International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A-Review Paper for Application of Cooling Heat Sinkbythe Processof Nanofluids

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ABSTRACT

The heat sink is analysed for five different Reynolds number and using Al_2O_3 nanoparticle with Water and Ethylene glycol as base fluid. Ansys fluent is used for numerical computations using single phase model. Results are validated with experimental data for different values of Reynolds number. Other parameters including thermal resistance, Nusselt number, pumping power and coefficient of heat transfer and mini-channel temperature variation are identified and analysed. The temperature-dependent fluid properties were taken into account in the model due to the strong temperature-dependent features of nanofluids. An average temperature minimum problem was studied subject to the fluid area and energy dissipation constraints by using the density method. In the method, the design variable is updated according to the gradient information obtained by an adjoint based sensitivity analysis process. The effects of the energy dissipation constraint, temperature-dependent fluid properties and nanofluid characteristics on optimal configurations of NCHS were numerically investigated with following conclusions. Nanofluids contain a small fraction of solid nanoparticles in base fluids. Nanofluids cooled small channel heat sinks, have been anticipated to be an excellent heat dissipation method for the next generation electronic devices. In this study, nanofluids are used with different volume fractions of nanoparticles as a coolant for the minichannel. Al2O3-water nanofluid and TiO2-water nanofluid were tested for the copper minichannel heat sink.

I. INTRODUCTION

The technological and scientific development in the past decades has led to an increase in demand for new cooling fluids able to surpass the conventional ones, namely air and water, to improve, among other characteristics, the lifespan of electronic systems and componentsThe working fluids that have been increasingly investigated are the nanofluids. Those fluids are the suspension of nanoparticles of metals, oxides, or multi-walled carbon nanotubes, with sizes between 1 and 100 nm, in conventional heat transfer fluids designated by base fluids (water, ethylene glycol, oil)The different thermal properties of such fluids, such as the thermal conductivity, can be adjusted by altering, among other parameters, the nanoparticles' concentration, making nanofluids suitable for a wide range of applications. Nevertheless, the preparation methods and use of the nanofluids still have some limitations. For instance, the sedimentation and aggregation of the nanoparticles are difficult to control and may increase the viscosity of the nanofluids, which in turn requires extra pumping power of the operating devicesIn this sense, the laboratory of the authors of this work was very useful for the potential boiling heat transfer of the nanofluids, especially when the use of this novel class of fluids came together with the development of innovative materials and biphilic surfaces, which will certainly improve the heat transfer capabilities of systems dealing with nucleate boiling heat transfer. Moreover, the research team of the authors of the present work has performed experimental work and numeric simulations, and have already published several scientific articles on the referred subjectThe literature is well documented that any progress in the liquid cooling of electronic devices using different fluids can significantly reduce the temperature of ic chips; subsequently improve the performance of electronic devices as well as the lifetime of devices. Although there are many ways through which improvement in electronics device performance can be achieved, the use of nanofluids through mini-channels or micro-channels for cooling electronics device design has attracted particular attention from a large number of scientists overthepastdecade.Theprincipalparametersaffectingthecoolingofnanofluidsareselection of nanoparticles and base fluid, nanoparticles concentration, stability, power required to operate. Increasing the development of electronic devices to produce high-performance ic chips means that more devices are built per chip.

II. SCOPE OF STUDY

From the literature review it is evident that sufficient research has been carried out on mini- channels or micro-channels heat sinks using different dielectric fluids, deionized water or even using two-three combinations of nanoparticles in water base fluid in nanofluids. Geometry of different dimensions is also studied using different channel numbers and their dimensions. Stability of nanoparticles in concentration in different nanofluids has also been studied for different applications. However, in the case of IC chips which are used nowdays for various applications, little has been reported regarding specific study (abhishek etal.).

The main significance of present study is,

1. To study single mini-channel for five Reynolds number for Al_2O_3 with water and ethyl glycol as base fluids for three different concentrations inmini-channels.

