National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Instrumentation

Cryostat-100

Thermal Insulation Test Apparatus

NASA Kennedy Space Center seeks partners interested in the Cryostat-100, an absolute heat measurement device for precise thermal performance measurements under actual-use cryogenic-vacuum conditions. It is a liquid nitrogen boiloff calorimeter with upper and lower guard chambers and full vacuum pressure range capability.

The Cryostat-100 vacuum cylinder and cold-mass assemblies include handling and manipulation devices to make sample material change-out fast, reliable, and safe for the operator. The boiloff flow from the test chamber is in direct proportion to the total heat transfer rate through the thickness of the test article. Flow rate is typically averaged over the liquid level from 88 to 92 percent to calculate the k-value.

BENEFITS

- Design is fully modular, portable, and adaptable to different fluids or environmental test conditions
- Well suited for a wide variety of insulation materials, including bulk fill, powders, multilayer, foams, clam-shells, layered composites, etc.
- The apparatus is easily adapted to different warm boundary temperatures up to 400 K and any cold boundary temperature above 77 K.
- The data are used to create standard reference materials for the calibration of other insulation test equipment.

THE TECHNOLOGY

Cryostat-100 combines the best features of previous cryostats developed by NASA, while offering new features and conveniences. This unit can readily handle the full range of cryogenic-vacuum conditions over several orders of magnitude of heat flux. Guide rings, handling tools, and other design items make insulation change-out and test measurement verification highly reliable and efficient to operate. The new apparatus requires less ancillary equipment (it is not connected to storage tank, phase separator, subcooler, etc.) to operate properly. It is top-loading, which makes disassembly, change-out, and instrumentation hook-up much faster. The thermal stability is improved because of internal vapor plates, a single-tube system of filling and venting, bellows feed-throughs, Kevlar thread suspensions, and heavy-wall stainless-steel construction.

The cold mass of Cryostat-100 is 1m long, with a diameter of 168 mm. The test articles can therefore be of a corresponding length and diameter, with a nominal thickness of 25.4 mm. Shorter lengths are acceptable, and thicknesses may be from 0 mm to 50 mm. Tests are conducted from ambient pressure (760 torr) to high vacuum (below 110-4 torr) and at any vacuum pressure increment between these two extremes. The residual gas (and purge gas) is typically nitrogen but can be any purge gas, such as helium, argon, or carbon dioxide.

Typically, eight cold vacuum pressures are performed for each test series. The warm boundary temperature is approximately 293 K, and the cold boundary temperature is approximately 78 K. The delta temperature for the cryogenic testing is therefore approximately 215 K. A unique lift mechanism provides for change-out of the insulation test specimens. It also provides for maintenance and other operations in the most effective and time-efficient ways. The lift mechanism is also a key to the modularity of the overall system.

APPLICATIONS

The technology has several potential applications:

- Insulation research, design, production, or quality control testing
- Biological specimen testing and research studies
- Instrumentation checkout and testing
- Structural material and composite evaluation for industrial applications, such as hydrogen fuel cells or superconducting power junctions

PUBLICATIONS

Patent No: 8,628,238; 9,488,607

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More Information

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