Insights into the thermo-hydrodynamics of a unit cell of a Pulsating Heat Pipe (PHP) through Experiments and CFD Modeling

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A pulsating heat pipe (PHP) is a promising heat transfer device for applications such as electronic cooling. The non-equilibrium phenomenon in a PHP arising due to factors such as pressure and temperature perturbations, flow regime changes, bubble nucleation and collapse, dynamic instabilities etc., make it very difficult for theoretical and experimental investigations on the parameters affecting the PHP characteristics. Therefore, a reduction of the PHP to a single unit cell consisting of a vapor bubble and liquid slug makes the investigation of the individual parameters on the oscillatory behavior much easier. The slug flow also referred to as the Taylor Bubble (T-B) flow is one of the most important flow patterns encountered during the operation of a PHP. In this lecture, it is attempted to understand the thermo-hydrodynamics of a unit cell of a Pulsating Heat Pipe (PHP) through experiments and CFD Modeling. The initial part will focus upon the experimental behavior of an oscillatory meniscus and the corresponding effects of the heat exchanger sizes on the oscillatory behavior will be presented. The latter part of the talk will discuss the details of both sensible and phase change heat transfer modeling of a unit cell using an improvised interface tracking scheme implemented in to the VOF model of OpenFOAM. The numerical method is then applied to conduct a parametric study on phase change heat transfer on a unit cell model of a PHP using FC-72 as the working fluid.