Enhancement of Heat Transfer with Nanofluids – A Review

S. G. Bahaley[1], A. V. Deshmukh[2]
[1]Professor, Dept. of Mechanical Engg., Prof. Ram Meghe Institute of Technology & Research, Badnera, India
[2]Assistant Professor, Dept. of Mechanical Engg., Prof. Ram Meghe Inst. of Tech. & Research, Badnera, India

***Abstract*: The performance of commercial and sensible appliances will be improved to perform some vital heat transfer duty by heat transfer sweetening techniques. The sweetening of warmth transfer mistreatment nanofluids are used mutually of the passive heat transfer techniques in many heat transfer applications. it's thought-about to own nice potential for warmth transfer sweetening and area unit extremely suited to application in heat transfer processes. In recent years, many vital analysis works are dispensed to grasp and justify the causes of the sweetening or management of warmth transfer mistreatment nanofluids. This review addresses the distinctive options of nanofluids, such a sweetening of warmth transfer, improvement in thermal conduction, increase in surface volume magnitude relation, Browanian motion, etc. From the studies of literatures, it's been found that the warmth transfer constant will increase with a rise within the concentration of solid particles. Sure studies with a smaller particle size indicate a rise within the heat transfer sweetening once is compared to values obtained with a bigger size. The many applications within the engineering field justify why numerous investigators have studied heat transfer with augmentation by a nanofluid within the device. this text presents a review of the warmth transfer applications of nanofluids to develop directions for future work. Future heat transfer studies will be performed with aluminous nanoparticles with totally different geometries and concentrations to contemplate heat transfer sweetening in stratified, transition and turbulence regions. There seems to be hardly any analysis within the use of nanofluids as refrigerants. Nanoparticle-refrigerant dispersions in two-phase heat transfer applications will be studied to explore the likelihood of raising the warmth transfer characteristics of condensers and evaporators employed in refrigeration and air con systems.**

***Keywords*: heat transfer, nanofluids**

1. Introduction

The characteristics of flow and warmth transfer in microchannels and microtubes have conjointly attracted a lot of attention of researchers attributable to the fast developments of micro-electromechanical systems (MEMS) and micro total analysis system [1]. These developments have nice impacts on the electronics cooling techniques, the micro heat money changer, engineering, human ordering project, medication engineering etc.

This aim of this critique is to summarize the warmth transfer sweetening potential of nanofluids each experimental and numerical work and on the result of the concentration and diameter of nanoparticles and therefore the form of cross sectional tubes [2].

A. Classification of Nano particles

Nano particles are broadly divided into various categories depending on their morphology, size and chemical properties.

1) Carbon-based nano particle

Fullerenes and Carbon Nanotubes (CNTs) represent 2 major categories of carbon-based Nano particles Fullerenes contain nano-material that ar manufactured from globose hollow cage like allotropical styles of carbon. These materials possess organized pentangular and polygon carbon units, whereas every carbon is sp2 hybridized. CNTs ar elongated, hollow structure, 1–2 nm in diameter. These will be expected as aluminiferous or conductive dependent on their diameter telicity. These structurally correspond to C sheet rolling upon itself. The rolled sheets will be single, double or several walls and so they named as single-walled (SWNTs), double-walled (DWNTs) or multi-walled carbon nanotubes (MWNTs).

2) Metal nano particles

Metal Nano particles ar strictly manufactured from the metals precursors. because of well-known localized surface Plasmon resonance (LSPR) characteristics, these Nano particles possess distinctive optoelectrical properties. Nano particles of the alkali and noble metals i.e. Cu, Ag and Au have a broad optical phenomenon within the visible zone of the magnetism star spectrum.

3) Ceramics nano particles

Ceramics Nano particles ar inorganic non-metallic solids, synthesized via heat and sequential cooling. they will be found in amorphous, crystalline, dense, porous or hollow forms. Therefore, these Nano particles have gotten nice attention of researchers because of their use in applications like chemical process, photocatalysis, photodegradation of dyes, and imaging applications.

4) Semiconductor nano particles

Semiconductor materials possess properties between metals and non-metals and Semiconductor Nano particles possess wide bandgaps and so showed vital alteration in their properties with bandgap standardisation. Therefore, they're vital materials in photocatalysis, ikon optics and electronic devices.

5) Compound nano particles

These are usually organic based mostly Nano particles and, they're largely nanospheres or noncapsular formed. The previous are matrix particles whose overall mass is mostly solid and also the alternative molecules are absorbable at the periphery of the spherical surface.

