Fabrication And Experimental Evaluation of Heat Pipe Using Nano Fluid

Chennabasappa Hampali[1], Sujay S[2], Chethan kumar M N[3], Sarfarazuddin M R[4], Sunil Kumar[5]
[1, 2, 3, 4, 5] Dept of Mechanical Engineering
[1, 2, 3, 4, 5] REVA University, Bengaluru, Karnataka, India

Abstract- *This work aims to investigate the experimental performance of cylindrical heat pipe using γ-Al_2O_3 Nano fluid under variable parameters like heat input, filling ratio and the inclination angles. Basically heat pipe is working on evaporating cooling principle. During experimentation performance characteristics like thermal conductivity, thermal resistance and efficiency of heat transfer are evaluated with varying parameters like filling ratio, inclination angle and heat input. Results are compared with and without using Nano fluids.*

Keywords- Heat pipe**,** γ-Al_2o_3Nanofluid**,** Thermal conductivity, Thermal resistance

I. INTRODUCTION

Heat pipe is an effective heat transfer device that can transport heat at high rates with a very small temperature gradient by utilizing the phase change of working fluid. Heat pipe make use of the highly efficient thermal transport process of evaporations and condensation to maximize the thermal conductance between a heat source and a heat sink. The amount of heat transported by these devices is normally several orders of magnitude greater than pure conduction through a solid metal. The heat pipes are more advantageous in heat recovery systems, solar energy, light water nuclear reactors, electronics cooling and aircraft cooling.

A heat pipe is an evaporative condensation device for transferring heat in which latent heat of vaporization is exploited to transport heat over long distances with a corresponding small temperature gradient. The heat transport is realized by means of evaporating a liquid in the heat inlet region called as evaporator and subsequently condensing the vapour in a heat rejection region called as condenser. Closed circulation of the working fluid is maintained by capillary action and or bulk forces. The heat pipe was originally invented by Gurgler of the General Motors Corporation in 1944, but did not truly garner any significant attention within the heat transfer community until the space program resurrected the concept in the early 1960’s. Early development of terrestrial applications of heat pipes preceded slowly however due to the high cost of energy the industrial community has begun to appreciate the significance of heat pipes in energy savings and design improvements in various applications.

II. LITERATURE SURVEY

Paison Naphon, et, al, [1] The enhancement of heat pipe thermal efficiency with nanofluids was presented. The heat pipe was fabricated from the straight copper tube with the outer diameter and length of 15 mm and 600 mm respectively. The heat pipe with the de-ionic water, alcohol, and nanofluids (alcohol and nanoparticles) were tested. The titanium nanoparticles with diameter of 21 nm were used in the study which the mixtures of alcohol and nanoparticles were prepared using an ultrasonic homogenizer. Effects of %charge amount of working fluid, heat pipe tilt angle and %nanoparticles volume concentrations on the thermal efficiency of heat pipe were considered.

Maryam Shafahi, et, al, [2] In this work, a two-dimensional analysis was used to study the thermal performance of a cylindrical heat pipe utilizing nanofluids. Three of the most common nanoparticles namely Al_2O_3, CuO, and TiO_2 are considered as the working fluid.Three of the most common nanoparticles, namely Al_2O_3, CuO, and TiO_2 are considered. The heat pipe velocity, pressure, temperature, and maximum heat transfer limit are obtained for different nanoparticle concentration levels and sizes. It was found that the thermal resistance decreases as the concentration increases or as the particle diameter decreases.

Jian Qu, et, al, [3] Thermal performances of two same oscillating heat pipes (OHPs) charged with SiO_2/water and Al_2O_3/water nanofluids respectively were investigated experimentally. Both the average evaporator wall temperature and the overall thermal resistance of the OHPs at different nanoparticle mass concentrations (0.6 wt.% for silica nanofluids and 1.2 wt.% for alumina nanofluids) and at the volume filling ratio of 50% were tested and compared.

For the alumina nanofluids-charged OHP, there existed an optimal concentration of 0.9 wt.% at which reductions in the overall thermal resistance and the evaporator wall temperature of about 0.057 C/W (or 25.7%) and 5.6 C (or 8.7%) respectively were obtained as compared with pure water. For the silica nanofluids-charged OHP, the overall thermal resistance and the evaporator wall temperature increased with the increase in the mass concentration of silica nanoparticles.

