National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Power Generation and Storage

High Efficiency Megawatt Motor

A Partially Superconducting Machine for Use as a Motor or Generator

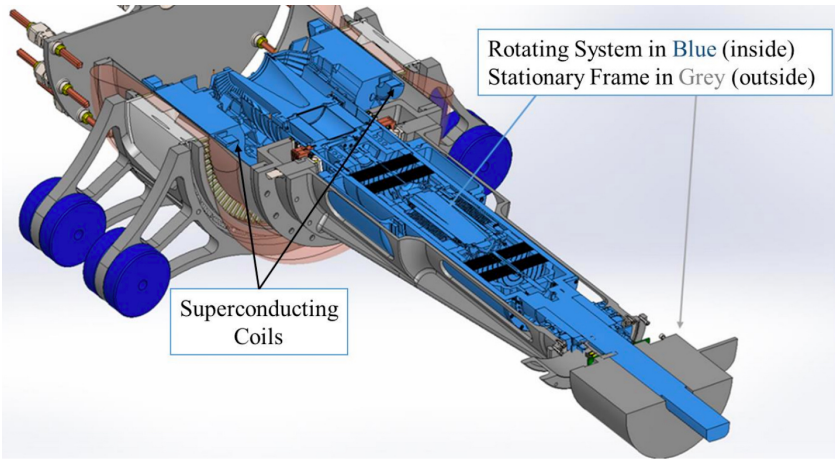
Innovators at the NASA Glenn Research Center have designed a High Efficiency Megawatt Motor (HEMM), a wound-field partially superconducting machine. The HEMM implements a combination of superconducting and non-superconducting elements, along with an integrated cryocooler, to achieve some of the benefits of a superconducting motor without the need for an external cryogenic system. This work is sponsored by the NASA Advanced Air Transportation Technologies project and the Hybrid Gas Electric subproject for use as an electrified aircraft propulsion (EAP) system. Electrification of propulsion has the potential to revolutionize the aviation industry by improving fuel efficiency, reducing emissions, and decreasing dependency on carbon-based fuels. While the HEMM is designed for future hybrid electric aircraft, the technology could be broadly applied to transportation markets including electric trains, hybrid cars, and turboelectric ships.

BENEFITS

- Provides optimal interface capability for aircraft applications: Interfaces with aircraft in the same way as any standard electric machine, uses standard aircraft cooling systems, implements direct drive at optimal turbomachinery speeds (no gearbox), and can be turned off if fault occurs (no permanent magnet)
- Enables compact, lightweight designs: 2-3 times lighter than the current state-of-the-art and implements a linear design without added components to enable machine compactness
- Eliminates the need for separate cryogenic system: The HEMM's integrated cryocooler avoids the additional mass, volume, and infrastructure required with a traditional superconducting machine
- High efficiency (>98%): Minimizes waste heat, enabling peak performance

THE TECHNOLOGY

The HEMM is a is a wound-field partially superconducting machine that implements a combination of rotor superconducting and stator normal conductor elements, along with an integrated acoustic cryocooler, to achieve some of the benefits of a superconducting motor without the need for an external cryogenic system. The combination of the described elements allows a motor to be built which essentially operates like any other motor when viewed as a black box, but substantially enhanced performance can be achieved. The incorporation of superconductors on the rotor to create a high-level magnetic field results in a specific power and efficiency that could not be achieved any other way. The HEMM can achieve over 98% efficiency in a lightweight electric machine with an operating power greater than 1.4 MW, a specific power greater than 16 kW/kg (ratio to electromagnetic mass), and a rated operating speed of 6800 RPM. The HEMM can be used as both a motor or a generator, offering a wide range of applications including propulsion systems for hybrid aircraft, electric trains, hybrid cars, and turboelectric ships, as well as generator systems for wind turbines, power plants, or motors for other industrial machinery.



High Efficiency Megawatt Motor (HEMM) cross-section

APPLICATIONS

The technology has several potential applications:

- Aerospace
- Automotive
- Industrial machinery
- Marine
- Propulsion
- Power

PUBLICATIONS

Patent No: 11,303,194

"High Efficiency Megawatt Machine Rotating Cryocooler Conce
Design," Ralph H. Jansen, et al., July 8. 2018,
https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/2019002
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"High Efficiency Megawatt Motor Preliminary Design," Ralph H.
et al., August 16, 2019,
https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/2019002
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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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More Information

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