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AVIATION CASE STUDY

ELECTRIC-POWERED AIRCRAFT: ELECTRIC PROPULSION UNIT (EPU)

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OMNISEAL® ROTARY LIP SEALS, MELDIN® POLYIMIDES & HYCOMP™ COMPOSITES

ELECTRIC-POWERED AIRCRAFT: ELECTRIC PROPULSION UNIT (EPU)

Dongyeop Shin November 2024

EPU FRICTION ENERGY CONSUMPTION LEAKAGE EXTENDED LIFETIME

Environment

An Electric Propulsion Unit (EPU) refers to the integrated system responsible for generating and managing thrust in electric-powered aircraft. This complex system plays a critical role in powering electric vertical takeoff and landing (eVTOL) aircraft – part of advanced air mobility (AAM) technologies that are designed to provide clean, efficient, and quiet air travel today and the future. There are many components in an EPU, which all need to work together for safe and efficient operations.

1. **Electric Motor:** Converts electrical energy into mechanical energy to drive the propellers or fans.
2. **Power Electronics (Inverter):** Manages the electrical flow between the battery and motor, converting direct current (DC) from batteries to alternating current (AC) for the motor.
3. **Battery System:** Provides energy needed for propulsion, often using advanced lithium-ion or solid-state batteries.
4. **Control System:** Regulates motor operation to ensure efficient and safe performance during all flight phases.
5. **Thermal Management:** Keeps the system within optimal temperature ranges, preventing overheating.

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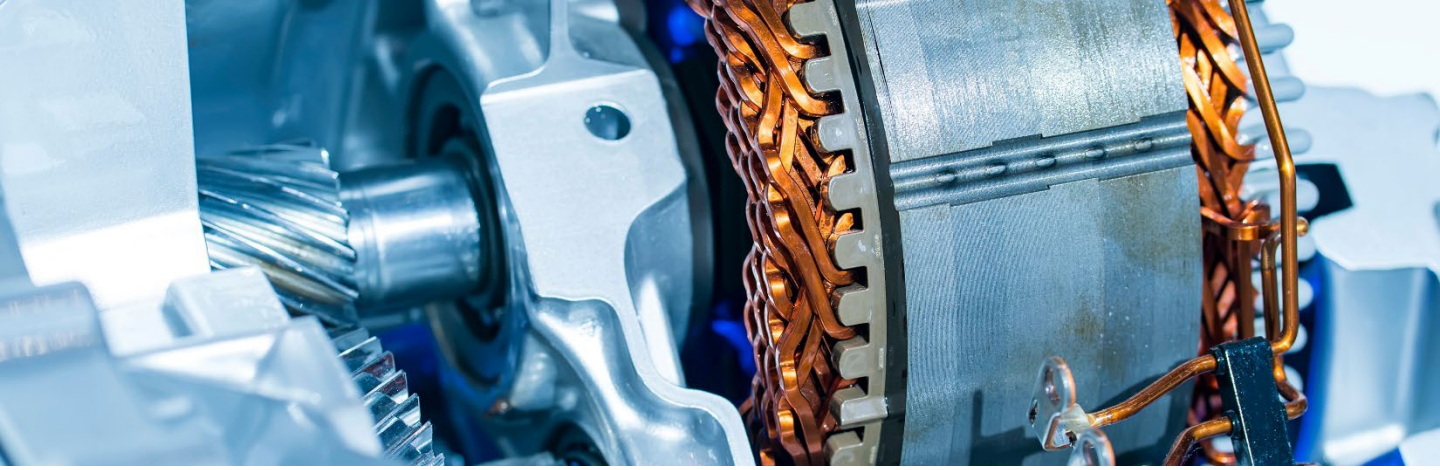

With so many components within an EPU system, how does it enable urban air mobility (UAM) and eVTOL functionality?

1. Efficient Vertical Takeoff & Landing: The unit provides precision control of multiple electric motors, which is ideal for crowded urban environments with limited space.
2. Distributed Electric Propulsion (DEP): Many eVTOLs use multiple EPUs in a distributed configuration to enhance redundancy and safety. If one motor fails, the others can compensate, reducing the likelihood of catastrophic failure.
3. Low Noise Operation: EPUs are significantly quieter than traditional internal combustion engines, making them suitable for urban environments with strict noise regulations.
4. Environmentally-Friendly Propulsion: EPUs emit zero emissions at the point of use, contributing to the goal of sustainable aviation and helping reduce the carbon footprint of urban transportation.
5. Scalability & Modularity: EPUs can be designed to scale for different types of aircraft, from small cargo drones to larger passenger eVTOLs, providing flexibility in aircraft design.

Challenge

As a complex system with many working parts, there are challenges to making sure the EPU is working properly, relating to energy storage, wiring and cooling.

