

Loop Heat Pipe With 3D Printed Evaporator Designed for the NASA VIPER Engineering Demonstration Unit. R. Gupta¹, C-H. Chen¹, and W. G. Anderson¹, ¹Advanced Cooling Technologies, Inc., 1046 New Holland Ave, Lancaster, PA 17601 (Contact: rohit.gupta@1-act.com)

Abstract: A Loop Heat Pipe (LHP) featuring a 3D printed evaporator was designed and fabricated by Advanced Cooling Technologies, Inc. (ACT) as part of the engineering demonstration unit for NASA's Volatiles Investigating Polar Exploration Rover (VIPER). The LHP formed part of ACT's thermal management solution for the NIRVSS and MSolo spectrometers. The 3D printed evaporator was developed by ACT as part of a separate NASA-funded SBIR program aimed at minimizing the manufacturing costs and lead times of evaporators by eliminating the labor-intensive processes. With 3D printing, the entire evaporator was printed as a single, continuous part complete with such components as the primary wick, the vapor grooves and the outer solid wall. A CAD rendering of the evaporator cross-section and a photograph are presented in Figure 1. The evaporator featured a 316L stainless steel construction with a length of 4-in and a diameter of 1-in. With an intensive parameter development effort, the primary wick capillary limit was maximized to an equivalent pore radius of under 8 μm at bubble point. The details on the wick capillary development can be found in a recent publication by this abstract's authors[1]. CAD renderings and photographs of the full LHP is shown in Figure 2. The LHP also featured a Thermal Control Valve (TCV), highlighted in Figure 2. The TCV was incorporated to allow for the vapor to bypass the condenser below a desired temperature. The LHP was tested successfully to the desired power level in the ACT testing facility. Given the success in meeting a set of mission-specific requirements, the current effort serves as a demonstration of significant technological progress in additively-manufactured advanced heat transfer devices.

References:

[1] Gupta, R., Chen, C-H., Anderson, W., "Progress on 3D Printed Loop Heat Pipes," 50th International Conference on Environmental Systems, 2021.

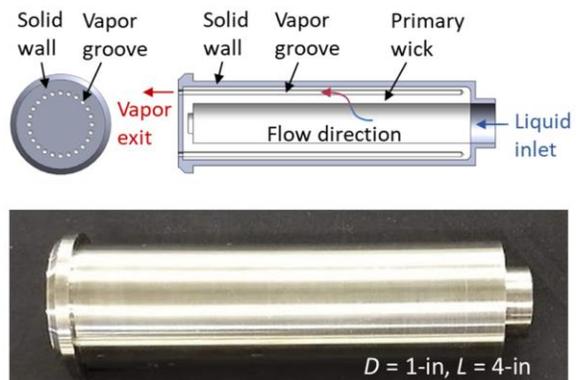


Figure 1. (top) CAD rendering of the 3D printed evaporator, and (bottom) a photograph of the 3D printed evaporator.

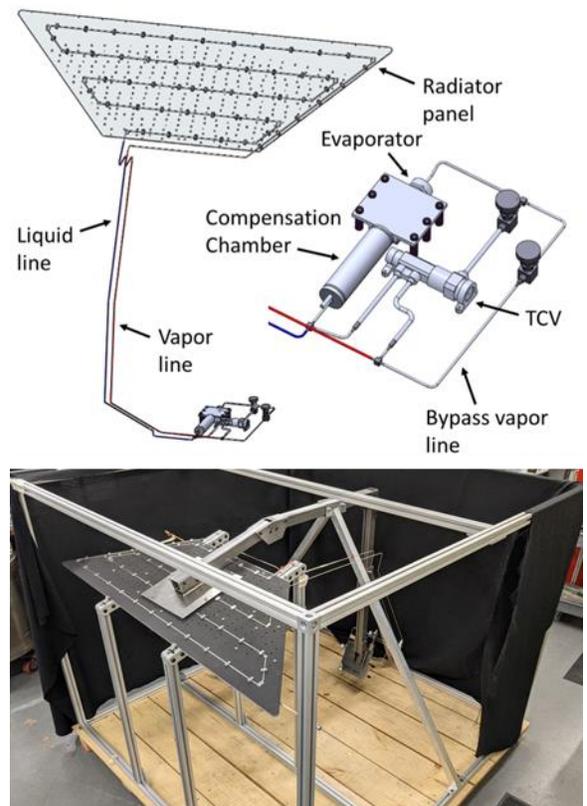


Figure 2. (top) CAD rendering of the LHP, and (bottom) a photograph of the LHP in the shipping rack.