2. Literature review

Many research workers tried to review the result of nanoparticles aboard fluids like water, ethanol and oil and shows the improvement that be get on attributable to the upper thermal conductivities for those fluids therefore there are a unit some experimental and numerical studies have been drained recent years.

C. Yang et. al [3] Theoretical: it's been found that Nusselt range has best bulk mean nanoparticle volume fraction price for corundum water nanofluids, whereas it solely will increase monotonously with bulk mean nanoparticle volume fraction for Ti water nanofluids.

Y. Raja Sekhar et. al [4] Experimental: The results found that The Nusselt range and friction issue will increase with increase of particle concentration. But, friction issue decreases with increase of Reynolds range of flow wherever because the Nusselt range will increase. Exploitation nanofluid with a high heat exchange will facilitate in scale back the scale of the warmth money handler or while not increasing the scale of the warmth money handler potency of the system are often improved. Further, exploitation twisted tapes and nanofluids within the pipe flows is advantageous since it's visible from the results that the energy gained with heat exchange is quite the energy spent on pumping power. It's clear from the results that heat transfer sweetening in an exceedingly horizontal tube will increase with Reynolds range of flow and nanoparticle concentration.

Adnan M. Hussein et. al [5] Numerical: knowledge measured showed that thermal conduction and consistency increase with increasing the quantity concentration of nanofluids with most deviation 19%and 6 June 1944, severally. Simulation results finished that the friction issue and Nusselt range increase with increasing the quantity concentration. On the opposite hand, the flat tube enhances heat transfer and reduces pressure come by 6 June 1944 and -4%, severally, as compared with circular tube.

Faris Mehemet Ali et. al [6] Numerical: The results show that, the thermal conduction and thermal diffusivity sweetening of nanofluids will increase because the particle size will increase. Thermal conduction and thermal diffusivity sweetening of Al_2O_3 nanofluids was increase because the volume fraction concentration will increase. This sweetening attributed to the numerous factors like, flight energy, nature of warmth transport in nanoparticle, and surface layer between solid/fluids.

S. Zeinali Heris et. al [7] Experimental: Experiments show that sizable sweetening of warmth transfer constant is achieved and this sweetening is up to twenty seven.6% at 2.5% volume fraction of nanoparticles examination to the bottom fluid (water), additionally it's been detected that convective heat transfer constant will increase with the increment of nanoparticles concentration in nanofluid particularly at high flow rates. The decrement of wall temperature discovered exploitation nanofluid.

Azari A. et. al [8] Experimental and numerical: Experimental and simulation results showed that the thermal performance of nanofluids is on top of that of the bottom fluid and also the heat transfer sweetening will increase with the particle volume concentration and Reynolds range.

Hassanain Ghani Hameed et. al [9] Numerical: Results found The nanoparticles among the liquid enhance the thermal performance of the warmth pipe by reducing the thermal resistance and temperature distinction by zero.168 K/W and five.06 K severally. whereas increasing the most heat load and also the capillary pressure by ninety-six W and 192.46 Pa severally of these results at input heat of thirty W and nanoparticles concentration of five Vol. %. The results of wall temperature distribution for the warmth pipe are compared with the previous study for a similar downside and an honest agreement has been achieved.

Mohamed H. Shedid [10] Numerical: Results of numerical simulations square measure compared associated s range grows with increasing concentration magnitude relation of Al howed an sweetening of Nusslet range as Peclet $2O_3$ and TiO_2 nanoparticles.

Layth W. Ismael et.al [11] Experimental: The experimental results stressed the sweetening of the thermal conduction because of the nanoparticles presence within the fluid bigger than microfluids, additionally shown the impact of the particle size and concentration on the thermal conduction. it's been recognized that the addition of extremely semi conductive particles will considerably increase the thermal conduction of warmth – transfer fluids. Particles within the small and nano – size vary have attracted the foremost interest attributable to their increased stability against alluviation and, as a result, reduction in potential for preventive a flow system. Moreover, the results showed that, the obtained thermal conductivities doubtlessly discovered that size and sort particles were a key issue poignant semi conductive heat transport in suspensions.

Hooman Yarmand et.al [12] Numerical: The numerical results indicate that SiO2-water has the best Nusselt range compared to alternative nanofluids whereas its all-time low heat transfers constant because of low thermal conduction. The Nusselt range will increase with the rise of the Reynolds range and also the volume fraction of nanoparticles.

Adnan M. Husseinet. al [13] Experimental: Results showed that the warmth transfer in automotive radiate by exploitation TiO2 and SiO2 nanoparticles distributed in water as a base fluid. Or will increase with increasing of nanofluid volume fraction.

Sami D. Salman et.al [14] Numerical: The results show that the warmth transfer sweetening the CuO nanoparticle. Will increase with a rise within the volume fraction of the CuO nanoparticle.

