

Variable Conductance Heat Pipes: Modelling and Applications

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The Variable Conductance Heat Pipes (VCHP) differs from other heat pipe types by its thermal control capability: The ability to keep the temperature of a device mounted on the evaporator almost constant, independent of changes of the VCHP boundary conditions (the by the device dissipated power and condenser heat sink).

The only viable VCHP is of the gas-buffered type. A gas-buffered VCHP can be without or with a cold reservoir (the latter without or with a capillary wick) and with a hot reservoir. Their thermal control properties are limited in case of passive control, even in case of passive feedback control for a VCHP equipped with a bellows reservoir. Perfect temperature control can only be realised using (active) electrical feedback control. A comparison between the various options clearly shows the advantages and drawbacks of the various VCHP options. Aspects of working fluid selection and reservoir sizing will be discussed, including feedback control issues.

The prediction of VCHP control behaviour depends on the particular thermal model used. Mostly this can be done using the Edwards-Marcus flat front model. For some VCHP applications, especially those requiring a VCHP with a low vapour pressure working fluid. Inertial effects (that can occur for instance during start-up) are to be included in the model. The model developed to account for inertial effects is presented. Modelling outcomes are discussed in detail, including the impact of inertial effects on (active) feedback thermal control.

A Loop Heat Pipe (LHP) normally operates in the constant conductance mode. But, under certain conditions, the LHP is able to operate also in a variable conductance mode. This will be discussed in detail.