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Influence of Evaporator Length and Inclination on the Performance of Acetone-Filled Heat Pipe

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Abstract: - Heat pipes serve as efficient tools for transferring heat between different points in closed-loop systems. The behaviour of heat pipes depends on various factors such as geometry, physical properties, and operational conditions. Therefore, parameters like evaporator length, input power to the evaporator, and tilt angles are analyzed during the investigation process. The heat pipe was designed to contain acetone filling up 50% of the evaporator volume. Testing was conducted with heat inputs ranging from 40W to 120W, at orientations of 45° and 90°. The heat pipe's performance is evaluated based on key parameters such as effectiveness, thermal resistance, and temperature gradient under varying heat inputs and inclinations. Effectiveness improves as heat input rises from 40W to 120W, with greater efficiency seen in a 125 mm evaporator length and a 90° inclination. Thermal resistance is minimized with a 125 mm evaporator and 100 W input. Lower heat inputs correspond to reduced temperature gradients, indicating faster heat transfer rates. Notably, the heat pipe demonstrates exceptional performance in terms of effectiveness and thermal resistance at a 90° tilt and 125 mm evaporator length.

Keywords: *Evaporator Length, Inclination, Acetone Filled, Heat Pipe, Heat Pipe behavior.*

1. Introduction

Heat pipes are innovative heat-transfer devices that effectively handle heat transfer by combining thermal conductivity and phase transition principles. The idea of heat pipes was initially proposed by Gaugler in 1942. By utilizing the latent heat of the vaporized working fluid and a minimal temperature gradient through the phase change of the working fluid, heat pipes achieve significantly higher thermal conductivity compared to solid conductors. These devices offer numerous advantages in various applications such as heat recovery systems, solar energy, light water nuclear reactors, electronics cooling, and aircraft cooling.

A standard heat pipe is comprised of a sealed vessel, a wick system, and a minimal quantity of working fluid necessary to saturate the wick, and it is in balance with its vapour. The pressure at which the heat pipe operates is equivalent to the vapour pressure of its working fluid. The heat pipe's length is segmented into three parts: the evaporator, adiabatic, and condenser sections, as illustrated in Figure 1.