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[Invited] Development of High Energy Density Superconducting-Magnetic-Energy-Storage (SMES) for Aerospace Electric Propulsion

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Electrical energy storage devices are critical components of electric power systems of every aerospace vehicle. They are needed for many functions, such as to provide high-power for pulsed loads, as an electrical accumulator unit (EAU) to handle transient loads both on/off the buses, for emergency power during generator or hydraulic-system failure, and as a high-capacity energy source for hybrid-electric-vehicle (HEV) or electric-vehicle (EV) propulsion. Hybrid-electric propulsion for airborne vehicles is understood to provide significant energy efficiency benefits, including during taxiing, for climb, cruise and descent phases, and regenerative (regen) power during descent which has been successfully demonstrated. As electric propulsion of aircraft progresses to 1-10 MW expected in the next 5-10 years, SMES is considered one of the few technology options that can provide high power capability particularly for fast charging, with reasonable weights. SMES along with supercapacitors are the only two technologies able to provide pulsed power for railgun applications, and to handle MW-class transient pulse loads such as high-energy-laser (HEL) shots or absorb high-power-system-faults.

Superconducting-magnetic-energy-storage (SMES) devices offer attractive and unique features for airborne vehicles including the highest power densities known achievable for any technology of 10-1000+ kW/kg for both charge and discharge, 100% storage efficiencies for unlimited times, and for some designs virtually no degradation for up to 10ˆ8 charge/discharge cycles. The energy density of SMES was traditionally < 10 Wh/kg, however recent computational investigations indicate the energy densities could reach > 100 Wh/kg and be competitive with Li-batteries. This paper will describe about the functions of SMES for aerospace electric propulsion, and provide a recent update on the development and performance of SMES devices being designed and built. In-house computation of the design of SMES devices optimized for mass-specific energy densities will be shown, and compared with devices presently existing or being developed.

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