A Review on "CFD Investigation of Finned Tube Heat Exchanger using Nano Fluids"

Kumar Vaibhav Gupta[1] Mr. Jagdeesh Saini[2]
[1]Research scholar [2]Assistant Professor
[1,2]Department of Mechanical Engineering
[1,2]B M College of Technology, Indore

Abstract— The concept of heat exchanger plays a major role in the refrigeration and air conditioning system. The rectangular fin arranged outside the hot fluid pipe & used the Al2O3 as a nano fluid to increase the heat transfer rate using counter flow exchanger. Preparing the nano fluid & increasing the heat transfer rate by using Al2O3+H2O. Increase of surface area utilized for heat exchange will ultimately increase the heat transfer rate. Thermal conductivity is considered important factor for rapid cooling and heating application. Base heat transfer fluid normally having low thermal conductivity, so we goes to Nano fluid for increases the heat transfer rate. Nano fluid is nanometre sized particle such as metal, oxide, and carbide etc., dispersed into base heat transfer fluid.

Key words: Nano Fluids, Thermal Conductivity, Heat Transfer Rate, Circular Tube, Finned Surface Area

I. Introduction

Now a day's heat exchanger has a wide application's from air conditioning, refrigeration up to engine cooling system. Heat exchanger does not cause any harmful effect on environment. The counter flow heat exchanger has more capacity to exchange the heat as compare to parallel floe heat exchanger. The conventional heat transfer fluids have inherently poor thermal conductivity which makes it insufficient for ultra-high cooling applications. So many scientists have tried to enhance the inherently poor thermal conductivity of these conventional heat transfer fluid using solid additives. We know that contact surface in heat exchanger plays very important role. As surface area utilized for heat transfer increases ultimately heat transfer rate increases and this can be achieve by providing fin's at pipe from which the heat is going to exchange. Nano fluids are supplied by two methods called the one-step and two-step methods. One step technique, the first step is production of nanoparticle and second step is the dispersion of the nanoparticle in a base fluid. Second technique is a mass production method of Nano fluids by utilising the inert gas condensation technique. The main disadvantage of two step method is form cluster during preparation of Nanoparticle

II. Literature survey

A. *L.B. Mapa et al:*

Measured enhanced thermal conductivity of Cu-water Nano fluid using shell and tube heat exchanger. Where the dimension of heat exchanger is 240x24x0.25mm, using 37 tubes. The outcome of this analysis is rate of heat transfer is increases with increasing flow rate and also its concentration. By nanoparticle dispersed into de-ionized base fluid a better enhancement is achieved.

B. *J. Koo et al:*

Investigated the nanoparticle collision and deposition in the surface wall with help of micro channel heat sink. Which has the dimension of 1cmx100micometerx300micrometer, water-Cuo and Cuo-ethylin glycolNano fluids are through the micro channel heat sink. Theyare investigated the base fluid should possess high prandle number, and get enhanced heat transfer rate by minimize particle-particle and particle-wall collision. Viscous dissipation effect is important of narrow channel, because Nuselt number high for high aspect ratio channel.

C. *Shung-Wen Kang et al:*

Studied about the relation between thermal resistance-size of nanoparticle with help of 211 micrometre*217 micrometre sized and deep grooved circular heat pipe and heat pipe maintain 400C temperature.They are finalized thermal resistance is directly proportional to the size of the nanoparticle. Maximum reduction of thermal resistance by using 10 nm sized particles, because particle size is increasing the wall temperature also increases. So small sized particle suitable for enhanced heat transfer rate. Thermal resistance is decreases with increasing heat and concentration of Nano particle.

D. *Shuichi Torri:*

Investigated convective heat transfer co efficient of diamond based Nano fluid by using heat tube apparatus. Specification of tube is 4.3mm,4mm outer and inner diameter respectively, and applied 100W power unofomly.They are showed the heat transfer coefficient is increases with increasing concentration and Reynolds number of Nano fluid. But at the same time increased the pressure drop with increasing concentration of Nano particle.

E. *S.J.Kim et al:*

Investigated formation of porous layer and wettability of Nano fluid using critical heat flux experiment and SEM images. They are used three different type of nanoparticles with different diameters such as Al2O3 (110-210nm), SiO2 (20-40nm) and ZrO2 (110-210). They are showed boiling is main factor to affect the heat transfer rate of Nano fluid. Due to nucleate boiling nanoparticle deposited on wall, so the porous layer is formed on the wall. Porous layer directly consequence for creating wettability, cavity and roughness of the surface wall. So heat transfer rate decreased due to boiling of Nano fluid.

F. *PaisarnNaphon et al:*

Investigated the thermal efficiency of heat pipe using titanium-alcohol Nano fluid, heat pipe dimensions are 60mm and 15mm length and outer diameter respectively.

The thermal efficiency increases with increasing tilt angle within 60o angle and concentration of nanoparticle.

G. *Anil Kumar et al:*

Studied the heat transfer enhancement of fin, utilizing AL2O3-Water Nano fluid analysed using CFD. Rayleigh number increases due to Brownian motion, ballistic phonon transport, clustering and dispersion effect of nanoparticle. At high Rayleigh number flow rate at centre of the circulation is increasing, so temperature is drop from centre of fin. Volume of the circulation increases the velocity at centre is increases as the result of increasing the solid-fluid heat transportation. Low aspect ratio fin is suitable for heat transfer enhancement, because heat affected zone is less.

