Acoustic Signature Analysis and Sound Source Localization for a Three-Phase AC Induction Motor. *Energies* **2021**, *14*, 7182. [CrossRef]