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MECHANICAL ENGINEERING
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ABSTRACT

Heat pipes are extensively used in spacecraft thermal control and electronics cooling for transfer of heat from high heat flux zones to low heat flux zones. The major advantage of heat pipe is it can transfer high heat flux with minimum temperature difference between the source and sink. Capillary forces generated by wick drives the fluid between condenser and evaporator. The working fluid collects heat in the evaporator, vaporizes and moves towards condenser. The vapour condenses back to liquid in the condenser by releasing the heat to surroundings. This condensed liquid flows back to the evaporator by capillary forces generated by wick.

Loop heat pipes (LHPs) are provided with wick at evaporator region unlike in conventional heat pipes to reduce the pressure drop and increase heat transport distances. The flat plate LHPs are always preferred due to their simple construction and can be mounted directly onto the electronics package without any saddle. But large heat leak from evaporator to compensation chamber (CC) of flat LHPs is their major drawback, which needs to be studied meticulously.

Extensive research has been carried out for understanding the steady state and transient characteristics of an LHP with different heat loads and working fluids. However, the literature lacks in the study of heat leak into the CC and its effect on its operating characteristics, particularly at high heat loads or catastrophic operating conditions.

The present study of heat leak into the CC of an LHP evaporator is a step forward for better understanding of the phenomena occurring in the CC and their effect on the heat transfer characteristics with acetone as working fluid. An optically accessible evaporator setup is built to visualize the phenomena inside the CC of capillary evaporator using high speed camera and two different thermal conductive material wicks, i.e., Bronze and UHMW-PE. Visualization inside the CC is carried out for bubble dynamics and correlated against heat loads. Heat transport capability at different operating regimes is evaluated and it is found that the highest evaporative heat transfer coefficient is achieved at the onset of nucleate boiling. Wick temperature overshoot is witnessed during start-up of the flow while using Bronze wick, but no such phenomenon is observed for UHMW-PE wick. This is attributed to higher thermal conductivity of Bronze wick, which would delay to attain required motive temperature head (second serviceability condition) to displace liquid into CC. The start-up duration decreases steeply with increase in heat load for both the wicks. It was found the probability of bubble size mostly depends on the wick pore size and marginally on heater power. As the bubble frequency (which is the measure of energy carried by bubbles) changes significantly with heater power, bubble dynamics have substantial implication on the evaporative heat transfer coefficient.

Global heat balance across the capillary evaporator is carried out and presented. Heat leak through the wicks (i.e., heat leak through temperature measurement and heat leak estimated from correlation) are compared and their effects on the heat transfer characteristics are also discussed.

July 9, 2020, 3:30 PM, Microsoft Teams

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ABOUT THE SPEAKER

Saleem M Basha received the B.Tech degree in Mechanical engineering from the Jawaharlal Nehru Technological University College of Engineering, Hyderabad, India. Since 2006, he was with the Thermal Systems Group, U R Rao Satellite Center, ISRO, Bangalore, India. He has been involved in thermal design and analysis of interplanetary missions and various Geostationary space crafts. He has developed thermal control system for India's maiden lunar lander and rover. Currently, he is involved in technology development projects like Thermo-electric generators, Mechanically pumped fluid loops and Compact emissometer at ISRO.

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