Journal of Applied Fluid Mechanics, Vol. 11, Special Issue, pp. 91-101, 2018.
Selected papers from *International Conference on Newer Techniques and Innovations in Mechanical Engineering* ***(ICONTIME 2K18)****, 2018*
Available online at www.jafmonline.net, ISSN 1735-3572, EISSN 1735-3645.
DOI: 10.36884/jafm.11.SI.29422

Experimental Heat Transfer Analysis on Heat Pipe using Sio$_2$ and Tio$_2$ Nano Fluid

P. Sakthivel[1†], G. Arunkumar[2], P. Navaneetha Krishnan[3], R. Ramkumar[2] and P. Parameswaran[2]

[1] Department of Mechanical Engineering, Sengunthar Engineering College, Tiruchengode, India
[2]Department of Mechanical Engineering, K Ramakrishnan College of Technology, Samayapuram – Trichy – 621 112, India
[3]Department of Mechanical Engineering, University College of Engineering, BIT Campus, Tiruchirappalii - 620 024, Tamilnadu, India

†*Corresponding Author Email: skt4design@gmail.com*

(Received May 15, 2018; accepted July 18, 2018)

ABSTRACT

This study describes the enhancement of thermal performance of heat pipe using SiO_2 and TiO_2 nano fliud. The study explains about the effects of heat pipe inclination and heat input on the thermal efficiency and thermal resistance. Heat pipe is an advance type of heat exchanger which transfers huge amount of heat due to the effect of capillary action and phase change heat transfer principle. Recent developments in the heat pipe with high thermal conductivity through nano fluids. This paper reviews, influence of various factors such as heat pipe tilt angle, charged amount of working fluid, nanoparticles type, size, mass/volume fraction and its effect on the improvement of thermal efficiency, heat transfer capacity and reduction in thermal resistance. The nano fluid preparation and the analysis of its thermal characteristics also have been reviewed.

Keywords: Nano fluids; Heat pipe; Inclinations; Thermal resistance; Thermal efficiency.

1. INTRODUCTION

Heat pipe is device working on two phase change of working fluid inside. This phase change of working fluid lead to increasing heat transport efficiency of heat pipe.It differs from a heat exchanger by virtue of its ability to transport heat against gravity by an evaporation- condensation cycle with the help of porous capillaries that form the wick. Using the proper working fluid for a given application is another critical element of proper heat pipe operation. The working fluid must have good thermal stability properties at the specified operational temperature and pressure. The quality and type of wick usually determines the performance of the heat pipe, for this is the heart of the product. Different types of wicks are used depending on the application for which the heat pipe is being used. The major components of a heat pipe are a sealed container, a wick structure, and a working fluid. The wick structure is placed on the inner surface of the heat pipe wall and is saturated with the liquid working and provides the structure to develop the capillary action for liquid returning from the condenser to the evaporator.Return of the liquid to the evaporator from the condenser is provided by wick structure from from Walunj Pathan (2015). This heat pipe concept was found especially for application in space during the 1960s by the NASA. One difficult problem in space was to transport the heat from the inner side to the outer side, because the heat transfer in vacuum is very low. So there is a unavoidable thing to create an effective and fast way to transport heat, without getting the effect of gravity action. The thing behind is to develop a flow fields that transport heat energy from one place to another through convection because convective heat transfer is very much faster than heat transfer by conduction. Nowadays heat pipes are used in several applications, where one has limited space and the necessity of a high heat flux. It is still in use in space systems, cooling of computers, cell phones and cooling of solar collectors. The nanofluids kept in the suspension of conventional fluids have the potential of superior heat transfer capability compared to the conventional fluids due to their improved thermal conductivity from Kakaça (2016). Lakshmanan

(2017) investigated about the optimum parameters for obtaining the best performance using alternate fuels of IC engines working under the current cooling system using Nanofluids.

