The industrialization processes underway around the world are presenting engineers with new challenges. The mechanization of production requires advanced control systems, often based on electrical technologies, to increase production efficiency. A prominent issue in this context is the efficient removal of heat from processors to maintain optimum temperature and maximize computing performance. There is also a growing interest in communications systems for space, including Earth orbit and interplanetary space, particularly at the initiative of space agencies such as NASA, which are encouraging private investors to participate through large contracts. However, both agencies and private companies are required to meet stringent safety and reliability standards and to optimize the modularity of equipment to reduce the cost and time of future missions.

The challenges of reliability and thermal efficiency apply to systems on Earth as well as in space. One solution for passive cooling is Pulsating Heat Pipes (PHPs), which use microchannels. Unlike active systems, PHPs have no moving parts, are lighter and easier to manufacture. The simplest version of a PHP is a closed capillary loop partially filled with refrigerant. In traditional heat pipes, liquid and vapor flow in separate channels, making it easier to analyze internal phenomena, whereas in PHPs liquid and vapor flow simultaneously, depending on phenomena occurring at the phase boundaries.

Typically, a PHP consists of a closed capillary tube partially filled with a working fluid (e.g. water), as shown in Figure 1. Unfortunately, several problems associated with PHPs remain unsolved. The biggest challenge at present is the phenomenon of complete evaporation (drying out; in the region highlighted in red). When this occurs, the entire system rapidly loses its heat transfer capacity, and the temperature rises. The main cause of complete evaporation is the gradual disappearance of the liquid film, and research to date has focused on its thickness in a constant velocity flow. However, the flow in PHP is highly dynamic and the thickness of the liquid film is not constant.

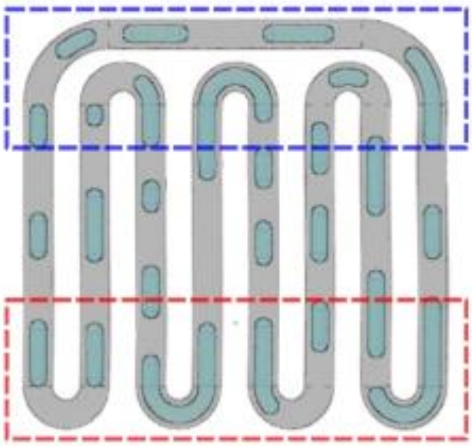

Figure 1 - Pulsating heat pipe.

Furthermore, the planned application to space technologies means that the scope of the research can be extended in the future, and the subject matter is within a dynamically developing field. Among other things, the author's previous research demonstrates the importance of research into two-phase fluids, including PHP, whose applications can be found from cryogenic temperatures to cooling electronics in space.

The project plans to perform flow tests under controlled conditions of velocity, angle of inclination, different channel diameters and operating media, and oscillation frequency. The liquid film and recirculation in the liquid region studied in this way will be novel due to the experiment performed for dynamically varying oscillatory flows in the capillaries. This will allow correlations to be developed for current empirical and numerical models, so that the flow dynamics can be considered more accurately at the design stage. The project will result in research findings that will contribute to the future optimization of the design of two-phase flow systems with dynamic flow, thereby reducing the cost of heat transfer systems.