III.SCAN OF LITERATURE REVIEW

From the literature recall, there are numerous works are going on to improve thermal performance of heat pipes by using different nanofluids and even accomplished the same.

So far, little attention has been paid to the heat pipes for different inclinations, volume concentration of nanofluid and size of the nanoparticles with wick structure and its effects on the thermal resistance ability by using water and various nanofluids. Some studies were performed on inclined two-phase thermosyphons.

In this study, distilled water and γ-Al_2O_3 Nano fluid 50nm in diameter with stainless steel as wick material on the cylindrical heat pipe made of copper tube. Hence the same attempt is to be tasked to understand the effects of the angle of inclinations and size of the nanoparticles on heat transfer characteristics.

IV.OBJECTIVES

- This work aim to investigate of experimental performance of wickless heat pipe ,heat exchanger charged with using suitable Nano fluid under variable source temperatures, mass flow rate and varying inclination angles.
- The experimentation would deal with finding out the enhancement in the performance characteristics like heat transfer rate, thermal resistance etc.

V.PRESENT WORK AND METHODOLOGY

The experiment is conducted using a cylindrical heat pipe which is manufactured as per mentioned dimensions. Stainless steel is used as a wick material. The heat pipe filled with water and then with γ-Al_2O_3 Nano fluid of particle size less than 100nm at 0.5%, 1% and 2% concentrations. The power input to the heat pipe is gradually raised to the desired power level.

The surface temperatures at different locations along the adiabatic section of heat pipe are measured at regular time intervals until the heat pipe reaches the steady state condition. Simultaneously the evaporator wall temperatures, condenser wall temperatures, water inlet and outlet temperatures in the condenser zone are measured. Once the steady state is reached, the input power is turned off and cooling water is allowed to flow through the condenser to cool the heat pipe and to make it ready for further experimental purpose. Then the power is increased to the next level and the heat pipe is tested for its performance. Experimental procedure is repeated for different heat inputs (30, 40, 50 and 60 W) and different inclinations of pipe (0°, 45° and 90°).

Fig5.1. Heat pipe

RESULTS AND DISCUSSIONS

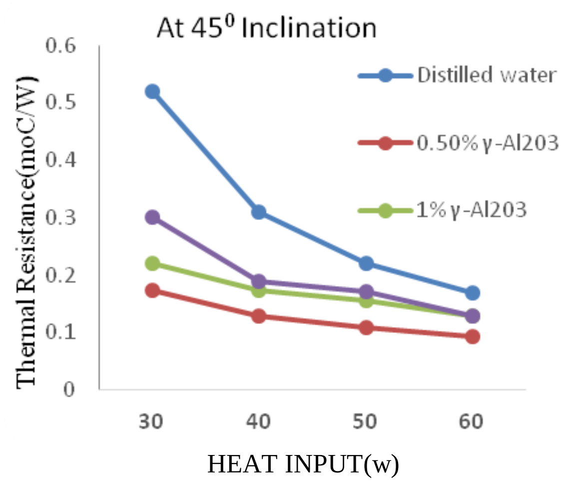

Fig 7.1.Heat input versus Thermal Resistance at 45^0

In the above graph four fluids are compared(Distilled water, 0.5%,1% and 2% concentrations of Nanofluid) with respect to Thermal Resistance v/s Heat input.The results are found to be decrease in Thermal resistance of $0.09m^0c/w$ at 0.5% concentration of nanofluid at 45^0 inclination Hence 0.5% concentration nanofluid yields better results.

VIII.CONCLUSION

Heat pipe technology has used in a wide variety of applications in the various heat transfer devices more especially in the electronic components. However, the heat transfer capacity is limited by the working fluid properties. The heat transfer enhancement can be accomplished by changing fluid properties and flow feature with nanoparticles suspension.

The experiment was conducted on the cylindrical heat pipe by using (γ-Al_2O_3) Aluminium Oxide Nano fluid of particle size less than 100 nm in diameter. Decreasing of thermal resistance of the heat pipe with γ-Al_2O_3nanofluid is presented. Effects of Nano fluid concentrations and heat pipe tilt angle on the heat pipe thermal resistance are taken into account.

The work ultimately concludes that for the cylindrical heat pipe

- Better results are found with distilled water and γ-Al_2O_3 Nano fluid as compared to only distilled water.
- Thermal resistance is decreased by $0.09m^0c/w$ with at 0.5% concentration at 45^0 inclination as shown in Fig 7.2.

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