**Numerical References:**

Kadam, S. T., & Kumar, R. (2014). Twenty first century cooling solution: Microchannel heat sinks. *International Journal of Thermal Sciences*, *85*, 73–92. <https://doi.org/10.1016/j.ijthermalsci.2014.06.013>

Summary: This paper provides a review of experimental studies on flow visualization, pressure drop and heat transfer characteristics of microchannels presented by different researchers. In general, the summary highlights the large variations between recent research and how single and two-phase models report significantly different correlations.

Liu, Y., Cui, J., Jiang, Y. X., & Li, W. Z. (2011). A numerical study on heat transfer performance of microchannels with different surface microstructures. *Applied Thermal Engineering*, *31*(5), 921–931. <https://doi.org/10.1016/j.applthermaleng.2010.11.015>

Summary: This paper numerically studies forced convection heat transfer in microchannels using CFD and Lattice Boltzman methods. The authors compare the results of their models with previous research (experimental and numerical) and find a good agreement with the literature. Furthermore, the authors investigate the effects of microchannel geometry and find that the heat exchange efficiency can be improved by incorporating a shield-shaped geometry at the inlet.

Kandlikar, S. G. (2013). *Flow Boiling in Minichannels and Microchannels*. *Heat Transfer and Fluid Flow in Minichannels and Microchannels* (Second Edi). Elsevier Ltd. <https://doi.org/10.1016/B978-0-08-098346-2.00005-3>

Summary: This is a book chapter by Kandlikar that focuses on all aspects of microchannel flow boiling. It isn’t a research article, but it provides a good summary of techniques and research up to around 2012.

Zhang, L., Koo, J.-M., Jiang, L., Asheghi, M., Goodson, K. E., Santiago, J. G., & Kenny, T. W. (2002). Measurements and modeling of two-phase flow in microchannels with nearly constant heat flux boundary conditions. *Journal of Microelectromechanical Systems*, *11*(1), 12–19. <https://doi.org/10.1109/84.982858>

Summary: These authors conduct an experimental study of a single and multiple channel heat exchangers with dimensions below 100 um. Additionally, the authors develop a thermal circuit model based on the experimental study to estimate the heat loss parameters for varying channel sizes.

Wang, G., Hao, L., & Cheng, P. (2009). An experimental and numerical study of forced convection in a microchannel with negligible axial heat conduction. *International Journal of Heat and Mass Transfer*, *52*(3–4), 1070–1074. <https://doi.org/10.1016/j.ijheatmasstransfer.2008.06.038>

Summary: This paper performs an experimental study of laminar forced convection of water and creates a three-dimensional numerical simulation to correlate with the experimental results. The authors conclude that the Navier-Stokes and energy equations are valid for modeling convection in a microchannel having a hydraulic diameter less than 155 um.

Magnini, M., Pulvirenti, B., & Thome, J. R. (2013). Numerical investigation of the influence of leading and sequential bubbles on slug flow boiling within a microchannel. *International Journal of Thermal Sciences*, *71*, 36–52. <https://doi.org/10.1016/j.ijthermalsci.2013.04.018>

Summary: This paper develops a multi-bubble simulation to study slug flows. The model created uses ANSYS with custom implementations for the Height Function and the evaporation model. This paper generates a number of valid conclusions considering the physical phenomena associated with slug flow and asserts that single-bubble simulations do not capture many of the underlying mechanics of slug flows.

Rostami, J., Abbassi, A., & Saffar-Avval, M. (2015). Optimization of conjugate heat transfer in wavy walls microchannels. *Applied Thermal Engineering*, *82*, 318–328. <https://doi.org/10.1016/j.applthermaleng.2015.02.069>

Summary: The authors develop a 3D numerical simulation to study the effects of geometry on conjugate heat transfer with water as the working fluid. Effects of geometrical parameters including aspect ratio, wall thickness, amplitude and wavelength have been investigated and the authors have found that wavy-walls increase the Nussult number.