Hsien-Hung Ting et. al [15] Numerical: The numerical results show that the warmth transfer coefficients and Nusselt ranges of Al2O3/water nanofluids increase with will increase within the Peclet number also as particle volume concentration. The warmth transfer constant of nanofluids is multiplied by twenty-five.5% at a particle volume concentration of two.5% and a Peclet range of 7500 as compared therewith of the bottom fluid (pure water).

Rabah Nebbati et. al [16] Numerical: The results of thermal and fluid mechanics fields show that nanofluids will provoke a rise within the average and native Nusselt numbers, a decrease of bottom surface native temperature and a small decrease of the shear stress on the wall, in comparison to predictions exploitation constant properties and nanoparticles free water.

Dr. Khalid Faisal ibn Abdel Aziz al-Saud ruler [17] Numerical: The numerical results show that because the solid volume fraction will increase, the warmth transfer is increased for all values of Lord Rayleigh range. This sweetening is additional important at high Lord Rayleigh range. all-time low heat transfer was obtained for TiO2 (50 nm) because of domination of physical phenomenon and enormous nanoparticles. Whereas conductor (20 nm), atomic number 29 (30 nm) – water nanofluids has the best heat transfer, severally.

Dr. Khalid Faisal ibn Abdel Aziz al-Saud ruler [18] Experimental: The measured results show that silver with oil nanofluid offers most heat transfer sweetening compared with chemical compound metal nanofluid used. The presence of conductor and ZrOR2R nanoparticles attributes to the generation of robust nano convection current and higher intermixture additionally, the warmth transfer constant and pressure drop is multiplied by exploitation nanofluids (Ag + oil, ZrO2 + oil) rather than the bottom fluid (oil).

Abdolbaqi prophet Khdher et. Al [19] Numerical: Results found that the warmth transfer rates and wall shear stress increase with a rise of nanofluid volume concentration. Additionally, the results of consistency and thermal conduction of the nanofluids show a major increment with the rise of volume fractions. Therefore, best particle volume fraction is taken into account in enhancing the performance of nanofluid in associate engineering system.

Bayram Sahin et. al [20] Experimental: it had been found that the particle volume concentrations on top of 1%vol. weren't acceptable with relevance the warmth transfer performance of the CuO-water nanofluid. No heat transfer sweetening was discovered at Re = four.000. The best heat transfer sweetening was achieved at Re = sixteen.000 and Φ = zero.005.

3. Application of nanofluids

Nano fluid may be used to cool automobile engine and fastening instrumentality and cool high heat flux device like high-energy microwave tube, and high-energy laser diode array. Some common applications are:

- Solar water heating
- Refrigeration
- Defense and space application
- Thermal storage
- Engine transmission oil
- Boiler exhaust's flue gas recovery
- Cooling of electronic circuit
- Nuclear cooling system

4. Conclusion

Nanofluid cooling has sort of application in power generation, industrial, info technology, and business sections. Promising blessings of Nanofluids through sweetening of warmth transfer are summarized as efficiency and safety boos in power generation, product size, price and waste reduction, product quality and aesthetic improvement, energy consumption and emission reduction, quicker communication and computation and ultimately in one-word prosperity of the society. Besides analysis and communication not solely can invaluably advance the science but also will bring the researcher kind completely different elements of the word nearer along for an agreeable participation and collaboration. Finally, dangerous and lots of unknown sides of the Nanofluids utilization should be self-addressed to confirm concerning spectacular role of this advanced technology in driving the life on planet earth towards a lot of prosperity. This finish are going to be met thorough years of in depth analysis and development of models, experiments and patents.

