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Improvement of Thermal Hydraulic Characteristics of MPFHS with Nanofluids –A Review

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Absract: Today's several new techniques have to be compelled to be explored for the developments of recent electronic devices for dissipating high heat flux for ensure stable and optimum operation. Like micro-channel heat sinks because of their tiny mass and volume still as larger space for cooling of high heat flux chips with using pin fins with different shapes and different arrangements. So as to more optimize the small heat sink performance, the various kinds of nano-fluids are used as a cooling agent. The most aim of this work is to review numerous researches tired past to boost heat transfer rate and hydraulic behaviour of small pin fins heat sink by either changing its geometry, climate condition and material, spacing between the fins and its configuration with differing kinds of nano-fluids, additionally with completely different size and concentration of nano particle .
Keywords- heat transfer, fins, nano fluid, computational fluid dynamic.

I. INTRODUCTION

Fins are used as associate extended surface to extend the heat transfer rate in a very big selection of engineering applications, and provide a sensible approach while not use of an excessive quantity of primary area for achieving a large heat transfer area. It's normally used for heat management in electrical appliances, cooling of combustion engine, like fins in an exceedingly automobile radiator. Therefore its vital issue to analysis the behavior of the fin in relation to temperature distribution for optimize the effectiveness. currently the present approach for enhance the heat transfer rate Nano-fluid is employed as a medium, containing nanoparticles (1–100 nm) of metal or metal compound that are uniformly and stably distributed in a base fluid for increase the thermal conductivity of base fluid. So that heat transfer from fin arrays has been studied extensively, both analytically and through an experiment.

II. LITERATURE REVIEW

Some of the vital paper associated with CFD analysis of heat transfer rate of fins are reviewed and mentioned here.

A. Denpong Soodphakdee et al (2001) [1]

They studied the heat transfer of heat sink with used fin geometry (round, elliptical or square) and plate fin in staggered & inline arrangement CFD simulation is done in this analysis. The result shows the at lower value of pressure drop & pumping power elliptical fins gives best performance and at higher value of pressure drop & pump power round fin work best. The result also shows the staggered arrangement gives better performance than inline arrangement.

B. R. Ricci and S. Montelpare (2006) [2]

Experimentally they have observed that in liquid cooled short pin fin heat sink with different geometry (circular, square, triangular, rhomboidal shapes) which is arranged in line & keeping constant heat flux boundary condition. The short pin fin cooled by water in forced convection, they calculate the convective heat transfer coefficient i.e. the nussult number & after the investigation they found the triangular shaped geometry is the best geometry as compare to the others.

C. T.J. John et al (2010) [3]

They numerically study the overall performance of a micro pin fin heat sink with single phase liquid flow & different fin geometry (square & circular shaped pin fin). They study the effect of thermal resistance & pressure drop of micro heat sinks when take various factors such as pitch distance in axial & transverse direction, aspect ratio & hydraulic diameter of pin fin & concluded that at Reynolds number 50-500. They found at the low Reynolds number (below 300) circular pin fin heat sink shows better performance as compare with square pin fin heat sink and vice versa at high Reynolds number. The figure of merit for both the heat sink increases as the aspect ratio of pin fin is increased.

D. H. A. Mohammed et al (2010) [4]

they done the investigation numerically on rectangular micro channel heat sink (MCHS) & also show the effect of Nano fluids. In the MCHS using Al_2O_3-water Nano fluid, reynold number 100-1000, volume fration 1-5%. The MCHS performance evaluated in terms of temperature profile, pressure drop, heat transfer coefficient, friction factor by using finite volume method. the result express the nanofluid with 5% volume fraction could not able to enhance the heat transfer & give same result as pure water. So that the presence of nanoparticle could enhance the heat transfer of MCHS. Result also shows when volume fraction of nanoparticle increases under the extreme heat flux, both heat transfer coefficient & wall shear stress increase but thermal resistance of MCHS decrease.