H. *Yu-Tang chen:*

Investigated the thermal resistance of heat pipe using Ag-DI Water Nano fluid, heat pipe made as 200cmx3mm length and thickness respectively. Heat resistance is increases with increasing concentration of Nano fluid up to 50ppm. Due to wettability of nanoparticle various geometry of wick is created on heat pipe.

I. *Eed Abdel Hafez Abdel-hadi et al:*

Investigated the heat transfer analysis of vapour compression system using CuO-R134a Nano fluid, test section made of copper horizontal tube and heat is applied 10-40 KW/m2. Heat flux, concentration, and size particle is important factor to enhance the heat transfer rate of Nano fluid. Heat transfer rate is increases with increasing heat flux, up to 55% of concentration of Nano fluid and up to 25nm sized particles.

J. *Somchaiwongwises et al:*

Investigated heat transfer enhancement and flow characteristic of Al2O3-Water Nano fluid using micro channel heat sink. The dimension of test section is 5x5mm and 50W heat is applied. Heat transfer is enhanced at high Reynolds number and high concentration of Nanofluid, because at high Reynolds number wall temperature is decreases and pressure drop is increased.

K. *Yannar et al:*

Investigated the flow and heat transfer characteristic of spiral pipe heat exchanger using different type of Nano fluid with different concentration such as Al2O3-water, TiO2-water, CuO-water Nano fluid with 1%, 1% and 3% concentration respectively. Test section made of copper tube had the ratio of pitch per diameter is 7, mean hydraulic diameter is 30mm, 10mm diameter and 1600mm length. Heat transfer enhanced 28% at 0.8% concentration of Nano fluid, due to high concentration shear stress of Nano fluid is increased. Heat transfer enhancement is high in spiral pipe compared with circular pipe, because the pressure drop is high in spiral pipe. Heat transfer co efficient is decreases when axial distance of Nano fluid is increasing, because formation of boundary layer.

L. *Nawaf.H et al:*

Investigated the thermal performance of air-water heat exchanger using TiO2Nano fluid. Air duct dimension is 100x30x300 mm, and water flow through inside the pipe had 5mm radius and 300 length. Air through external surface of pipe as the result of heat is transferred. Heat transfer coefficient is increases with increasing Reynolds number at constant volume of friction up to 0.6% and increasing concentration at constant Reynolds number up to 1000, but at high concentration needs high pumping power. Nessult number is increases with increasing Reynolds number, high heat transfer is occurred in this condition, but decreases when axial distance is increasing at aerofoil particular angle of attack. Maximum heat is transferred at 0-1000 angle of aerofoil.

III. CONCLUSION

1) The heat transfer rate can be increased by using the nano fluid.
2) The heat transfer rate can be increased by using the finned surface.
3) Thermal conductivity is depending upon types of partical material.
4) Thermal conductivity can be changed by varying the sizes of nano material.
5) Required heat transfer rate can be obtained by using suitable base fluid.
6) Heat transfer rate increases with increase in concentration of nano particle
7) Heat transfer rate is directly proportional to Reynolds number and peclet number of nano fluid
8) Concentration of nano particle increases the pressure drop of nano fluid

REFERENCES

[1] [1] L.B.Mapa, Sana Mazhar, Heat transfer in mini heat exchanger using Nano fluids. IL/IN sectional conference.

[2] [2] J.Koo, C.Kleinstrecer, Laminar Nano fluid flow in micro heat sink. International journal of heat and mass transfer 48(2005).

[3] [3] Shung-Wei Kang, Wei-Chiang Wei, Sheng-Hong Tsai, Shih-Yu YANG, Experimental investigation of silver Nano fluid on heat pipe thermal performance, Applied thermal engineering 26(2006).

[4] [4] Shuichi Torii, Experimental study on convective heat transfer of aqueous suspension of Nano diamond particle, International symposium on Eco Topia science 07 (2007).

[5] [5] S.J.Kim, I.C. Bang, J.Buongiorno,and, and L.N.Hu, Study of pool boiling and critical heat flux enhancement in Nano fluid.bullletin of the polish academy of sciences technical science.vol55,no 2,2007.

[6] [6] PaisarnNaphon, Pichai Assad among Kol, TeerapongBorirak, Experimental investigation of titanium Nano fluid on the heat pipe thermal efficiency, International communication in HMT 35 (2008).

[7] [7] S.H.Anil Kumar and G.Jilani, convective heat transfer enhancement in an enclosure with fin utilizing Nano fluid, International journal of aerospace and mechanical engineering.

[8] [8] Yu-Tang Chen, Experimental study of silver Nano fluid on heat pipe thermal performance, Journal of

marine science and technology, vol18, No.5 pp.731-734.
[9] [9] Eed Abdel-Hafer ABDEL-Hadi, Sherif Handy Taher, Abdel Hamid Mohamed Torki, and Samar sabryHauad, Heat transfer analysis of vapour compression system using Nano Cuo-R134a. International conference on advanced materials engineering vol. 15(2011).
[10] [10] WeerapunBuangthongsuk and SomchaiWongwises, Heat transfer enhancement and flow characteristic of alumina- water Nano fluid flowing through a micro channel heat sink. The second TSME International conference on mechanical engineering. 19-21 October 2011.
[11] [11] Yanuar, N.Putra, Gunawan S.M.Bagi, Flow and convective heat transfer characteristic of spiral pipe for Nano fluid. IJRRAS 7(3).June 2011.
[12] [12] Nawaf H. Saeid and Tan HengChaia, Investigation of thermal performance of air to water heat exchanger using Nano fluid, IIUM Engineering journal special issue mechanical engineering, 2011.