1. Energy Density: Current battery technology limits the range and payload capacity of eVTOL aircraft.
2. Thermal Management: Keeping EPUs cool during high-demand flight phases, like takeoff and climb, is a challenging task.

Solution

Omniseal Solutions provides several polymer sealing and material solutions that protect critical parts of the EPU. Our rotary lip seals are used in electric motors, ensuring durability, efficiency, and performance by protecting against contaminants and retaining lubricants. Our composite and polyimide materials offer advanced thermal and electrical insulation, enabling electric motors to handle high temperatures and electrical loads efficiently. Together, these precision solutions are pivotal in high-performance applications such as eVTOL aircraft, EVs, and aerospace systems, where reliability, efficiency, and weight reduction are paramount.

Technology Advantages of Omniseal® Rotary Lip Seals in Electric Motors

- **Prevent Contaminant Ingress:** Rotary lip seals create a barrier that prevents contaminants (like dirt, moisture, and debris) from entering the electric motor. Keeping internal components clean is critical to ensuring efficiency and longevity.
- **Retain Lubricants:** Seals ensure that lubricants (like grease or oil) remain inside bearings and other moving parts, reducing friction and wear, which is essential for smooth motor operation and energy efficiency.
- **Reduce Friction and Wear:** Low-friction materials used in our rotary lip seals minimize energy losses and extend the motor's lifespan, contributing to the overall reliability of electric systems.
- **Handle High Rotational Speeds:** In high-speed electric motors, such as those used in eVTOLs, seals must withstand high RPMs without degrading. Our sealing solutions offer excellent durability and performance under such extreme conditions.
- **Provide Temperature Resistance:** Electric motors can generate substantial heat; therefore, these seals must perform reliably across a broad temperature range. Our advanced material formulations provide high thermal stability and wear resistance.

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Solution

Technology Advantages of Meldin® Polyimide & Hycomp™ Composite Material Solutions

Our Meldin® polyimide-based materials and Hycomp™ thermoset composites are designed to address thermal and electrical insulation challenges. These properties are especially important in electric motors, generators, and other electrical applications, including aviation and eVTOL systems.

- **Minimizing Heat Transfer:** Meldin® materials offer excellent thermal insulation, preventing heat transfer between motor components. This helps maintain optimal performance by keeping sensitive parts, such as bearings and electronics, cool.
- **Handling High Temperatures:** Motors, especially in eVTOL and aerospace applications, often face extreme operating temperatures. Meldin® polyimide solutions are known for withstanding high temperatures (up to 600°F / 316°C) without losing mechanical integrity.
- **Electrical Isolation:** Hycomp™ composites are used for insulating parts to prevent electrical arcing or short circuits. This is essential in electric motors where close-tolerance components need to be electrically isolated.
- **Lightweight yet Strong:** Meldin® and Hycomp™ materials are lightweight, reducing the weight of motors, which is critical for eVTOL and electric aircraft applications. They also exhibit excellent mechanical strength, ensuring structural integrity.
- **Corrosion & Chemical Resistance:** These advanced materials are highly resistant to chemicals, oils, and environmental degradation, extending the lifespan of components in harsh operational environments.

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Partner For Today & Tomorrow

For the past 60 years, Omniseal Solutions has supported the aviation industry in commercial aircraft, helicopters and now advanced air mobility and eVTOLs. Proven as reliable global partners, our customers rely on our team to custom engineer sealing technologies that meet stringent performance requirements as well as comply to aerospace sealing and material standards.

Our polymer rotary lip seals are valued in this demanding industry as leak tight solutions over a long lifetime, both in dynamic and static conditions, while reducing frictional torque to the minimum. Combined with its compact and efficient design that saves space and weight, as well as significantly reduce energy consumption, our lip seals are best suited for EPU applications.

Enabling The Future of Mobility With Precision Seals & Advanced Materials For Safer & Efficient Flight

Specification

Solution	• Omniseal® Rotary Lip Seal
Area	• Electric Propulsion Unit (EPU)
Material	• Fluoroloy®
Technical Details	• Media: MIL-PRF-7808, MIL-PRF-23699, Aircraft Turbine Engine • Temperature: -40 °F to +300 °F • Speed: up to 100 ft/s (30 m/s) • Pressure: 0 to 1 psid • Leakage: minimum to no leakage • Lifetime: 20,000 to 35,000 hours

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Design Expertise & Tailor-made Solutions for Your Critical Applications

Omniseal Solutions is a global engineering leader with over 65 years of historical legacy, relentlessly dedicated to the design and manufacture of precision sealing and wear control solutions that protect critical applications in the most demanding environments and passionately driven to push *Beyond the Boundaries of Possible*.

Contact Our Expert

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