Research theme	Design, Production and Management
Research title	Modelling and experimental investigation of a thermally driven self-oscillating pump
Researcher	M.P. Zwier
Research period	From Jan 2014 till Aug 2015
Company	Univerisity of Twente & National Aerospace Laboratory (NLR)
Supervisor	dr. ir. W.W. Wits

Background

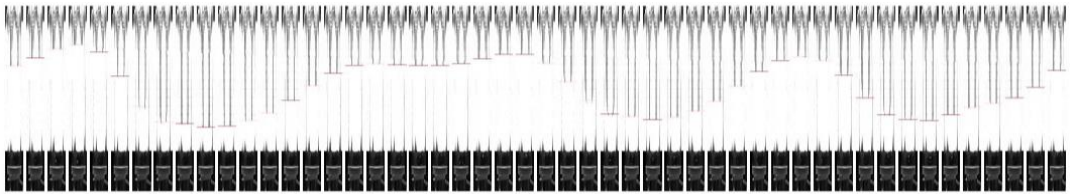
The thermal control of electronics plays an increasingly important role in the design of future aerospace applications. When the cooling of electronics with heat pipes and loop heat pipes is insufficient, mechanical driven cool loops are used. These mechanical driven cooling loops operate on the basis of single or two-phase fluid flow and are usually powered by a single pump. A single mechanical micro pump contains moving parts that are subjected to wear, making the pump a single point of failure. Therefore, a reliable lightweight pump with less or no moving parts would improve the thermal design of aerospace applications. The new pump consists of a single stainless steel tube which is divided into three sections: evaporator, adiabatic and condenser section. An expanding and contracting vapour bubble oscillates between the evaporator and condenser driven by thermal energy. The vapour bubble acts like a piston, pumping fluid with the aid of the check valves.

Assignment

The goal of my research was to experimentally investigate the behaviour of the self-oscillating pump driven by thermal energy and to better understand the influences of the different design parameters. Besides the experimental investigation an existing numerical model was improved.

Results

During the experimental investigation the prototype pump performed well and stable continuous oscillating behavior in the range of 3 to 6 Hz was observed. The experiments showed however that the output mass flow and pressure head of the pump were less than expected. The increase of evaporator input power did not result in more output power and a maximum threshold value was observed. A secondary cause was the repetitive inflow of relatively cold working fluid into the pump. The tube diameter has a directly proportional relationship with the output mass flow. The maximum obtained pump flow was 165 ml/min and the pressure head reached 1.25 bar with the prototype operating at ambient pressure.



1 second of video analysis of the oscillating vapour bubble

Personal experience

During this thesis I had the opportunity to not only numerically model the oscillating behaviour of the vapour bubble but also to conduct multiple experiments with the developed prototypes at the thermal laboratory of the NLR in Marknesse. I enjoyed working in the laboratory, conducting the experiments and to be able to see the influences of your own design choices. The guidance and supervision at the NLR were very pleasant. The colleges at the thermal laboratory always had good solution to little problems I faced during the experiments.