Phase-Change Thermal Systems Laboratory

Laboratory Coordinator: Dr. Sameer Khandekar

Associated Faculty Members (if any):

List of Major Equipment:

- FLIR Infra-Red Thermographic Camera
- High Speed Videographic Camera
- Laser-Flash Thermal Diffusivity Measurement System
- Goniometer and Tensiometer
- Mass Spectrometer
- Helium Leak Detector
- Mass Flow Controllers
- Environmental Chamber and Flow Facility
- Lathe, Milling and Drilling Machines
- Pressure/Temperature Transducers and DAQ Systems
- Constant temperature Baths/Circulators (Various Units)
- AC/DC Power supplies (Various Units)

Brief description of the laboratory:

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Laboratory research keywords:

Design of Experiments; Evaporation; Boiling; Condensation; Water Desalination; Fog Harvesting; Nuclear Containment Thermal-hydraulics; Heat Pipes and Thermosyphons; Energy Systems

Year	Major research and development activity
2020-2021	▪ Thermal Performances of a Flat-plate Pulsating Heat Pipe Tested with Water, Aqueous Mixtures and Surfactants.
2019-2020	**Interfacial dynamics and Transport Phenomena** ▪ Drop-on-drop Impact Dynamics on a Superhydrophobic Surface ▪ Evaporation Rate of Warm Water Placed inside a Partially-filled Top Cooled Enclosure was determined using non-invasive interferometry and supporting mathematical modeling. **Spray Cooling of high-power LEDs** ▪ Thermal Characterization of Spray Impingement Heat Transfer over a High-Power LED Module was carryout and heat flux of the order of 1000

	W/cm^2 was demonstrated with this technique.
2018-2019	**Interfacial dynamics and Transport Phenomena** ▪ Coalescence dynamics of sessile and pendant liquid drops placed on a hydrophobic surface was experimentally investigated. Vertical and sidewise (horizontal) coalescence was explored. ▪ Evaporation dynamics of liquid bridge formed between two heated hydrophilic and hydrophobic flat surfaces was explored.
2017-2018	**Development of Loop Heat Pipes:** ▪ Loop Heat Pipes were indigenously developed with Copper and Nickle bi-porous wicks. The LHPs were successfully deployed for thermal management of high-power LEDs. ▪ Miniature Ammonia Loop Heat Pipe for Terrestrial Systems were developed, tested and applied for electronics thermal management. Numerical model to predict the heat transfer characteristics were developed. ▪ Dynamic Evolution of an Evaporating Liquid Meniscus from Structured Screen Meshes and other type of porous structures, as applicable to heat pipes was experimentally studied. ▪ Effect of externally imposed vibrations on the thermal performance of miniature loop heat pipes for avionics cooling was investigated.
2016-2017	**Understanding Transport Phenomena of Ferrofluids** ▪ Experiments were designed to estimate the heat transfer coefficient for single-phase and two phase (air-ferrofluid) flow of ferrofluids in capillary tubes. ▪ On-demand Augmentation in Heat Transfer of Taylor Bubble Flows Using Ferrofluids was demonstrated via dedicated experiments under different boundary conditions. The multi-physics flow and heat transfer of magnetically activated ferrofluids was modeled. **Flexible Heat Pipes for Space Applications:** ▪ Flexible wicked heat pipes were designed for space applications and prototypes were supplied to Indian Space Research Organization. **Development of heat flux sensor:** ▪ Based on inverse heat transfer techniques, an algorithm was developed to estimate heat flux with the help of one/two thermocouples. This was implemented and a real-time heat flux measurement sensor was developed and tested. This was eventually installed in the Nuclear Containment Facility THYCON.
2015-2016	**Understanding pulsating heat pipes:** ▪ Pulsating Laminar Flows in Microchannels were explored to estimate the transport coefficients. ▪ Experiments were conducted on pulsating Taylor bubble flows in micro-

	channels, in the context of understanding Pulsating Heat Pipes. ▪ Evaporation of a single liquid plug moving inside a capillary tube was studied with the focus on understanding the physics of thin film evaporation near the contact line. ▪ Experiments were conducted to understand the thransport phenomena of Thermally induced oscillating two-phase flows in mini-channels. **Steam Condensation in Nuclear Containments** ▪ Experimental setup to decipher the flow of steam-helium-air mixture inside nuclear containment structures were initiated. ▪ A CFD based Modeling Approach for Predicting Steam Condensation in the Presence of Non-condensable Gases was developed and results were validated with supporting experiments. ▪ Effect of surface inclination on film-wise condensation heat transfer during flow of steam-air mixtures was investigated.