References

[1] Wei S.W, S.H Tsai, S. Y. Yang, S. W. Kang, "Effect of Nano Fluid Concentration on Heat Pipe Thermal Performance," IASME Trans, 2 (2005), pp. 1432-1439
[2] Hwang, Y., Park, H. S., Lee, J. K., and Jung, W. H., "Thermal conductivity and Lubrication Characteristics of Nanofluids", Current Applied Physics, 6S1 (2006), pp. 67– 71
[3] C. Yang, W. Li, A. Nakayama, 'Convective heat transfer of Nanofluids in a concentric annulus' 'International Journal of Thermal Sciences' seventy-one (2013) 249-257.
[4] Y. Raja Sekhara, K. V. Sharmab, R. Thundil Karupparaja, C. Chiranjeevia 'Heat Transfer improvement with Al_2O_3 Nanofluids and Twisted Tapes in a Pipe for solar Thermal Applications' 'International Conference On design AND manufacturing, IConDM 2013 Procedia Engineering sixty-four (2013), 1474 – 1484.
[5] Adnan M. Hussein, K. V. Sharma, R. A. Bakar, and K. Kadirgama.'The effect of Nanofluid Volume Concentration on Heat Transfer and Friction factor inside a Horizontal Tube' Hindawi publication Corporation 'Journal of Nanomaterials' Volume 2013.
[6] Faris soldier, W. Mahmood Mat Yunus and Zaina Abidin Talib "Study of the impact of particles size and volume fraction concentration on the thermal conduction and Journal of Physical Sciences' Vol. 8(28), pp. 1442-1457, 30 July, 2013.
[7] S. ZeinaliHeris, Taofik H. Nassan, S. H. Noie, H. Sardarabadi, M. Sardarabadi "Laminar convective heat transfer of Al2O3/water nanofluid through sq. cross-sectional duct" 'International Journal of warmth and Fluid Flow' 2013.
[8] A. Azari, M. Kalbasi and M. Rahimi "CFD and experimental investigation on the warmth transfer characteristics of alumina nanofluids below the streamline flow regime" 'Brazilian Journal of Chemical Engineering', vol. 31, no. 02, pp. 469 - 481, April-June, 2014

[9] Hassanain Ghani Hameed, Abudl-Muhsin A. Rageb, "Numerical simulation of thermal performaance of constaant cylindrical heat pipe using nanofluids Al-Qadisiya Journal for Engineering Sciences, Vol. 7, No. 4, 2014.
[10] Mohamed H. Shedid" process Heat Transfer for Nanofluids through Associate in Nursing annulate Tube" "Proceedings of the International Conference on Heat Transfer and Fluid Flow" national capital, Czech Republic, August 11-12, 2014.
[11] Layth W. Ismael, Khalid Faisal ibn Abdel Aziz al-Saud. Sultan" A comparative Study on the Thermal conductivity of small and Nano fluids by victimization Silver and metal Oxide" Al-Qadisiya Journal for Engineering Sciences, Vol. 7, No. 2, 2014.
[12] Hooman Yarmand, Samira Gharehkhani, Carlos Newaz Kazi, Emad Sadeghinezhad, and Mohammad Reza Safaei " Numerical Investigation of warmth Transfer improvement in a Rectangular Heated Pipe for Turbulent Nanofluid" Hindawi publication Corporation, Scientific World Journal. Volume 2014.
[13] Adnan M. Hussein, R. A. Bakar, K. Kadirgama, K. V. Sharma" Heat transfer augmentation of an automotive radiator using nanofluids " Heat and Mass Transfer journal, November 2014, Volume 50, Issue 11, pp 1553-1561.
[14] Lappish D. Salman, Abdul emeer H. Kadhum, Mohd S. Takriff, and Abu Bakar Mohamad "Heat Transfer improvement of bedded Nanofluids Flow in a Circular Tube Fitted with Parabolic-Cut Twisted Tape Inserts" Hindawi publication Corporation, Scientific World Journal Volume 2014.
[15] Hsien-Hung Ting and Shuhn-Shyurng Hou" Investigation of bedded Convective Heat Transfer for Al_2O_3-Water Nanofluids Flowing through a sq. crosswise Duct with a constant Heat Flux" Materials 2015, 8, 5321-5335.
[16] Rabah Nebbati, Mahfoud Kadj" Study of forced convection of a nanofluid used as a heat carrier in a microchannel heat sink" "International Conference on Technologies and Materials for Renewable Energy, surroundings and property, TMREES15", 2015.
[17] Khalid Faisal ibn Abdel Aziz al-Saud grand Turk "Numerical answer of warmth Transfer and Flow of Nanofluids in Annulus With Fins hooked up on the Inner Cylinder" Journal of city University/Engineering Sciences/ No. (2) / Vol. (23): 2015.
[18] Dr. Khalid Faisal ibn Abdel Aziz al-Saud grand Turk "Augmentation of warmth Transfer Through device With and while not Fins by victimization Nano fluids" Journal of Engineering and Development, Vol. 19. No. 4, July 2015.
[19] Abdolbaqi Mohammad Khdher, Rizalman Mamat, Nor Azwadi Che Sidik "The Effects of Turbulent Nanofluids and Secondary Flow on the warmth Transfer through a Straight Channel" Recent Advances in Mathematical and process ways, 2015.
[20] Bayram Sahin, Eyuphan Manay and Eda Feyza Akyurek " Associate in Nursing Experimental Study on Heat Transfer and Pressure Drop of CuO-Water Nanofluid" Hindawi publication Corporation, Journal of Nanomaterials, Volume 2015.