PROJECT OVERVIEW

Project Title:

Adaptable Single Active Loop Thermal Control System (TCS) for Future Space Missions

Principal Investigator:

Issam Mudawar, Professor and Director of Boiling and Two-Phase Flow Laboratory
Purdue University, Mechanical Engineering Building, 585 Purdue Mall
West Lafayette, IN 47907-2088
Phone: (765) 494-5705; Fax: (765) 494-0539; Email: *mudawar@ecn.purdue.edu*

NASA Collaborator:

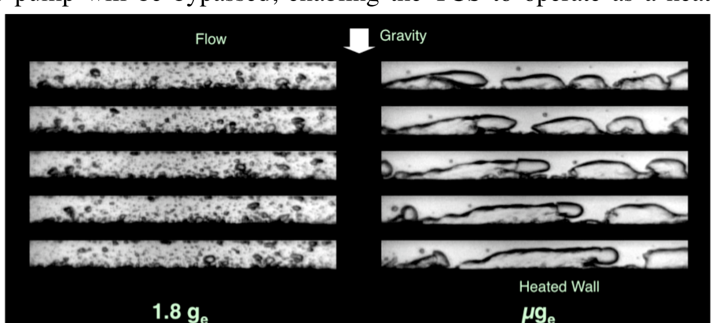
Mohammad Mojibul Hasan
NASA Glenn Research Center; Microgravity Fluid Physics Branch, MS 77-5
21000 Brookpark Rd, Cleveland, Ohio 44135
Phone: (216) 977-7494; Fax: (216) 433-8050; Email: *mohammad.m.hasan@nasa.gov*

Brief Paragraph:

The primary objectives of this study are to develop (1) a fundamental understanding of two-phase transport phenomena and (2) design concepts for a thermal control system (TCS) for future space missions. The proposed system architecture will enable the TCS to be reconfigured during the various mission phases to respond, not only to varying heat load, but to heat rejection temperature as well.

Summary:

This study will explore both fundamental two-phase transport phenomena and concept development for a thermal control system (TCS) for future space missions utilizing a single active cooling loop. The system architecture enables the TCS to be reconfigured during the various mission phases to respond, not only to varying heat load, but to heat rejection temperature as well. The system will consist of an actively controlled accumulator, pump, cold plates (evaporators), condenser/radiator, and compressor, in addition to control, bypass and throttling valves. For cold environments, the heat will be rejected by radiation, during which the compressor will be bypassed, reducing the system to a simple pumped loop that, depending on heat load, can operate in either a single-phase liquid mode or two-phase mode. For warmer environments, the pump will be bypassed, enabling the TCS to operate as a heat pump. Situations involving very high transient heat loads (*e.g.,* during reentry) will be handled by passing vapor through a water-cooled flash evaporator/sublimator. Great improvements to thermal performance of the cold plates (evaporators) and condenser will be realized by capitalizing on recent findings concerning mini/micro-channel evaporation and condensation that could lead to major reductions in TCS weight and volume while providing very high heat transfer coefficients. The proposed study is expected to yield (a) fundamental pressure drop and heat transfer models for cold plate (evaporator) design (including minimum flow requirements that preclude any dependence on gravity), (b) fundamental pressure drop and heat transfer models for condenser design, (c) thermodynamic assessment for optimum loop configuration, and (d) assessment of the benefits of incorporating nano-particles to enhance heat transfer performance. This project will be a joint effort between the Purdue University Boiling and Two-Phase Flow Laboratory (PU-BTPFL) and the NASA Glenn Research Center.



Channel flow boiling at 1.8 g_e and μg_e