CHAPTER I

INTRODUCTION

Energy conservation is becoming increasingly important as the cost of fossil fuel rises and the world reserves diminish. Intensive studies are being made by industrial plants to find out where and how the total energy input to an industrial process is being wasted. In many instances, it has been technically and economically feasible to heat from some industrial exhausts. The heat pipe, because of its high effectiveness in heat transfer, is a prime candidate for applications involving the conservation (recovery) of energy, and has been used to advantage in heat recovery system, and energy conversion devices.

The heat pipe is a device of very high thermal conductance for transmitting heat from one location to another over a small temperature gradient. The idea of the heat was first suggusted by R.S. gaugler (1) in 1942. It was not, however, until its independent invention by G.M. Grover (2,3) in the early 1960s that the remarkable properties of the heat pipe became appreciated and serious development work took place.

The heat pipe is a sealed tube or chamber of various shapes whose inner surface are lined with a porous capillary wick. The wick is saturated with the liquid phase of a working fluid and the remaining volume of the tube contains the vapor phase. Heat applied at the evaporator by an external source vaporizes the working fluid in the section. The resulting difference in pressure drives vapor from the evaporator to the condenser where it condenses releasing the latent heat of vaporization to a heat sink in that section of the pipe. Depletion of liquid by evaporation causes the liquid-vapor interface in the evaporator to enter into the wick surface (see Fig. 1.2) and a capillary pressure is developed there. This capillary pressure pumps the condensed liquid back to the evaporator for reevaporation. That is, the heat pipe can continuously transport the latent heat of vaporization from the evaporator section to the condenser section without drying out wick. This process will continue as long as the flow passage for the working fluid is not blocked and a sufficient capillary pressure is maintained.

