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COOLING SOLUTIONS FOR EMBEDDED SYSTEM

Abstract

In the astronautic field, to improve flexibility and provide an easier maintenance of the aircrafts, we witness an increasingly widespread use of electrical systems to replace hydraulic and pneumatic technologies. This target implies a significantly higher number of dissipating electronic components embedded in a given vehicle. Furthermore, the general tendency towards components miniaturization leads to an increasing dissipated heat flux. Power density increasing, thermal management is crucial to ensure performance, lifespan and reliability of onboard systems. Facing these new thermal constraints, classic solutions for cooling, like heat pipes, reach their operating limit. Thus, new cooling solutions have to be developed, or existing solutions may be recycled and drastically improved. Two-phase capillary pumped loop cooling systems offer the best ratio of mass to transport capability and are therefore the most suitable solution to cope with miniaturization constraints. Indeed, Loop Heat Pipe (LHP) can transfer heat flux of a few dozen of W/cm along several meters under gravity or under space environment. Moreover they do not require any mechanical system to set the motion of the fluid which is induced by the capillary evaporator where the vaporization of the fluid into a porous wick, create a pressure difference leading to the circulation of the fluid along the loop. The downside of regular LHP is that only the heat produced by a single source can be managed. However, most of the time, many onboard dissipating components need their temperature to be controlled. Thus, in the context of the SOCOOL project ("SOlutions for COOLing") led at the IRT Saint Exupery, a novel architecture of LHP has been developed, in which several auxiliary two phase evaporators have been added in series with the two phase reservoir. Hence, the breadboard has the following characteristics: out of the main capillary evaporator, the LHP line crosses a first condenser, the three auxiliary evaporators, a second condenser, and then returns to the evaporator. The main capillary evaporator drives the mass flow rate while auxiliary evaporators are dedicated to heat transfer only. During the first part of the project, experimental investigations have been made in order to explain the loop behavior and the changes in flow regimes within auxiliary evaporators when power is applied to them. The operating limits and the operating conditions were notably pointed out. However, it had been noticed, that the trigger of boiling inside the auxiliary evaporators was hard to reproduce and an overshoot of the liquid temperature was observed before boiling incipience. This mean that the liquid temperature was warmer than the saturation. This problem is recurrent within the use of two phase evaporators but have to be solved because the temperature of hot sources needs to be maintain under a critical value in order to prevent the equipment from being damaged. Therefore, the breadboard has been modified and the auxiliary evaporators have been adapted to enhance the boiling incipience. The use of these new evaporators eases the trigger of boiling and reduces the temperature overshoot compared with the previous evaporators. This overshoot has not completely vanished but it is now more reproducible. The reliability of the complete loop is indeed greatly improved. New geometry of evaporators will now be tested. Comparing all the results obtained with these different evaporators and conclude on a most effective geometry will be one of the purpose of my internship. Moreover a new design of a multi-sources LHP is under conception. This new breadboard will allow validating the operability and demonstrate the capacity of the system to operate under flight conditions. My goal will be to perform various measurement

to validate the concept and point out the operating characteristics. These two studies will be presented during the IAC.