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M2Po3D-01: Superconducting Coil Pack Manufacturing and Risk Reduction Testing for NASA's AC Loss Test Rig

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Superconducting coils are designed for carrying high electrical current at low losses for use in future superconducting power transmission lines, transformers, fault current limiters, and electric machines for aircraft. The coils in the armature (typically the stator winding) of electric machines are exposed to highly dynamic magnetic excitation. In this environment, it is critical to understand the alternating current (AC) losses in the superconductor and significantly limit or avoid AC losses in the surrounding structures (coil pack) that provide mechanical support and thermal management to the coil. These coils are often fluid cooled. Accordingly, these coil packs should be electrically insulative and fluid-leak tight. The design and construction of stator coil packs is an open area of research. NASA Glenn has designed and built a new test rig aimed at measuring AC losses of superconducting wires, cables, and coils in a representative stator environment. Before AC losses can be quantified over a range of anticipated operational conditions however, a key challenge that must be addressed is reliable manufacturing of electrically-insulative and fluid-leak tight coil packs. The coil packs must be able to tolerate numerous pressure and thermal cycles anticipated for use in future superconducting electrical machines. Multiple coil packs samples were recently designed and fabricated from G-10 with internal passages for gaseous helium coolant flow. To properly validate that the structure is suitable for future AC loss testing, samples were tested for gas flow rate, thermal cycling (77-300 K), and both static pressure and pressure cycling up to expected maximum operating pressure of 758 kPa in ambient and liquid nitrogen environments. This paper describes the coil pack design and manufacturing in addition to the test results, which indicate that the current coil pack design and manufacturing process are suitable for planned AC loss testing.

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