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Encountering Classic and New Ideas at IEMDC

Earlier this year, I was able to attend the IEEE International Electric Machines and Drives Conference (IEMDC) in San Francisco. IEMDC is a conference that is cosponsored by the IEEE Industry Applications Society (IAS), IEEE Industrial Electronics Society, IEEE Power & Energy Society, and IEEE Power Electronics Society. This is IEEE's only conference completely focused on machines and drives. [The IAS technically cosponsors the IEEE International Conference on Electrical Machines (ICEM) and IEEE International Conference on Electrical Machines and Systems (ICEMS) conferences and is proud of our long collaborations with these organizations, but these aren't financially backed by IEEE.] Held every two years, IEMDC is a great example of collaboration between four sister Societies with organization rotating between the Societies. This year's successful event was led by the Industrial Electronics Society.

One of the reasons why I enjoyed this year's IEMDC so much was that I was able to attend simply as a researcher, not in my Society role as your president. IEMDC is like a home research conference for me; much of my research career has been focused on electrical machines, and I first attended IEMDC in 1999. In previous years, I have been a member of the Steering Committee, and I am glad to see the continued success of this event. IEMDC this year was also one of the first fully "back to normal" conferences I have attended postpandemic, with full meeting rooms, exhibits, plenary sessions, and engaging conversations in hallways.

What struck me this year is how much the world of electrical machines has changed while still remaining the same. Since the pioneering times of Tesla and Ferraris, the principles behind the vast majority of electric machinery are unchanged: flux and current interact according to Maxwell's equations, resulting in force and torque. It really sounds quite simple, but I know the IAS membership reading this article includes many of the world's leading experts in electric machines, who know that simple principles and practice are often worlds apart.

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In my early career in electric machinery, the challenge was to develop electromagnetic models that would quickly simulate the performance of machines under fixed conditions, typically at a fixed frequency, speed, and load. Machines developed this way are still critically important for both electricity generation and substantial industrial loads, in settings discussed in this issue of *Industry Applications Magazine*. However, IEMDC this year demonstrated how much things have changed over the past three decades.

Fast electromagnetic models are now readily available and able to predict performance with a consistency that may exceed the test measurements of either finished machines or the material properties of their components [1]. We now need better material science and testing to characterize the nonlinear materials in a machine in its finished manufactured state and to understand normal and standard deviations in the measured performance to be able to produce consistent products.

Digital Object Identifier 10.1109/MIAS.2023.3304829
Date of current version: 11 October 2023

Plenary talks at the conference included a focus on electric machinery and drives for road vehicles and aircraft. Electric vertical takeoff and landing aircraft for commercial passenger use are moving toward the market at a speed that may surprise the average consumer. Small drones for personal and industrial use have become common, and larger passenger versions are a logical progression.

The momentum behind transportation electrification has pushed a need for high power and torque densities (both by mass and volume) that do not exist in static electric machinery. Keeping with Maxwell's equations, when flux density is limited by material saturation, the only option is to increase the current density, with obvious impacts on heat density and resulting advanced cooling models. IEMDC this year featured developments in thermal modeling, spray and direct cooling technology, additively manufactured windings with built-in heat pipes, and manufacturing techniques that increase winding density and cooling capacity.

Many of the developments in what once may have been considered exotic applications of machines and drives are already finding their way into conventional industrial settings. A better understanding of losses and cooling is enabling the market in International Efficiency Class 5 (IE5) Ultra Premium Efficiency motors. Operating efficiency gains through the use of IE5 motors are significant, and gains are likely to have a significant impact on the energy costs and total CO_2 emissions of large industrial plants.

The need for high-performance and high-efficiency electrical machines and drives continues to grow. IAS members are leading the charge in driving cutting-edge machine developments and implementing new solutions in the transportation and renewable energy sectors. These new developments result in reliable, cost-effective, and safe installations of electric machines across the continuous process industries.

Reference

[1] "Simulation versus experimental verification [Society News]," *IEEE Ind. Appl. Mag.*, vol. 28, no. 3, pp. 88–94, May/Jun. 2022, doi: 10.1109/MIAS.2022.3148628.