High Temperature Mechanically Pumped Fluid Loop for Space Applications – Working Fluid Selection

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ABSTRACT

Mechanically pumped single-phase fluid loops are increasingly being used for heat rejection purposes in space applications. Examples of Earth orbiting missions using this technology include NSTS Shuttles (water and Freon-based loops) and the International Space Station (water and ammonia-based loops). For deep space missions, both the Mars Pathfinder (1996) and Mars Exploration Rover (2003) missions used mechanically pumped Freon-11 loops for their primary Heat Rejection Systems (HRS.) Mechanically pumped loops are particularly well suited for rejecting large amounts of waste heat from spacecraft and future missions incorporating components with extremely high thermal energy dissipation (*e.g.* radar instruments, Radioisotope-based power sources) are ideal candidates for their use. However, previous implementations of mechanically pumped loops were designed for moderate temperatures (below 60°C) and, thus, would require relatively large radiators to reject high heat loads to space. Loops designed for a higher operating temperature would allow large amounts of heat to be rejected within the constraints of a mass efficient thermal control system.

A Heat Rejection System using a mechanically pumped high temperature (100 to 150°C) fluid loop is currently being investigated at the Jet Propulsion Laboratory for future Mars missions. Under this work, several heat transfer fluids were investigated in order to select a suitable working fluid for the system. In addition to the thermal and hydrodynamic properties of the candidate fluids, heritage hardware and designs from the HRS of the previous Mars missions were considered. This paper details the results from the trade-off study and the rationale for selecting water as the high temperature working fluid. In addition to this survey, a mechanically pumped loop life test setup was fabricated to study the long term performance of a high temperature HRS. Chemical and material analyses are being conducted to study the compatibility of high temperature water with various materials likely to be used in a flight fluid loop system. These findings, along with preliminary performance data from the high temperature life test, will also be included.