# ME – PhD Thesis Colloquium

## Experimental investigation of horizontal evaporator thermosyphons for low and high heat flux applications

**Aalekh Srivastava, PhD Student, Department of Mechanical Engineering, IISc Bengaluru**

**September 16, 2026 at 04:00PM**

**Venue: ME Conference Room, ME@IISc**


## ABSTRACT

A thermosyphon is a hermetically sealed passive heat-transfer device used in various thermal management applications. It consists of an evaporator, a condenser, and an adiabatic section and is filled with a working fluid that undergoes phase change. The condenser is located above the evaporator, and liquid returns to it by gravity. If the condensed liquid and vapor flow in the same tube, it is called a *tubular* thermosyphon, whereas if they have separate flow paths, it is called a *loop* thermosyphon. The heat-transfer capacity of the former is limited by vapor shear; hence, for high-heat-load applications, loop thermosyphons are preferred. The first part of this work presents the development and characterization of a thermosyphon for low heat flux radiative sky cooling, whereas the latter part of the thesis focuses on a loop thermosyphon for high heat flux applications such as thermal management of power electronics, electric motors and rack-level cooling in data centers.

The low-heat-flux application considered here is the development and characterization of a thermosyphon for cooling perishable produce in a vegetable cart, in conjunction with radiative sky cooling (100-150 W/m$^2$). We experimentally characterize several tubular thermosyphons to thermally couple the tray containing perishable produce to the radiator canopy. In general, the thermal resistance of thermosyphons *decreases* as heat load increases. Some fluids even exhibit flow instabilities at low heat loads, such as geysering, which leads to temperature fluctuations. The research began with a study on the performance characterization with horizontal and vertical evaporator orientations for different working fluids. Later, an experimental study was conducted to examine the effects of the working fluid, internal surface modifications, and fill ratios. The finalized design was tested under open-sky conditions with actual radiative sky cooling and demonstrated sub-ambient temperatures. We also developed a novel *figure of merit* to assist in selecting a working fluid for low-heat-flux applications.

For high-heat-flux thermal management, a loop thermosyphon with a horizontal evaporator is studied. Performance characterization includes understanding startup, transient, and steady-state thermal behavior with various working fluids. To further understand the operating characteristics of a loop thermosyphon, a thermal and visualization study was conducted. These investigations revealed two different flow regimes within the evaporator, which are linked to distinct thermal characteristics. These flow regimes and thermal characteristics depend on the heat load and working fluids. *Flow-regime maps* are developed based on known internal parameters, such as mass flux versus vapor quality, and with non-dimensional numbers.

The final phase of this study experimentally evaluates a *loop* thermosyphon with an air-cooled condenser (as found in automotive applications) and two horizontal evaporators in parallel. Two configurations are studied, namely, different height (DHC) and same height (SHC). In the former, the evaporators are at different heights, whereas in the latter, they are at the same height. The study considers both uniform and non-uniform heat loads on the evaporators. Under uniform heating, the heat-transfer capacity of DHC was only 35% of that of SHC, with minimal variation in thermal resistance (<10%). Under non-uniform heating, load variations across evaporators in SHC did not significantly alter thermal resistance or heat-transfer capacity. However, the performance of the top evaporator in DHC was compromised by the thermal load of the bottom evaporator, resulting in degraded thermal resistance and heat-transfer capacity. Consequently, SHC is preferred. When DHC is necessary, the top evaporator is the critical design parameter dictating overall thermosyphon performance.


## ABOUT THE SPEAKER

Aalekh Srivastava is a Ph.D. student in the Department of Mechanical Engineering working with Prof. Pradip Dutta, Prof. Amrit Ambirajan and Prof. Susmita Dash at the Indian Institute of Science (IISc) Bengaluru. He completed his B.Tech. in Mechanical Engineering from Madan Mohan Malaviya University of Technology (Gorakhpur) and M.Tech. in Thermal System Design from SVNIT (Surat). He joined IISc in August 2021. His research interests include thermodynamics, heat transfer, and two-phase flow with a particular focus on passive heat transfer devices such as tubular and loop thermosyphons.