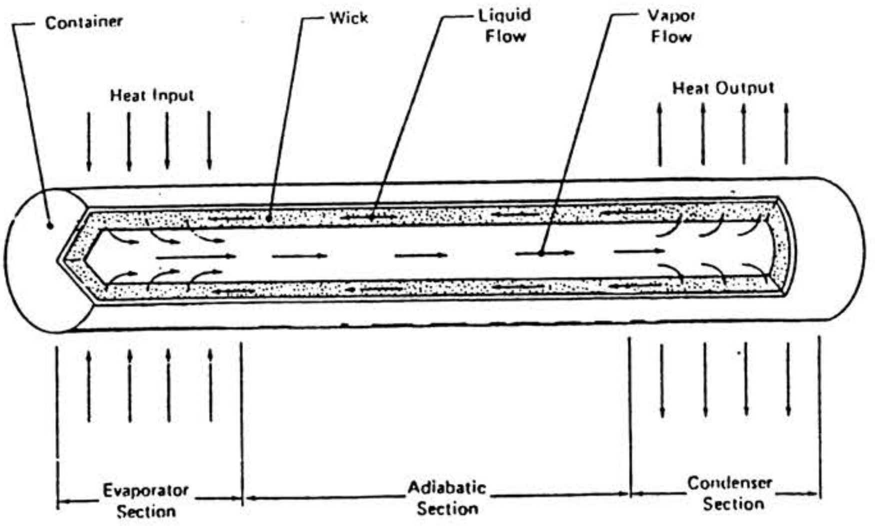

Fig. 1.1 Component and principle of operation of a conventional heat pipe

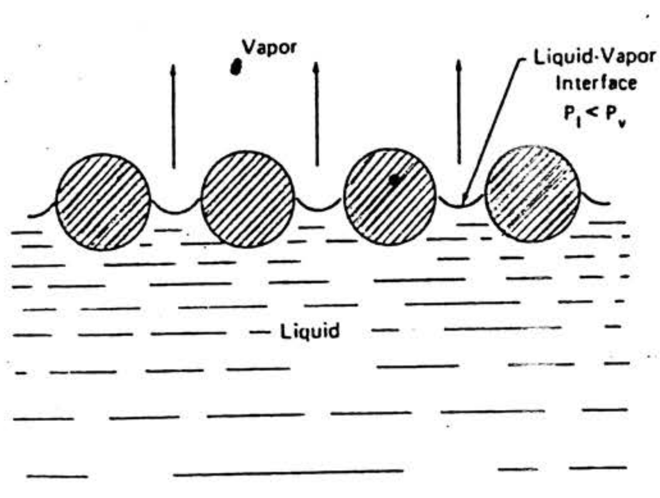

Fig. 1.2 Development of capillary pressure at liquid-vapor interface

The heatpipe is similar in some respects to the thermal syphon (see Fig. 1.3).

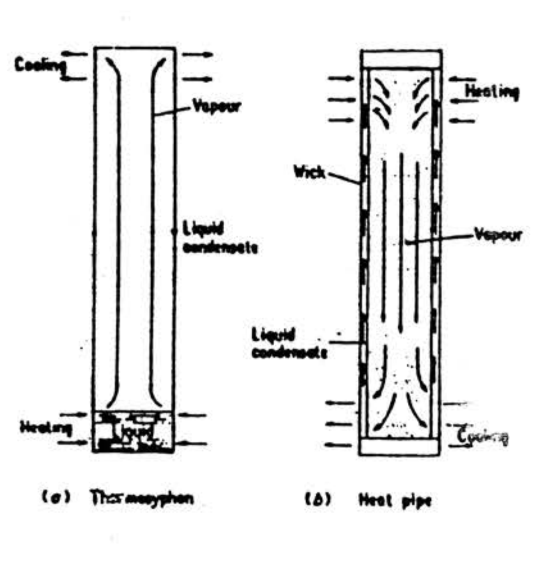

Fig. 1.3 The heatpipe and thermal syphon

In the thermo-syphon, a small quantity of liquid is placed in a tube, from which the air then evacuated and the sealed. The lower end of the tube is heated causing the liquid to evaporize and the vapor to move to the cold end of the tube, where it is condensed. The condensate is returned to the hot end by gravity. Since the latent heat of evaporation is large, considerable quantities of heat can be transported with a very small temperature difference from end to end. Thus the structure will have a high effective thermal conductance. One limitation of the basic thermal syphon is that in order for the condensate to be returned to the evaporator region by gravitational force, the later must be situated at the lowest point.

Since 1964, the heat pipe have found numerous applications. Liquid-metal heat pipes have been widely used in energetics for cooling nuclear and isotope reactor, for building thermionic and thermoelectric generators, and for heat recovery in gasification plants. Moderate-temperature heat pipes have been used in electronics to cool such items as generator tubes, travelling tubes, and instrument packages while in energetics they have been used to cool shafts, turbine blades, generators, motors, and transformers. In heat recovery they have been employed to collect heat from exhaust gases, solar energy, and geothermal energy. In metal cutting moderate-temperature heat pipes have been used to cool cutting tools. And, finally, in spacecraft they have served to control the temperature of vehicles, instruments, and space suits. The cryogenic heat pipes have been used in communications for cooling infrared sensors, parametric amplifiers, and lasers systems and in medicine for cryogenic eye and tumor surgery.

The list of applications is quite long and is growing at a rapid pace.

1.1 The Objectives of This Study

The main objectives are to:

1. Study experimentally the dynamic behavior of a heat pipe (mainly the transient behavior of heat pipe surface temperature and heat flux trough heat pipe)

2. Develop a computer model to predict the unsteady state (transient) behavior of the same heat pipe..

1.2 The Scope of Study

The scope encompasses the following:

1. Set up and carry out experiments to collect data on the transient behavior of a heat pipe under various operating conditions
2. Develop a computer model to predict the transient behavior of the same heat pipe.
3. Compare the results predicted by the computer model with the experimental results.
4. Improve the computer model, if necessary.