2. HEAT PIPE PRINCIPLE

A heat pipe is broadly divided in three sections namely, evaporator, adiabatic and condenser. A typical heat pipe as shown in Figure 1.1 has one evaporator section that takes heat from a source. The heat absorbed in the evaporator causes change of phase of the working fluid from liquid to vapor from Walunj Pathan (2015).

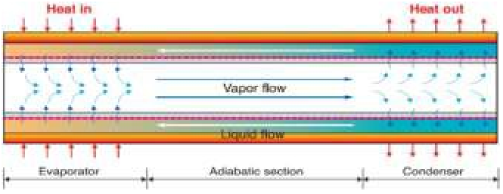

Fig. 1. Simple Heat Pipe

3. EXPERIMENTAL SETUP

Copper tube used for experiment with an inner diameter of 9.5mm and outer diameter of 10.5mm. The entire length of the copper tube is 1metre. One end of the copper tube was permanently closed and another end of the copper tube was temporarily open and closed to refill various concentration of nano fluid. The experimental setup is shown in Fig. 2.

There are 3 sections in this copper tube like evaporation, adiabatic and condensation. The length of evaporation section is 300mm and adiabatic section is 400mm and condenser section is 300mm. A wire mesh made up of stainless steel material to place inside of the copper tube. There are three K type thermocouples fixed on the top surface of the stainless steel tube by using M-Seal.

Fig. 2. Experimental Setup

4. PREPARATION OF NANOFLUIDS

The preparations of Nano fluid include as the production of Nano based particles and then blend into the base fluid. The two methods are used to prepare the Nano fluids are single-step method and two-step method. For the preparation of SiO_2 and TiO_2 particles, two-step method is more suitable from Monirimanesh (2016). In the two step method, initially nano–scale sized metals, metal oxides, fiber particles and carbon nanotubes (CNT/NCT) are prepared. Then the dry powder is produced by various processes like chemical vapor condensation, mechanical alloying, etc. Thereafter, it is dispersed in the base fluids. Monirimanesh (2016) gives the agglomeration is high in this method, because of its prolonged stages in the preparation.

5. PRINCIPLE OF PROBE SONICATOR

Sonication is the act of applying sound energy to agitate particles in a sample, for various purposes. ultrasonic frequencies (>20 kHz) are usually used, leading to the process also being known as ultrasonication or ultra- sonication In the laboratory, it is usually applied using an ultra sonic colloquially known as a sonicator. Sonication can be used to speed dissolution, by breaking intermolecular interactions. It is commonly used in nanotechnology for evenly dispersing nanoparticles in liquids. Additionally, it is used to break up aggregates of micron-sized colloidal particles. Probe sonicator as shown Fig. 3.

The current study silicon di oxide and Titanium oxide of 0.1%,0.25%,0.50%,0.75% mass concentration is considered. The required volume fraction of 0.1%,0.25%,0.50%,0.75% was prepared by dispersed the specified quantity in distilled water. Tables below show the mass of SiO_2 and TiO_2 nanoparticles and various volume concentration of nano fluids.

6. FORMULA

1. $R = T_e\text{-}T_c\ /\ Q$ (°C/W) as per Walunj Pathan (2015) Where, R= Thermal Resistance(°C/W)

Q= Power (W)

T_e= Evaporator Temperature (°C)

T_c= Condenser Temperature (°C)

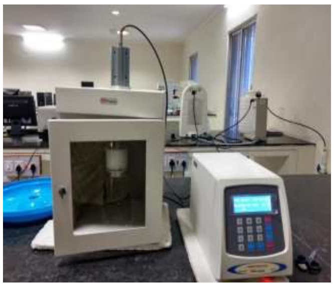

Fig. 3. Probe Sonicator

The preferential spatial distribution of nanotubes probably linked to their aspect ratio where the inter-nanotubes interaction and the number of contacts are more important that the formation of a percolated network from "Lamas et al. (2015)". Addition of nanoparticles into the base liquid can enhance the thermal conduction, and also increase the viscosity and reduce the special heat capacity from Cao et al. (2014).