E. H. A. Mohammed et al (2011) [5]

they discussed in this investigation the impact of various nanofluid on triangular micro channel heat sink. Water is using as a base fluid & using various types nanofluid such as Al_2O_3, Ag, Cuo, diamond, SiO_2, TiO_2 as coolants. This study covers the volume fraction 2% 3-D steady, laminar flow with finite volume method. Based on this experiment shows that the diamnd-H_2O & Ag-H_2O attains overall heat transfer enhancement & low pressure drop as compare with pure water.

H. Mehdi Nafer and Mohammad Tavassoli (2011) [6]

they did the analytical simulation model in electrical device & optimize the thermal performance. They have done also to calculate maximum heat dissipation at the least material cost. According to these fin on a heat sink may vary with size for example square, rectangular, circular, triangular, cylindrical cross section. It is observe that the designer does not know about the actual flow velocity through fin. By the input data such as biot number, heat transfer coefficient ratio etc. & by the iterative method we calculate the fin length & thickness. The overall result show the maximum effective heat transfer surface area in heat sink has the lowest thermal resistance when the heat transfer coefficient ratio is 1.

I. Minghou Liu et al (2011) [7]

They are studied the heat transfer in micro square pin fin heat sink with 20x20 mm^2heat transfer area & 625 staggered micro square pin fins are arranged. the cross section of micro pin fin is 559x559 μm^2 or 445x445 μm^2& height is 3mm which is fabricated on copper test section. They take deionized water as coolant liquid &reynold number from 60 to 800. The result show that both the heat sink having huge heat dissipation capability for the 445 X 445 μm^2cross section area pin fin heat sink the heat dissipation reach 2.83 x 10^6 w/m2with 57.225 L/h flow rate & temperature of surface become 73.4c & result also shows the pressure drop increases with reynold number.

J. Guan Qiu Li et al (2012) [8

they did the experiment of condensation characteristic inside five micro fin tubes for single phase flow & select outer diameter 5mm for all tubes & helix angle 18^0C.They also take following data mass fluxes 200 to 650 kg/m^2s, nominal saturation temperature 320k, inlet & outlet qualities 0.8 & 0.1 respectively. The result obtained from this experiments is tubes 4 has highest condensation heat transfer coefficient & pressure drop penalty and tube 5 has highest enhancement ratio but intermediate heat transfer coefficient.

K. Hamid rezaseyf and mortezafeizbakhshi (2012) [9]

they did computational analysis on convective heat transfer of micro pin fin heat sink using DI-water as base coolant fluid and two nanofluid (cuo, Al_2O_3,) with various mean diameter sizes. Cuonanofluid with 28.6 & 29 nm and $Al_2O_3$with 38.4 & 47 nm mean diameter sizes. They also investigate thermal& hydraulic behaviour of MPFHS & dependence of nussult&eular number, overall heat transfer coefficient efficiency reynold number, volume fraction, type & size of nanoparticles. The result show following points when volume fraction increases the eular&nussult number & overall heat transfer efficiency increase. when reynold number increases the nussult & overall heat transfer efficiency increase but eular number decreases. Last point is when nanoparticle size decreases the nussult number increase forAl_2O_3-water nanofluid but decreases for cuo-water nanofluid.

L. C.J. Ho and Chen (2013) [10]

they did experiment studied in copper mini channel heat sink using Al_2O3-water nanofluid and determine forced convective heat transfer. They take Reynolds number ranging from 133 to 1515 & they compare the result with the pure water & on the basis of inlet & bulk temperature difference they calculate average heat transfer coefficient & after the experiment they found the nanofluid cooled heat sink gives higher average heat transfer coefficient as compareto pure water.

