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Wickless two phase heat transfer devices: current advances and future perspectives

Heat pipes and thermosyphons are passive two-phase heat transfer devices with very high thermal conductance, consisting of a rigid envelope firstly evacuated, filled with a working fluid and sealed. The internal motion of the working fluid from the hot zone (evaporator) to the cold zone (condenser), is thermally induced and governed by the interplay of phase change, gravity and capillary forces. Since the latent heat of evaporation is large, considerable heat loads can be transferred with a very small temperature difference from end to end. Since 1960s, the original concept of Heat Pipe evolved towards several different devices that have been, studied and tested. Nowadays, the heat pipe technology is widely applied in different technical areas ranging from space to terrestrial applications, from micro to large sized applications and from cryogenics to high temperatures. Among all the two phase heat transfer devices, the ones that are able to work without any capillary wick structure, (i.e. wickless devices) present some advantages and still maintain outstanding thermal performances. Thermosyphons, loop thermosyphons, pulsating heat pipes and vapour chambers are only few examples of wickless devices in the literature. What are their peculiarities and their limitations? Which device is the most indicate for any different application? What are the perspectives of their use in future applications? These are a few general but fundamental questions the research attempt to answer at present. This works, therefore, illustrates the complex physical mechanisms occurring inside the wickless devices in order to describe the most reliable correlations developed and tested so far in the literature to predict their operative temperatures and the heat power capability as well as their operational limits. The excellent heat transfer performance joined with a huge versatility in terms of operative conditions, make the wickless device the best candidate in several technological areas. A large number of applications examples are presented and described by emphasizing the efficiency improvement achieved so far. Finally, an overview of the perspectives for future research and applications are provided.