Leng, C., Wang, X. D., Wang, T. H., & Yan, W. M. (2015). Multi-parameter optimization of flow and heat transfer for a novel double-layered microchannel heat sink. *International Journal of Heat and Mass Transfer*, *84*, 359–369. <https://doi.org/10.1016/j.ijheatmasstransfer.2015.01.040>

Summary: The authors perform an optimization study for a double-layer microchannel heat sink. The optimization algorithm is composed of a three-dimensional solid–fluid conjugate heat sink model and a simplified conjugate-gradient method. Additionally, the authors provide a set of parameters for the optimal geometry of a double-layer microchannel heat sink.

Zhou, S., Xu, X., & Sammakia, B. G. (2013). Modeling of boiling flow in microchannels for nucleation characteristics and performance optimization. *International Journal of Heat and Mass Transfer*, *64*, 706–718. <https://doi.org/10.1016/j.ijheatmasstransfer.2013.05.031>

Summary: This paper develops a Level-Set, Two-Phase Flow model to study the characteristics of nucleate boiling. Additionally, the paper compares the performance of enhanced and plain wall-channels and their effects on CHF. The effects of geometry on nucleation cavities are studied and an optimized geometry is proposed.

Magnini, M., Pulvirenti, B., & Thome, J. R. (2013). Numerical investigation of hydrodynamics and heat transfer of elongated bubbles during flow boiling in a microchannel. *International Journal of Heat and Mass Transfer*, *59*(1), 451–471. <https://doi.org/10.1016/j.ijheatmasstransfer.2012.12.010>

Summary: This paper considers the same model as the paper from Magnini above, but focuses specifically on a single slug bubble. The numerical investigation confirms that thin film evaporation is the primary heat transfer mechanism in the channel and a new transient heat conduction model for the liquid film region is proposed here.

Conti, A., Lorenzini, G., & Jaluria, Y. (2012). Transient conjugate heat transfer in straight microchannels. *International Journal of Heat and Mass Transfer*, *55*(25–26), 7532–7543. <https://doi.org/10.1016/j.ijheatmasstransfer.2012.07.046>

Summary: The authors utilize commercial software to examine heat removal from straight rectangular microchannels affected by a time-dependent heat flux input. The effects of the amplitude of the heat flux variation, inlet velocity, and geometry, including the thickness of the heat sink, are investigated. Channels of smaller width are found to be more sensitive to the heat flux source, especially for higher input values. The velocity of the media is found to be the most important parameter of the study as it effect the pressure drop through the channel.

Duryodhan, V. S., Singh, A., Singh, S. G., & Agrawal, A. (2015). Convective heat transfer in diverging and converging microchannels. *International Journal of Heat and Mass Transfer*, *80*, 424–438. <https://doi.org/10.1016/j.ijheatmasstransfer.2014.09.042>

Summary: The authors perform an experimental and three-dimensional numerical study on single phase liquid flow for heated diverging and heated converging media in microchannels. The study uses an 8° angle of divergence and a channel diameter of 156 um. Their results show that the conjugate effect results in a significant improvement in converging microchannels.

**Analytical References:**

Szczukiewicz, S., Borhani, N., & Thome, J. R. (2013). Two-phase flow operational maps for multi-microchannel evaporators. *International Journal of Heat and Fluid Flow*, *42*, 176–189. <https://doi.org/10.1016/j.ijheatfluidflow.2013.03.006>

Summary: The current paper presents new operational maps for several different multi-microchannel evaporators, with and without any inlet restrictions (micro-orifices), for two-phase flow refrigerants. Flow instabilities, vapor back flow, and flow maldistribution prevented by placing restrictions at the inlet of each channel. High-speed flow visualization distinguished eight different operating regimes of the two-phase flow depending on the tested operating conditions.