M. PaisarnNaphon and LursukdNakharintr (2013) [11]

they are studied the heat transfer characteristic in the mini rectangular heat sink with the use of mixture of two nanofluid. They are TiO_2& water. The TiO_2 used as working fluid & deionized water as base fluid fluid.in this study the method used is deionized water cooling method in heat sink with three different channel heights which is fabricated from aluminium and from the result they found the average heat transfer rates is high for nanofluid as a coolant are more than for water.

N. Md. Farahad Ismail et al (2013) [12]

they are numerically investigated the turbulence heat convection from solid and longitudinally perforated rectangular fin. To improve the performance of cooling effect of square and circular cross sectional perforation are arranged. In which three dimensional fluid flow and perforated fins are mounted on a flate plate. Take incompressible air as working fluid, Reynolds number $2x10^4$ to $3.9x10^4$, prandtl number 0.71 result shows the perforated fins gives batter effectivity then the solid fins and also found that both the cross-section gives same amount of heat dissipation rate but circular fin gives less pressure drop.

O. Hardik D. Rathod et al (2013) [13]

they are studied the effect of different variables on the transfer of four stroke SI engine through fins. To study the various research papers related to fins and effect on heat transfer coefficient by changing cross-section, climate condition and material etc. The extended surface (fin) are generally used to increase heat transfer rate by increase the heat transfer area. This study is very useful to understand the batter geometry and material for the fins and for batter engine cooling. This paper gives the following result heat transfer coefficient, fluid properties, & heat transfer coefficient increased by surround fluid velocity etc.

P. Amol B. Dhumne et al (2013) [14]

they analysis experimentally heat transfer enhancement and pressure drop in a rectangular channel over a flat surface equipped with cylindrical perforated pin fins. The experiment covers the Reynolds number 13500-42000, the clearance ratio 0, 0.33, & 1, the inter fin spacing ratio 1.208, 1.524, 1.944 & 3.417. correlation equation developed using nussult number and Reynolds number for the heat transfer, friction factor & enhancement efficiency. The above experiment shows the use of cylindrical perforated pin fins gives better heat transfer enhancement as compare to solid cylindrical fins enhance efficiency vary and depending on the clearance ratio inter fin spacing ratio. For higher thermal performance they suggested lower clearance ratio, inter fin spacing ratio & lower reynold number.

Q. HalehShafeie et al (2013) [15]

they are numerically study of laminar forced convection in water cooled heat sink. Two pin finned microchannel heat sink (MCHSs) and pin fin heat sink (PFHSs) are studied. The distribution patterns of the fabricated pin fins are both oblique and staggered. The navier – stokes and energy equation are solved to find hydraulic and heat transfer performance of the heat sink and compare the heat removal fluxes in both the MCHSs and PFHSs with different height in equal pumping power . After the complete study they found for same pumping power heat removal of MCHSs gives better performance PFHSs at medium and high pumping power and PFHSs gives slightly better performance then MCHSs for small pumping power.

R. W.H. Azmi et al (2013) [16]

they are determined experimentally the heat transfer coefficient and friction factor using of SiO_2nanofluid flow in a circular tube under constant heat flux boundary condition in the turbulent region and take partical volumetric concentration up to 4%, reynold number in the range 5000-27000 at a bulk temperature 30^0Cand they determined the pressure drop increase with partical concentration up to 3% and decrease thereafter and SiO_2nanofluid friction factor decrease with increase in reynold at any concentration.

S. Ahmadreza Abbasi Baharanchi (2013) [17]

he reviewed on potential applications of Nanofluid technology in heat transfer enhancement. He sheds light on the present state of the art tentative research started in this field and hosts today's new ideas to resolve the present and upcoming issues with fast developing devices and power generation technologies that the world is experiencing.

