Proceedings of the Canadian Society for Mechanical Engineering International Congress 2022
CSME Congress 2022
June 5-8, 2022, Edmonton, AB, Canada

ON PREDICTING THE BOILING AND CONDENSATION THERMAL RESISTANCE OF A THERMOSYPHON

Dwaipayan Sarkar[1*], Eric Savory[1], Christopher DeGroot[1]
[1]Department of Mechanical & Materials Engineering, Western University, London, Canada
*dsarkar3@uwo.ca

ABSTRACT

Thermosyphons are passive heat transfer devices (typically cylindrical or rectangular cross-sectioned) that employ phase change heat transfer and natural convection processes to transport heat rapidly (almost 250 times to that of an equivalent volume of copper) between the given heat source and the sink. A potentially important application of thermosyphons has been towards the cooling of automotive plastic injection parts in mold cavity systems.

A new set of correlation equations for predicting the boiling (R_{boil}) and condensation (R_{cond}) thermal resistance of a thermosyphon is proposed. The boiling resistance comprises of thermal resistance components from natural convection, pool boiling, and film evaporation processes, whereas the condensation resistance include drop condensation and film condensation processes. The equations are developed using the Buckingham Pi theorem using the principles of boiling and condensation.

Various geometrical parameters such as the aspect ratio (AR), the fill ratio (FR), thermosyphon orientation (θ), the working fluid thermophysical properties influence the magnitude of R_{boil} and R_{cond}. An experimental simulation is currently in progress to simulate the performance of thermosyphon under various operating conditions in order to identify the parameters that exert the maximum influence on R_{boil} and R_{cond}. Knowing it, one should be able to optimize the design of a thermosyphon to achieve minimum R_{boil} and R_{cond} and, therefore, maximum the heat transfer rate, Q_{max}.