Advanced Mechanically Pumped Thermal Control Loops for Future Spacecraft

Gajanana C. Birur*, Pradeep Bhandari, and Anthony I. Paris
Jet Propulsion Laboratory, California Institute of Technology
and
Valentin Izraelev,
Advanced Bionics Inc., Hopkins, Minnesota

*Primary Contact address:
Jet Propulsion Laboratory
4800 Oak Grove Blvd., M/S 125-109
Pasadena, CA 91109
Phone: (818) 354-4762
Fax: (818) 393-1633
E-mail: gaj.birur@jpl.nasa.gov

Abstract

After the successful implementation and flight of a mechanically pumped cooling loop (MPL) on Mars Pathfinder, there has been an increasing interest in using mechanically pumps for thermal control of robotic spacecraft for science missions and on communication satellites. Some of the key issues in the use of mechanical pumps have been the reliability of pumps for long-term operation and performance of pumps in more extreme temperatures than used in the past.

One of the two pump related activities currently underway at JPL is the long-term life testing of pumps for future science spacecraft. Two different kinds of centrifugal pumps are undergoing long-term life tests in ambient temperature. Both pumps have no bearings and seals and use CFC-11 as the single-phase working fluid. One of the pumps is based on a novel concept of a floating rotor with large clearances that makes it resistant to failure due to particulate clogging. The performance of the pumps is being evaluated to investigate the long-term reliability of the pumps. The pumps are designed for pressure heads of 50 kPa and a flow rate of about one liter per minute. Further, a test bed is being setup for testing pumps at elevated temperatures. The elevated temperature life test will be conducted at 150 to 175 C. The second pump related activity is on the development of novel MPL based thermal control architectures for future science spacecraft. Some of the architectures being studied are on thermal control concepts using thermal energy management principles. Both single-phase and two-phase concepts are being investigated.

This paper describes the reliability and performance results from the long-term testing of pumps and benefits and drawbacks of different MPL based thermal architecture for the science spacecraft for deep space and earth orbiting missions.