ECE 590I POWER & ENERGY SYSTEMS SEMINAR

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Status of Cryogenic/Superconducting Drivetrains and Components, and Impacts for Hybrid-Electric Aircraft Propulsion

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Abstract

New technologies and energy sources are available for increasing the efficiency or lowering the cost of transportation that have been fully developed and commercialized for the automotive industry, including hybrid-electric-vehicle (HEV), battery-electric-vehicle (BEV), fuel cells (FC) mostly using liquid H2, and liquid-natural-gas (LNG). The increase of energy efficiencies can be very significant up to 3x or more from the use of non-combustion energy sources and 'smart' energy management including brake regeneration. The use of these technologies is increasingly being realized for aircraft propulsion in the last 5 years, and has been successfully implemented in 2 and 4 passenger aircraft. This paper will summarize recent progress in this field for aircraft, and present the unique properties of cryogenic/superconducting machines and the different ways they can positively impact hybrid-electric or all-electric propulsion. The studies will be done for different size and power level aircraft, and properties of cryogenic systems and components will be compared to Cu-wire or conventional based systems. Drivetrain components studied include generators and motors, power transmission cables, power storage devices including Li-batteries and superconducting magnetic energy storage (SMES), power electronics including inverters, and cryogenic technologies.

Biography

Dr. Timothy J. Haugan is a Senior Physicist and Research Team Leader for the Mechanical and Thermal Systems Branch (RQQM) of the Air Force Research Laboratory, Aerospace Systems Directorate. He is an author of over 125 scientific papers, including first author of a paper published in Nature that is the second-highest cited paper out of 11,000 plus on YBaCuO superconductors since 1996. He is also co-author of over 280 scientific presentations. He works in several research areas including superconductivity, cryogenic power, thin film deposition, room temperature electric wire development, and novel power devices. His work encompasses research and development of materials, as well as device and system applications. Specific applications include all-electric and hybrid-electric propulsion, MW-class power systems and components for propulsion, conventional and superconducting rotating machine generator and motor technology, lightweight superconducting cables for aircraft applications, superconducting magnetic energy storage (SMES) devices for aerospace applications, and novel devices.