What Really Happens in a Thermosyphon?

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Abstract:

Most of our understanding of boiling and condensing heat transfer and two phase pressure drop in thermosyphon reboilers has been derived from cryogenic heat transfer in plate-fin test sections. While fundamental models for film and slug-flow have been shown to work in some regions, the best available predictions for boiling and condensing have been obtained with the Chen(1966) and CSBK(1992) correlations respectively. However, limited flow visualisation experiments with low surface tension fluids indicate that while these correlations perform reasonably well over their limited ranges of application in idealised test geometries, there are a number of pitfalls awaiting the unwary designer. Not least is the question of hydraulics in the condensing stream, where it is known that actual two-phase condensing coefficients can be substantially higher than those predicted by the Chun-Seban based correlation. It is suggested that in most thermosyphons there is a significant sub-cooled condensate region, caused by outlet distributor flooding. This has the effect of reducing the overall condensing coefficient by about 20%. The implications of this sub-cooling on inert gas handling and downcomer design are discussed. On the boiling side, the requirement for adequate recirculation (in oxygen-rich streams) has tended to limit the choice of fin-types. By understanding what influences two-phase pressure drop, deposition, and flow pattern it can be shown that alternative fin choices enhance throughway area, shear and overall heat transfer rates. Extension of this semi-mechanistic approach to other fluids and other operating conditions (high pressure) would enable improved thermosyphon and other reboiler designs to be achieved.