Pulsating Heat Pipe with integrated Tesla Valve

Since electronics become more powerful and more compact, they produce more heat on a smaller surface area. Therefore electronics gets overheated more quickly. To produce reliable and cheap electronics cooling (also in vertical directions) a pulsating heat pipe (PHP) is used. A PHP consists of a thin meandering channel (diameter of about 0.5mm) that is filled with a fluid (figure 1). The PHP uses the vapor pressure that is created locally when the liquid evaporates at a hot spot. By this evaporation and the inertia, an oscillation is created. By this, the heat can be removed very efficiently. Although at NLR they have several working PHPs, the working mechanism is not fully understood.

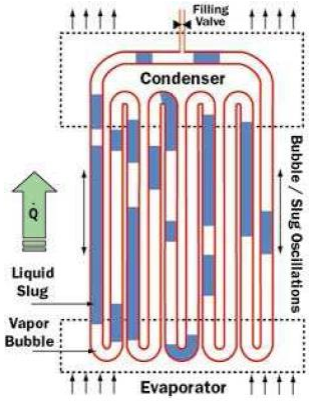
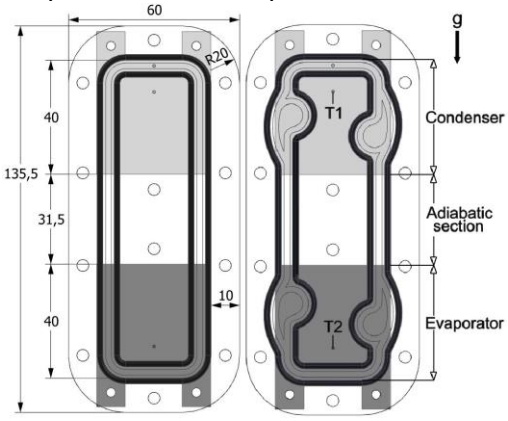


Figure 1. Pulsating Heat Pipe

Previous research has shown that the operation of the pulsating heat pipe is most efficient when on top of a pulsating flow, a rotational slug-plug flow is established. In a rotational flow, the residence time of a slug that moves from condenser to evaporator or vice versa is the longest. More residence time means more time for heat transfer to take place, thus a more efficient device. An elegant solution is to incorporate Tesla valves in the PHP design. The Tesla type valves are valves with no moving parts that rely on a geometry to create a difference in pressure drop, depending on the flow direction through the valve. This diodicity in pressure drop can be used to promote the flow direction in one direction.



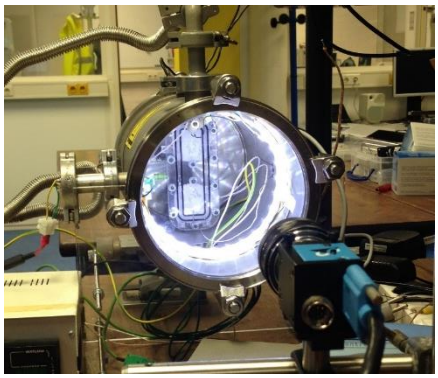


Figure 2. Normal Pulsating Heat Pipe and PHP with integrated Tesla valves (left) and experimental set-up to measure effective thermal resistance of the PHP (right)

In previous research we have shown that this principle indeed improves the thermal performance for a single turn PHP. However for practical applications, e.g. in aerospace applications, the design has to be extended to multi-turn PHPs. The goal of this project is study multi-turn PHPs numerically and experimentally.
Part of this graduation project can be carried out at NLR Flevoland.

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