7. RESULTS AND DISCUSSIONS

7.1 Copper Pipe at 0^0 Angle of Inclination

Tables 1 to 4 infers that the thermal resistance of SiO_2 nanofluid at 0^0 angle of inclination of heat pipe for various concentrations: For 0.1, minimum Thermal Resistance is 0.47. For 0.25, minimum Thermal Resistance is 0.47. For 0.5, minimum Thermal Resistance is 0.48.For 0.75, minimum Thermal Resistance is 0.48.

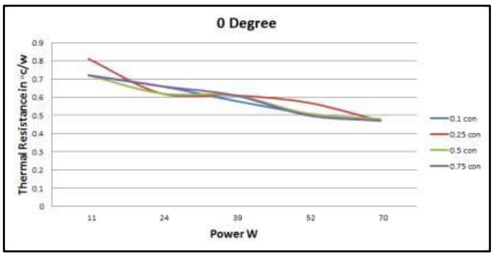

Fig. 4 Copper pipe at 0^0 angle of inclination

Table 1 SiO_2 Nanofluid at 0^0 angle of inclination in 0.1 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	55	32	0.58
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

Table 2 SiO_2 Nanofluid at 0^0 angle of inclination in 0.25 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	26	0.81
2	20	1.2	24	43	28	0.62
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	41	0.57
5	50	1.4	70	88	55	0.47

Table 3 SiO_2 Nanofluid at 0^0 angle of inclination in 0.5 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	43	28	0.62
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	89	55	0.48

Table 4 SiO_2 Nanofluid at 0^0 angle of inclination in 0.75 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	45	28	0.70
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

7.2 Copper Pipe at 30^0 Angle of Inclination

Tables 5 to 8 infers that the thermal resistance of SiO_2 nanofluid at 30^0 angle of inclination of heat pipe for various concentrations: For 0.1, minimum Thermal Resistance is 0.47.For 0.25, minimum Thermal Resistance is 0.47.For 0.50, and minimum Thermal Resistance is 0.47. For 0.75, minimum Thermal Resistance is 0.48.

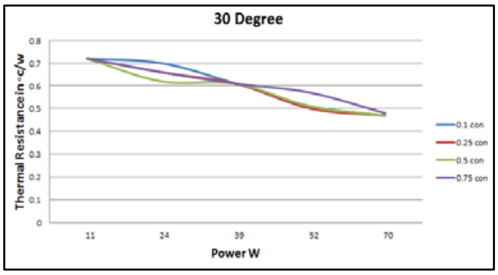

Fig. 5 Copper pipe at 30^0 angle of inclination

Table 5 SiO_2 Nanofluid at 30^0 angle of inclination in 0.1 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	45	28	0.70
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

Table 6 SiO_2 Nanofluid at 30^0 angle of inclination in 0.25 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	41	0.5
5	50	1.4	70	88	55	0.47

Table 7 SiO_2 Nanofluid at 30^0 angle of inclination in 0.5 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	43	28	0.62
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

Table 8 SiO_2 Nanofluid at 30^0 angle of inclination in 0.75 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	55	40	0.61
4	40	1.3	52	66	41	0.57
5	50	1.4	70	88	54	0.48

7.3 Copper Pipe at 45^0 Angle of Inclination

Tables from 9 to 12 infers that the thermal resistance of SiO_2 nanofluid at 45^0 angle of inclination of heat pipe for various concentrations:For 0.10, minimum Thermal Resistance is 0.48.For 0.25, minimum Thermal Resistance is 0.48.For 0.50, minimum Thermal Resistance is 0.47.For 0.75, minimum Thermal Resistance is 0.45.

