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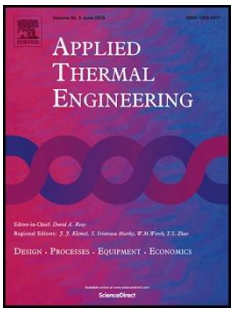

Title: Experimental investigation and visual observation of a vapor-liquid separated flat loop heat pipe evaporator

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Experimental Investigation and Visual Observation of a Vapor-Liquid Separated Flat Loop Heat Pipe Evaporator

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Highlight:

- A special structure of evaporator of LHP was studied.
- The LHP was mainly driven by pressure difference to complete the single direction circulation.
- The effect of the height of the evaporation chamber is studied.
- The optimal height of the evaporation chamber can reduce the thermal resistance of the heat pipe.

Abstract: It is known that the circulation driven head of heat pipe is mainly determined by both the vapor pressure head and the liquid pressure head generated at the phase change interface. In this paper, a unique operation mechanism is proposed; in this mechanism, the circulation of the loop heat pipe (LHP) is primarily driven by the phase change formed at the vapor-liquid interface. To test the new mechanism, a visual flat LHP evaporator prototype and an open experimental system were deliberately designed and assembled to obtain the operation characteristics inside of the evaporation chamber (EC). Three main experimental stages, the pre-boiling, boiling and steady stages, were observed during the start-up process. The evaporation chamber with 5-mm height whose evaporator thermal resistance and LHP thermal resistance are 0.015 ℃/W and 0.36 ℃/W, respectively, has a better heat transfer performance. The results showed that the circulation driven head formed inside of the EC played an important role in promoting the operation performance, especially when the wick, the vapor-liquid interface and the bottom of the evaporator arrived at a reasonable situation.

Key words: capillary loop heat pipe; flat heat pipe evaporator; wick; vapor-liquid interface; visualization

1. Introduction

As is known, the cooling device for high heat flux components is critical to promote the runtime reliability, optimize the performance and extend the lifetime of the product. With continuous development of large application servers, data processing centers and aerospace equipment, research and development of cost-effective thermal management become increasingly important to corresponding enterprises [1].

Typically, the waste heat output produced by a single Central Processing Unit (CPU) can achieve a total of more than 25-50 W/cm^2 and is expected to show a future rise with the increase in processor clock speed, the decrease of figure size and package space [2-5]. Therefore, the development speed and scale of large application servers and data centers will largely be affected by the research and development progress of its cooling devices.

The first flat shaped evaporator was patented by Yu. F. Gerasimov et al. in 1975 [6]. This