T. Mushtak Ismael Hasan (2014) [18]

In this paper he has numerically investigated the heat transfer and flow characteristics in micro pin fin heat sink with Nano fluid. They used three different fins (square, triangular, circular) in addition to unfinned heat sink. Nano fluid is used as a cooling fluid instead of pure fluid. here two types of Nano fluid used (diamond-water, Al_2O_3-water) select volumetric concentration in range (1-4)% with boundary condition constant wall temperature and the Reynolds number in range (100-900) and to insure that the flow should be remain in laminar range. The result obtained from the following present work is by increasing volumetric concentration of Nano fluid increase the amount of heat dissipation and increase the pressure drop all fin shaped. In both the nano fluid diamond-water Nano fluid is better than Al_2O_3-waternanofluid and carry large amount of heat transfer rate another result shows the circular fin give higher heat transfer rate as compare with other fins and highest pressure drop with square fin.

U. A.A. Alfaryjat et al. (2014) [19]

they are numerically investigated the water flow and heat transfer characteristics which are affected by the geometrical parameter of micro channel heat sink when we use different channel shapes. Here we used three different channel shapes (hexagonal, circular and rhombus). In this study covers the reynold number value in the range of 100 – 1000 and maintained heat flux is 500 KW/M^2. finite volume method used to solve the governing equation and numbers of exclusive attributes and they found the smallest hydraulic diameter of the hexagonal cross-section MCHS. The best channel shape for the pressure drop and heat transfer coefficient and highest value of temperature, friction factor, and thermal resistance are found with the use of rhombus cross-section MCHS.

V. Navin Raja Kuppusamy et al. (2014) [20]

They have conducted numerical simulation for study the fluid flow and heat transfer characteristics of nanofluids in a triangular grooved microchannel heat sink (TGMCHS). Finite volume method (FVM) is used for solved the governing and energy equations. The influence of the geometrical parameters such as the angle (50–100_), depth (10–25 lm) and pitch (400–550 lm) of the groove on the thermal performance of TGMCHS was examined. The effects of different nanoparticle types (Al2O3, CuO, SiO2, ZnO), volume fraction (Ø = 0.01– Ø = 0.04), particle diameter (25–80 nm) and base fluid (water, ethylene glycol, engine oil) at different Reynolds numbers are also studied and they founded the thermal performance of TGMCHS had significant increment with the increment of angle and depth of the groove accompanied with an optimum groove pitch. It is also detected that the TGMCHS thermal performance of using Al2O3–H2O (Ø = 0.04, dnp = 25 nm) is better compared to the simple MCHS using water.

III. CONCLUSION

This is ascertained from literature survey that heat transfer management is extremely necessary parameter for cooling the equipment, stationary engines and plenty of engineering application, for the economical operating and additionally avoid the heating drawback, therefore we tend to wants the optimized styles of fins that is employed as associate extended surface and providing the massive heat transfer expanse with minimum material and most heat transfer rate. however as a result of several issue like material, fluid rate, cross section, climate condition, thermo-physical properties of operating fluid have an effect on the heat transfer rate of fins, the most dominant variable typically offered to designer is geometry of fin array. And choice of operating fluid as a coolant. Several new techniques are recommended by researchers like using different shapes of pin fin with different arrangements with different Nano fluids so as to boost small heat sink performance. Nano fluid could be a reasonably fluid containing tiny amount of Nano-sized particles (usually less than 100 nm) of metal and metal oxide that are uniformly and stably suspended in base liquid for enhance the thermal physical phenomenon There are several researches in literature created to review the small pin fin sink with completely different fins profiles and configurations and to review the flow and heat transfer in several Nano fluids. And founded that:-

A. Nano fluids offer the higher performance in heat transfer as compared to the standard fluid.
B. Staggered arrangement of fins offer the most effective result compared to different configuration.
C. Diamond-water Nano fluids is usually recommended to attain overall heat transfer improvement compared with pure water.
D. Circular pin fins offers the higher heat transfer rate compared to different normal geometry.
E. Square pin fins offers the high pressure drop compared to different commonplace geometry.