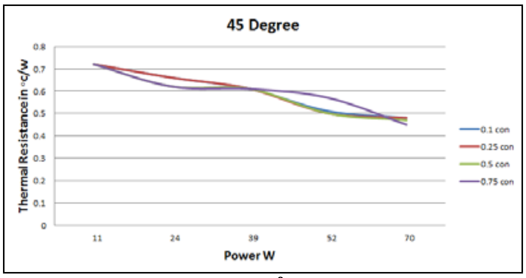

Fig. 6. Copper pipe at 45^0 angle of inclination

Table 9 SiO_2 Nanofluid at 45^0 angle of inclination in 0.1 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	89	55	0.48

Table 10 SiO_2 Nanofluid at 45^0 angle of inclination in 0.25 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	41	0.50
5	50	1.4	70	89	55	0.48

Table 11 SiO_2 Nanofluid at 45^0 angle of incliation in 0.5 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	43	28	0.62
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	41	0.5
5	50	1.4	70	88	55	0.47

Table 12 SiO_2 Nanofluid at 45^0 angle of inclination in 0.75 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	43	28	0.62
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.57
5	50	1.4	70	88	56	0.45

7.4 Copper Pipe at 60^0 Angle of Inclination

Tables from 13 to 16 infers that the thermal resistance of SiO_2 nanofluid at 60^0 angle of inclination for various concentrations: For 0.10, minimum Thermal Resistance is 0.47.For 0.25, minimum Thermal Resistance is 0.48.For 0.50, minimum Thermal Resistance is 0.48.For 0.75, minimum Thermal Resistance is 0.45.

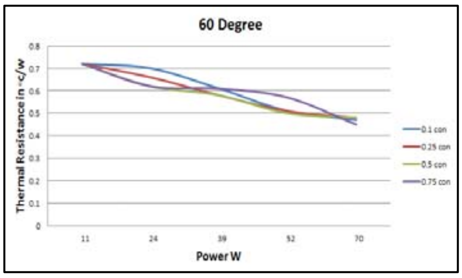

Fig. 7. Copper pipe at 60^0 angle of inclination

Table 13 SiO_2 Nanofluid at 60^0 angle of inclination in 0.1 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	45	28	0.70
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

Table 14 SiO_2 Nanofluid at 45^0 angle of inclination in 0.25 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	55	39	0.58
4	40	1.3	52	67	40	0.51
5	50	1.4	70	89	55	0.48

Table 15 SiO_2 Nanofluid at 45^0 angle of inclination in 0.5 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	43	28	0.62
3	30	1.3	39	55	32	0.58
4	40	1.3	52	67	41	0.50
5	50	1.4	70	88	54	0.48

Table 16 SiO_2 Nanofluid at 45^0 angle of inclination in 0.75 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	43	28	0.62
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	41	0.57
5	50	1.4	70	88	56	0.45

For Titanium Di Oxide:

a. Copper Pipe at 0^0 Angle Ofinclination

Tables from 17 to 20 infers that the thermal resistance of TiO_2 nanofluid at 0^0 angle of inclination for various concentrations: For 0.10, minimum Thermal Resistance is 0.50.For 0.25, minimum Thermal Resistance is 0.50.For 0.50, minimum Thermal Resistance is 0.50.For 0.75, minimum Thermal Resistance is 0.48.

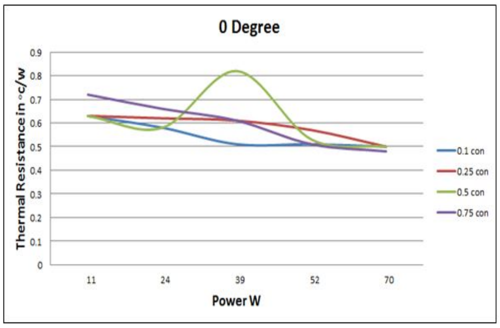

Fig. 8 Copper pipe at 0^0 angle of inclination

Table 17 Tio2 nanofluid at 0^0 angle of inclination in 0.1 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °c (Te)	Condenser Temperature in °c (Tc)	Thermal Resistance in °c/w
1	10	1.1	11	34	27	0.63
2	20	1.2	24	42	28	0.58
3	30	1.3	39	50	30	0.51
4	40	1.3	52	78	51	0.51
5	50	1.4	70	93	58	0.50

