Cryogenic Shrouds for Testing Thermal-Insulation Panels

These shrouds enable maintenance of required thermal and mechanical conditions.

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Cryogenic shrouds have been designed and built for use in thermomechanical testing of samples of thermal-insulation panels on cryogenic vessels. In the original application for which these shrouds were specifically designed, the samples are representative of the large-area thermal-insulation panels on the space-shuttle external tanks that hold liquid hydrogen and liquid oxygen, and the purpose of the testing is to demonstrate the ability of bonded layers in the panels to resist delamination under a combination of applied uniaxial mechanical loads and realistic operational temperatures. Presumably, the shrouds and the tests performed by use of them could be modified to enable similar evaluation of thermomechanical properties of thermal-insulation panels for cryogenic vessels other than the external tanks of the space shuttles.

The shrouds are required to enable maintenance of required temperatures on the inner and outer surfaces of the thermal-insulation-panel samples, to enable visual observation of the outer surfaces of the samples, and not to introduce any measurable loads into the panels. For each panel sample, there are two shrouds: one to be mounted on the inner surface (the surface that would be in contact with a tank containing a cryogenic liquid during normal use) and one to be mounted on the outer surface (the surface that would be exposed to ambient air or other warmer environment during normal use). The shrouds for testing specimens of thermal-insulation-panels for the liquid-hydrogen tank are made largely of titanium; the shrouds for testing specimens of thermal-insulation-panels for the liquid-oxygen tank are made largely of an aluminum-lithium alloy.

The specific temperature requirements are the following: The inner shroud must make it possible to maintain a temperature of –321 °F (–196 °C) [the approximate temperature of liquid nitrogen] or –453 °F (about –269 °C) [the approximate temperature of liquid helium] on the inner face of the sample. The outer shroud must make it possible to maintain a temperature between –30 and 0 °F (between about –34 and about –18 °C) on the outer surface of the sample by blowing a cryogenic gas or missile-grade air along that surface. To enable viewing of the outer surface of the sample during testing, the outer shroud includes a window comprising two layers of poly(methyl methacrylate) with a gap between them to reduce fogging.

To ensure that the shrouds do not introduce any measurable loads into a panel specimen, the shrouds are cushioned on the specimen by seals made of a fluoropolymer-membrane/fabric composite material and are held in place on the specimen by means of symmetrically placed clamps with poly(tetrafluoroethylene) pads. Instrumentation ports for thermocouples and strain gauges used in the tests are incorporated into the shrouds.

This work was done by Jeffrey Norris, Robert Carroll, and Charles Kirch of Lockheed Martin Corp. for Marshall Space Flight Center. Further information is contained in a TSP (see page 1). MFS-32444-1