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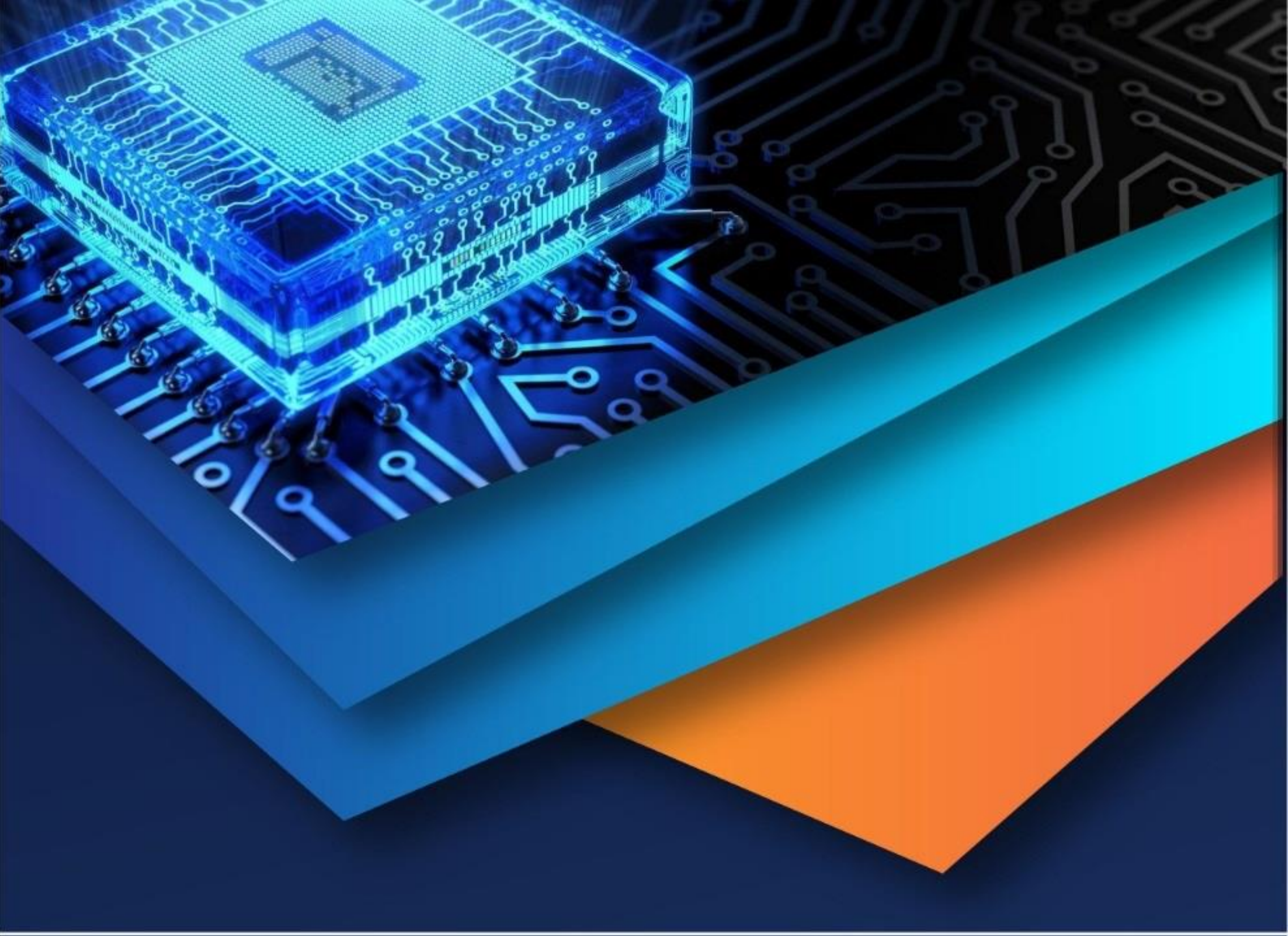

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