High Temperature Water-Titanium Heat Pipes for Spacecraft Fission Power

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Abstract. NASA is examining small fission reactors for future space transportation and surface power applications. The Kilopower system will use a nuclear reactor to supply energy to Stirling convertors to produce electricity. Titanium/water heat pipes will be used to carry the waste heat from the Stirling to a radiator, where the heat is rejected. Most current water heat pipe designs are for surface fission power, and use gravity aided heat pipes (thermosyphons). The Kilopower system will be designed to operate in space, which will require a different heat pipe design than the thermosyphons used in surface applications. The heat pipe design needs to support the Kilopower system through four different operating conditions: operation in space, with zero gravity; operation on earth, with a slight adverse orientation, to estimate performance in space; ground testing, with the heat pipes operating gravity aided; and launch, with the evaporator elevated above the condenser. During the last two conditions, vertical ground testing and launch, the heat pipe wick will deprime and will need to re-prime for operation in space operation after launch. Two heat pipe wick designs were identified as readily repriming after depriming: grooved wick heat pipes and self-venting arterial heat pipes. In the grooved wick design a screen or sintered wick is required in the evaporator during start-up. This hybrid-wick design is necessary to supply liquid to the evaporator during vertical operation. Two heat pipes were designed, fabricated and tested: a self-venting arterial wick and a hybrid groove-screen wick design. This paper presents the design of the two heat pipes and test results which were used to evaluate which heat pipe wick design is better suited for the Kilopower system.

Keywords: Kilopower, heat pipe, hybrid wick, self-venting arterial wick