
SESSION 11: Regenerator & Recuperator Investigations

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Compact Mesh-based Recuperator for 40 K Space Reverse Turbo-Brayton Cooler and Remote Cooling Applications

A. Onufrena and T. Koettig, CERN, Switzerland; T. Tirolien, ESA/ESTEC, The Netherlands; H.J.M. ter Brake, Univ. of Twente, The Netherlands

The high-effectiveness compact recuperator (or counter-flow heat exchanger) is a critical component of the 40 K Reverse Turbo-Brayton Cryocooler, which is currently developed for space applications. Also, in remote systems that aim to distribute the cooling power of a cryocooler by means of an active fluid circulation, high-effectiveness recuperators are of paramount importance. A series of novel mesh-based recuperators has been designed, constructed and tested in a collaboration between ESA, CERN and University of Twente. The designs were accomplished using a numerical model based on experimental and theoretical data. Their performance in the 10-290 K temperature and 1-5 bar pressure operation ranges was experimentally tested and analyzed. The test stand was constructed to measure the effectiveness and the pressure drop of both fluid streams at variable system pressure, mass flow rate and temperature conditions. A tremendous increase in effectiveness from 94.9 % (NTU = 18.8) to 98.0 % (NTU = 49) was achieved between the first and second design iterations in the tests with helium. The numerical model was correlated with the test results, and two designs of a 40 K neon recuperator with 98.6 % predicted effectiveness are proposed.