NASA SBIR/STTR Technologies

NNX09CA23C - Advanced Long-Life Cryocooler Technology for Zero-Boil-Off Cryogen Storage

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Identification and Significance of Innovation

Long-life, high-capacity cryocoolers are a critical need for future space systems utilizing stored cryogens. The cooling requirements for some missions will range from 10 to 50 W at temperatures between 20 and 120 K. Space cryocoolers at this capacity do not exist. The proposed effort will result in the development of a high capacity turbine. The turbine will enable turbo-Brayton cryocoolers that are lightweight, extremely efficient and easy to integrate with cryogenic storage dewars without significant performance penalties. The predicted cryocooler efficiency is better than any cryocooler previously developed for space.

Expected TRL Range at the end of Contract (1-9): 4

20 K Turboalternator for ZBO Cryogen Storage Systems

Technical Objectives and Work Plan

The primary goal for the Phase II project is to demonstrate the thermodynamic performance of the 20 K turbine at design operating conditions. The primary accomplishments were: completed detailed design of cold turbine, fabricated and assembled cold turbine, developed a test plan and test facility, mapped turbine performance and revised cryocooler performance predictions. We were unable to map the turbine performance at 20 K due to limitations in the test facility so this work was performed at 40 K. We obtained useful test data at 40 K that were used to assess the performance of the turboalternator and identify improvements for future builds. The TRL of the technology is now at 4.

NASA and Non-NASA Applications

Space applications include cryogen storage for planetary and extraterrestrial exploration missions, Crew Exploration Vehicles, extended-life orbital transfer vehicles, long-term geosynchronous missions, and in-space propellant depots and extraterrestrial bases. Terrestrial applications include cooling for spaceport cryogen storage and cryogen transportation systems. Non-NASA commercial applications include cooling for gas separation, gas liquefaction, cryogen storage and transportation systems; high-temperature superconducting systems; and liquid hydrogen storage systems for automotive fuel cells.