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Editorial

Thermal Management in Electrical Machines

Christopher Micallef

Department of Mechanical Engineering, Faculty of Engineering, University of Malta, MSD 2080 Msida, Malta; christopher.micallef@um.edu.mt

1. Introduction

Apart from protecting electrical machines from temperature related failures, thermal management of electrical machines is employed in the design phase of electrical machines to achieve higher efficiencies and higher power densities. There are many techniques that can be used to predict and monitor the thermal performance of electrical machines. Some of the most common techniques for predicting the thermal performance is the use of lumped capacitance thermal networks and, more recently, Computational Fluid Dynamics (CFD) tools. On the other hand, temperature sensors located in critical areas of the machine windings or winding resistance monitoring are used for machine monitoring during operation.

For this Special Issue, which addresses the thermal management of electrical machines, topics of interest included numerical models for heat transfer in electrical machines, CFD analysis of fluid and heat flow in electrical machines, thermal testing of electrical machines, thermal design methodologies used in electrical machines, temperature distribution in electrical machine windings, temperature measurement techniques in rotor and stator windings of electrical machines and common temperature related faults in electrical machines.

2. A Short Review of the Contributions in This Issue

In this Special Issue of Energies titled "Thermal Management in Electrical Machines", four papers were accepted for publication.

Ruiye Li et al. [1] present a methodology for the design and optimization of non-uniform stator radial ducts in long electrical machines. The proposed methodology makes use of electromagnetic-thermal coupled models that have been optimized using genetic algorithms. This work is very relevant to long machines where an axial temperature gradient is normally present, and where the winding hot spot might be difficult to locate. Through this proposed design methodology, the axial temperature gradient in the stator windings is limited, resulting in the stator windings having a flatter temperature distribution. The results obtained on a 15 MW turbogenerator show a reduction in the peak temperature of 7.3 °C.

Camilleri Robert et al. [2] present a direct liquid cooled machine with segmented stator with an integrated heat sink in the concentrated wound coils. CFD and Lumped Parameter Thermal Networks (LPTN) were presented. The models were calibrated against experimental results. Through this novel configuration, the authors managed to decrease the maximum temperature of the windings by 87 °C. This is equivalent to 140% increase in the current density at the maximum rated insulation temperature.

Graffeo Federica et al. [3] present an improved, yet simplified thermal model, of an electrical machine used in a brake-by-wire (BBW) application. A conventional LPTN, based on symmetry assumptions, was investigated. An extensive test campaign, consisting of pulses and load cycle tests that were representative of real machine operations, were conducted on a prototype BBW machine embedded with several temperature sensors. These experimental test results supported by results from a Finite Element Analysis (FEA)

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study, paved the way to the proposal of a simplified phase split LPTN that is capable of predicting temperature variations in the machine.

Boglietti Aldo et al. [4] present a second order LPTN for a stator winding that includes end windings thermal effects. The LPTN parameters were calibrated against the results obtained from a DC test performed on a Totally Enclosed Fan Cooled (TEFC) machine. The proposed LPTN was then validated against results obtained from AC tests. The accuracy of the proposed second order LPTN was within 3%, an excellent result considering the simplicity of the thermal model.

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