Table 18 Tio2 nanofluid at 0^0 angle of inclination in 0.25 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.63
2	20	1.2	24	43	28	0.62
3	30	1.3	39	59	35	0.61
4	40	1.3	52	81	51	0.57
5	50	1.4	70	94	59	0.50

Table 19 Tio2 nanofluid at 0^0 angle of inclination in 0.5 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	36	29	0.63
2	20	1.2	24	43	29	0.58
3	30	1.3	39	63	31	0.82
4	40	1.3	52	80	52	0.53
5	50	1.4	70	94	59	0.50

Table 20 Tio2 nanofluid at 0^0 angle of inclination in 0.75 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	89	55	0.48

7.6 Copper Pipe at 30^0 Angle of Inclination

The above tables 21 to 24 infers that the thermal resistance of Tio_2 nanofluid at 30^0 angle of inclination for various concentrations: For 0.10, minimum Thermal Resistance is 0.48.For 0.25, minimum Thermal Resistance is 0.48.For 0.50, minimum Thermal Resistance is 0.47.for 0.75, minimum Thermal Resistance is 0.42.

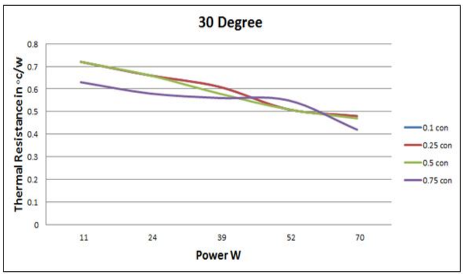

Fig. 9. Copper pipe at 30^0 angle of inclination

Table 21 Tio_2 nanofluid at 30^0 angle of inclination in 0.1 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	89	55	0.48

Table 22 Tio_2 nanofluid at 30^0 angle of inclination in 0.25 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	89	55	0.48

Table 23 Tio_2 nanofluid at 30^0 angle of inclination in 0.5 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	44	28	0.66
3	30	1.3	39	55	32	0.58
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

Table 24 Tio_2 nanofluid at 30^0 angle of inclination in 0.75 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	28	0.63
2	20	1.2	24	44	30	0.58
3	30	1.3	39	62	40	0.56
4	40	1.3	52	81	52	0.55
5	50	1.4	70	92	62	0.42

7.7 Copper Pipe at 45^0 Angle of Inclination

Tables from 25 to 28 infers that the thermal resistance of Tio_2 nanofluid at 45^0 angle of inclination for various concentrations: For 0.10, minimum Thermal Resistance is 0.47.For 0.25, minimum Thermal Resistance is 0.45.For 0.50, minimum Thermal Resistance is 0.47.For 0.75, minimum Thermal Resistance is 0.42.

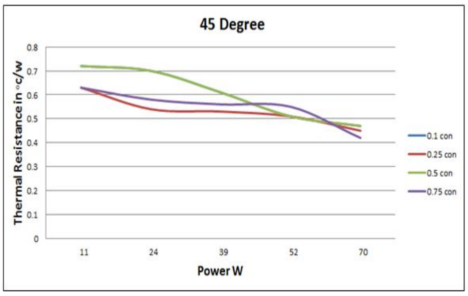

Fig. 10. Copper pipe at 45^0 angle of inclination

Table 25 Tio_2 nanofluid at 45^0 angle of inclination in 0.1 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	45	28	0.70
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

Table 26 Tio_2 nanofluid at 45^0 angle of inclination in 0.25 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	34	27	0.63
2	20	1.2	24	43	30	0.54
3	30	1.3	39	59	38	0.53
4	40	1.3	52	80	53	0.51
5	50	1.4	70	94	62	0.45

