# CHAPTER VII

# CONCLUSIONS

The main conclusion of the present work are as follows:

1. A copper / water heat pipe (three layers of 150-mesh brass) was studied experimentally under unsteady state (start up) conditions. The tilt angle ( antigravity) was used as a parameter ($10^{\circ}C$, $20^{\circ}C$, $30^{\circ}C$) while applied heat input was varied (5.34-5.45, 7.5-7.6, 13.08-13.12, 16.45-33.23 watts). The limiting heat flux was fonnd to be due to capillary limitation and its value agree well with the theoretical value (for exemple, 17.4 W. versus 17.04 W. at $\psi = 10^{\circ}C$ and 33.28 W. heat input).

2. The temperature response of the heat flux versus time during the startup period up to the steady state was obtained. The time responses of the heat pipe surface temperature appear to be of linear first-order system. The time constant of the system under various operating conditions was next determined. It is concluded that the time constant of the tested heat pipe is essentially independent of the applied heat input, but depend slightly on the antigravity tilt angle in a reverse manner.

3. Since the dynamic behavior of the heat pipe can be approximated by a first-order system, we may as well use a simple empirical model instead of the present elaborate lumped-parameter transport model to predict the time response (startup) of the heat pipe, provided the true time constant of the heat pipe has been found

a priori.

4. There appears to be a linear correlation between the heat input to the heating wire and the heat transfer rate through the heat pipe, provided the system is not under limiting heat transfer condition. Therefore the correlation can be used to predict the steady state heat transfer rate at any tilt angle in the absence of heat transfer limitation.

5. Heat transfer rate of the heat pipe generally decreases when the antigravity tilt angle increases with the heat input being kept constant. At the same tilt angle, however, the heat transfer rate increased as heat input increases.

6. The effective thermal conductivity of the heat pipe was found to depend strongly to the tilt angle and the applied heat input. The highest observed value is approximately 35 times better than a copper rod of the same dimensions as the heat pipe, when the heat transfer rate is 4.36 W. and tilt angle 20 degrees (antigravity).

7. A mathematical dynamic lumped model of the heat pipe has been derived, and the simulation results compared with the experimental data to see how good the model is. It is found that the dynamic model give startup results that agree only qualitativly with the experimental results, primarily because there are still uncertainty in the theoretical determination of some model parameters, especially the effective view fartor for heat radiation from the heating wire and effective thermal conductance of the heat pipe wall plus liquid-filled wick.