This presentation summarizes experimental and modeling results in the context of applications of shear driven (including zero/micro-gravity flows) annular regime operations of milli-meter scale innovative flow-boilers and condensers. Besides describing the innovative operations, the presentation summarizes more recent computational and experimental results obtained for annular/stratified internal boiling and condensing flows. The reported results come from experiments as well as from a new fundamental scientific computational tool. The computations yield accurate numerical solutions of the full two-dimensional steady and unsteady governing equations.

The results highlight: (i) experimental ways for realizing high amplitude wavy annular thin film flows, (ii) differences in flow physics for shear driven (horizontal channels) and gravity driven (inclined channels) flows, (iii) non-linear stability analyses based identification of annular to plug-slug transition boundary, (iv) summary of the correlations developed to predict heat-transfer rates and the length of the annular regime, and (v) discussions of contact line flow-physics and acoustics enabled standing wave formations that are needed for very high heat-flux operations.

The talk also relates the science to technologies that can address cooling needs for devices operating at high heat-load and high heat-flux ($\geq 1$ kW/cm$^2$) values – such as in supercomputer and data center cooling.

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