Costa-Patry, E., & Thome, J. R. (2013). Flow pattern-based flow boiling heat transfer model for microchannels. *International Journal of Refrigeration*, *36*(2), 414–420. <https://doi.org/10.1016/j.ijrefrig.2012.12.006>

Summary: The authors provide some updates to a three-zone flow boiling model for slug flow (previously developed), including further proof that the dryout thickness is well represented by setting it equal to the measured channel roughness for the silicon, copper and stainless steel test surfaces. Next, a non-circular channel version of the Cioncolinie-Thome unified annular flow model for convective boiling is proposed. These two methods are joined together into a flow pattern-based method using a new heat flux-dependent flow pattern transition criterion between slug flow and annular flow. The method predicts the results quite accurately and also captures the trends in the heat transfer coefficients well.

Wang, Y., & Sefiane, K. (2013). Single bubble geometry evolution in micro-scale space. *International Journal of Thermal Sciences*, *67*, 31–40. <https://doi.org/10.1016/j.ijthermalsci.2012.11.011>

Summary: Two types of single vapor bubble growth in micro-scale space are experimentally investigated and properties which are influential to bubble growth are discussed. Bubble growth during flow boiling in high aspect ratio micro-channels is also examined to extensively investigate the single bubble growth in a dynamic configuration.

Harirchian, T., & Garimella, S. V. (2010). A comprehensive flow regime map for microchannel flow boiling with quantitative transition criteria. *International Journal of Heat and Mass Transfer*, *53*(13–14), 2694–2702. <https://doi.org/10.1016/j.ijheatmasstransfer.2010.02.039>

Summary: This paper provides a comprehensive review of the flow regime map for microchannel flow boiling. The authors argue that channel dimensions and flow properties alone are insufficient for determining confinement effects in microchannel boiling. Additionally, the authors propose new criterion for physical confinement in microchannel flow boiling, termed the convective confinement number, that incorporates the effects of mass flux, as well as channel cross-sectional area and fluid properties.

Liu, T. Y., Li, P. L., Liu, C. W., & Gau, C. (2011). Boiling flow characteristics in microchannels with very hydrophobic surface to super-hydrophilic surface. *International Journal of Heat and Mass Transfer*, *54*(1–3), 126–134. <https://doi.org/10.1016/j.ijheatmasstransfer.2010.09.060>

Summary: The authors conduct an experimental study of microchannel flow boiling with three identical channels that have a different wettability. Different boiling flow patterns on a surface with different wettability were found, which leads to large difference in temperature oscillations. Periodic oscillation in temperatures was not found in both the hydrophobic and the super-hydrophilic surface.

Xu, L., & Xu, J. (2012). Nanofluid stabilizes and enhances convective boiling heat transfer in a single microchannel. *International Journal of Heat and Mass Transfer*, *55*(21–22), 5673–5686. <https://doi.org/10.1016/j.ijheatmasstransfer.2012.05.063>

Summary: The authors perform an experimental study of microchannel flow boiling using water with nanofluids. The boiling flow displays chaotic behavior due to the random bubble coalescence and breakup in the milliseconds timescale at moderate heat fluxes for pure water. The flow instability with large oscillation amplitudes and long cycle periods was observed with further increases in heat fluxes.

Harirchian, T., & Garimella, S. V. (2009). Effects of channel dimension, heat flux, and mass flux on flow boiling regimes in microchannels. *International Journal of Multiphase Flow*, *35*(4), 349–362. <https://doi.org/10.1016/j.ijmultiphaseflow.2009.01.003>

Summary: The authors perform an experimental study of microchannel flow boiling to study the effects of channel dimensions, heat flux, and mass flux for different flow boiling regimes. Flow visualizations are per- formed with a high-speed digital video camera while local measurements of the heat transfer coefficient are simultaneously obtained. The visualizations and the heat transfer data show that flow regimes in the microchannels of width 400 um and larger are similar, with nucleate boiling being dominant in these channels over a wide range of heat flux