Table 27 Tio_2 nanofluid at 45^0 angle of inclination in 0.50 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	45	28	0.70
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

Table 28 Tio_2 nanofluid at 45^0 angle of inclination in 0.75 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	28	0.63
2	20	1.2	24	44	30	0.58
3	30	1.3	39	62	40	0.56
4	40	1.3	52	81	52	0.55
5	50	1.4	70	92	62	0.42

7.8 Copper Pipe at 600 Angle Of Inclination

Tables 29-32 show that the thermal resistance of TiO_2 nanofluid at 60^0 angle of inclination for various concentrations: For 0.10, minimum Thermal Resistance is 0.47.For 0.25, minimum Thermal Resistance is 0.42.For 0.50, minimum Thermal Resistance is 0.42.For 0.75, minimum Thermal Resistance is 0.41.

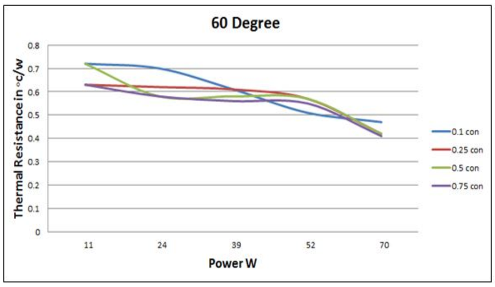

Fig. 11 Copper pipe at 60^0 angle of inclination

Table 29 Tio2 nanofluid at 60^0 angle of inclination in 0.1 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	27	0.72
2	20	1.2	24	45	28	0.70
3	30	1.3	39	56	39	0.61
4	40	1.3	52	67	40	0.51
5	50	1.4	70	88	55	0.47

Table 30 Tio2 nanofluid at 60^0 angle of inclination in 0.25 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	34	28	0.63
2	20	1.2	24	43	29	0.62
3	30	1.3	39	60	40	0.61
4	40	1.3	52	79	54	0.57
5	50	1.4	70	92	62	0.42

Table 31 Tio2 nanofluid at 60^0 angle of inclination in 0.50 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	36	28	0.72
2	20	1.2	24	45	31	0.58
3	30	1.3	39	61	38	0.58
4	40	1.3	52	81	52	0.57
5	50	1.4	70	92	62	0.42

Table 32 Tio2 nanofluid at 60^0 angle of inclination in 0.75 concentration

S.NO	Voltage	Current	Power	Evaporator Temperature in °C (Te)	Condenser Temprature in °C (Tc)	Thermal Resisance in °C/w
1	10	1.1	11	35	28	0.63
2	20	1.2	24	44	30	0.58
3	30	1.3	39	62	40	0.56
4	40	1.3	52	81	52	0.55
5	50	1.4	70	92	63	0.41

8. CONCLUSION

This paper deals with the thermal analysis of the heat pipe by using silicon di oxide and Titanium di oxide nano fluid as the working fluid. A nanofluid is an innovative heat pipe working fluid with metal nanoparticles dispersed on it. In present case, the pure water with diluted 20nm silicon particles and titanium particles, inside circular heat pipes, was experimentally tested, showing that the thermal performance of the heat pipe was considerably increased.The major reason for increasing the thermal performance of heat pipe by using nanofluid can be explained as follows. The convective heat coefficient of nanofluid is higher than pure water. Therefore, it is expected that the thermal performance of heat pipe will be enhanced. As a result, the higher thermal performances of the nanofluid have proved its potential as substitute for conventional pure water in the grooved heat pipe the thermal performances of the cylindrical heat pipe under various operating parameters such as heat input fill ratio and angle of inclination were experimentally investigated using the SiO2-DI water and TiO2-DI as a working fluid. Based on the experimental results, the thermal resistance decreased as the angle of inclination increased and reached optimum efficiency value was obtained when the heat pipe was operated with angle of inclination 60°. The minimum thermal resistance is obtained in 0.75 concentration of titanium oxide at 60 is 0.41.

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