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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 18 June 2024, 16:00 s.t., TUDa, via Zoom

Prof. Jader R. Barbosa Jr.

Polo – Research Laboratories for Emerging Technologies in Cooling and Thermophysics, Federal University of Santa Catarina

Zoom information:
Meeting-ID: 684 0327 5048
Kenncode: 079857

Recent developments in near room-temperature magnetic refrigeration

Abstract:

Magnetic heat pumps involve transferring thermal energy from a low-temperature heat source to a high-temperature heat sink through magnetic work on a solid-state refrigerant undergoing a magnetic phase transition. In the active magnetic regenerator (AMR) cycle, the coupling of thermal, hydraulic, and magnetic phenomena in a porous magnetocaloric matrix subjected to alternating flows of a liquid coolant provides cooling capacity at a specified temperature span. Noteworthy advantages of magnetic refrigeration include the reversibility of the magnetocaloric effect in select materials, the utilization of permanent magnets for magnetization work recovery, and the absence of environmentally harmful substances. In this presentation, I will review recent results on the design, commissioning, and testing of two TRL-6 magnetic cooling prototypes: a 30-bottle wine cooler and a 9000-BTU/h magnetic air conditioner. The discussion will focus on: (i) Developing high-fidelity, first-principles modeling approaches and artificial intelligence-based methods to design and optimize magnetic circuit-AMR assemblies; (ii) Designing, optimizing, and integrating ancillary sub-systems, such as heat exchangers, insulated cabinets, and hydraulic management systems (flow-magnetic field synchronization and control); (iii) Proposing thermodynamic performance evaluation criteria (1st and 2nd-law based) and test procedures for magnetic refrigerators based on standards and test methods for conventional systems; and (iv) Outlining the major challenges involved in commercializing magnetic cooling technologies and identifying new areas in need of further research.

About the speaker:

Jader Barbosa earned his Ph.D. in Chemical Engineering from Imperial College London. His academic interests span Fluids Engineering and Thermal Sciences, with a focus on Thermodynamics, Phase Change, Multiphase Flows, Enhanced Heat Transfer, and Emerging Cooling Technologies. Dr. Barbosa has authored over 350 scientific papers in indexed journals and international peer-reviewed conferences, and has advised or co-advised 54 theses/dissertations. Additionally, he has contributed to the co-authorship of three patents. He serves on the Scientific Council of the International Centre for Heat and Mass Transfer (ICHMT) and holds the position of President of the Assembly of World Conferences on Experimental Heat Transfer, Fluid Mechanics, and Thermodynamics. Dr. Barbosa is also a member of the Scientific Committee of the THERMAG Conferences. Currently, he serves as the co-Editor-in-Chief of the Journal of the Brazilian Society of Mechanical Sciences and Engineering (Springer) and as a Subject Editor of Applied Thermal Engineering (Elsevier).