THERMAL PERFORMANCE OF STIRLING-CYCLE CRYOCOOLERS: A COMPARISON OF JPL-TESTED COOLERS

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Spacecraft cryocoolers continue to attract interest in the space science community. To date, many Stirling-cycle cryocoolers have been characterized by JPL in a number of performance areas including thermal performance. A variety of factors have been used to evaluate the efficiency and cooling power of cryocoolers at cryogenic cold-tip temperatures. A comparison of the measured thermal performance of several cryocoolers is presented.

The various cryocoolers tested by JPL include single compressor/single displacer, back-to-back dual compressor/dual displacer, back-to-back dual compressor/single displacer, and in-line single compressor/single displacer configurations. These cryocoolers were designed with various compressor and displacer sizes and strokes and were designed to operate at a drive frequency that is particular to each cooler. Although the design differences between various coolers complicates their comparison, this paper aims to evaluate the thermal performance data so that cooler-to-coolers comparisons can be made. As part of these comparisons, the paper explores the measured sensitivity of thermal performance to wide range of operational variables. These include piston and displacer stroke, piston/displacer phase, fill pressure, heat sink temperature, and drive frequency. A multivariable plot format aids in the understanding of the complex interdependence of input power, cold-tip temperature, cold-tip heat load, specific power (efficiency), and the operational variable.

This paper provides the community with insight into the expected performance and limitations of state-of-the-art cryocoolers.

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