2. Optimizing the base fluid and concentration ofnanoparticle.

3. To forecast temperature variation throughout the channel due tonanoparticles.

4. Tostudylocalheattransfercoefficientsofvariouscombination.Therefore,thisparticular aspect will be thoroughly investigated in the present work in view of the fact that an optimum geometric configuration and concentration of nanofluids should have ahigher

5. Heattransfercoefficientresultinginbettercoolingefficiencyandlesspowerrequirement.

Details of mini-channelconfiguration

In the illustration of heat sink with heat supplied through Integrated circuit (IC) Chip from bottom and it is removed by flowing fluid through mini-channels. Chip is located closed to the inlet of the mini-channels and centered over the width of heat sink as shown in Fig.1 constant heat flux q'' is provided through IC device. The inlet temperature of fluid was 313K.

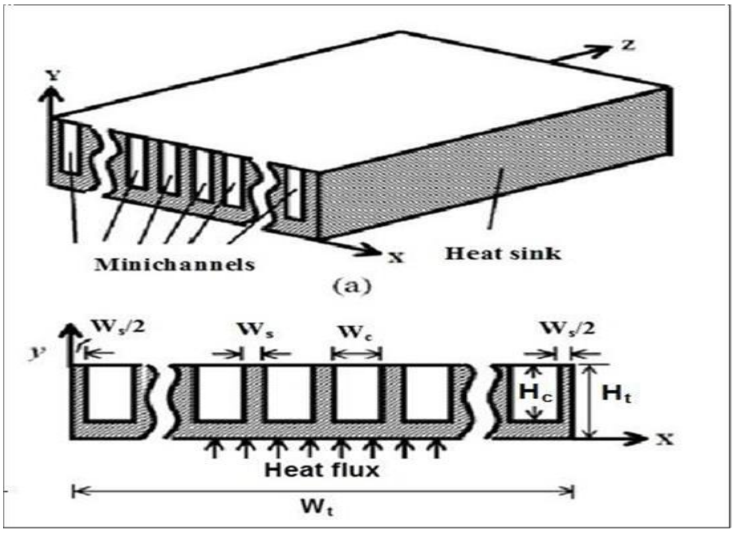

Fig.1 Diagram of mini-channels heat sink

Effects of nanofluids by varying Al_2O_3 nanoparticles concentration in Ethylene glycol

In this section discussion is done on values of local heat transfer coefficient (h), nusselt number (Nu),fanning friction factor (f) and maximum wall temperature thermal resistance (R) for Al_2O_3 + Ethyleneglycol (EG). Here from and values for local heat transfer coefficient can be observed. As itcan be noted from there is very little variation in values for h when pure EG is used. The values werein range of 2300-2600 (W/m2K) thus graph looks nearly straight as compared to other concentrations. Incase of Ø=5%, a dramatic change in values can be seen with respect to Re. Firstly value of h increases tilla value of Re≈1250 to 1300 then it shows a decrement in value of h. Addition of nanoparticles i.e for Ø=5%results in increment in h by 7.86%. ForØ=8%, h increases till Re≈600 then shown small variation till Re≈1200 and then again increases with Re.Addition of nanoparticles i.e for Ø=8% results in increment in h by 10.91%.From and Fig.2 values of Nu can be noted. Since, Nu depends on h, Dh and keff, it remains nearlyconstant for pure EG i.e for Ø=0%, similar to h. But as Ø changes thermal conductivity of nanofluid (keff)also changes. For Ø=5% Nu increases till Re≈1250 to 1300, after this it decreases similar to h, but at Re=238value of Nu for Ø=5% is less than that is for 0%. It can be explained by fact that increment in keff is morethan h as Ø changes. Thus it can be noted that for below a particular value of Re, increasing concentrationdo not results in increment in Nu or heat transfer. Addition of nanoparticles i.e for Ø=5% results inincrement in Nu by 28.6%.

Effects of nanofluids by varying Al_2O_3 nanoparticles concentration inWater

To examine the effects of thermal resistance, temperature variation along the fluid flow, local convective heat transfer coefficients, viscosity effects, pressure drop and pumping power, three different base fluid combination and Al2O3 nanoparticle by varying their concentration from as 0%,5% and

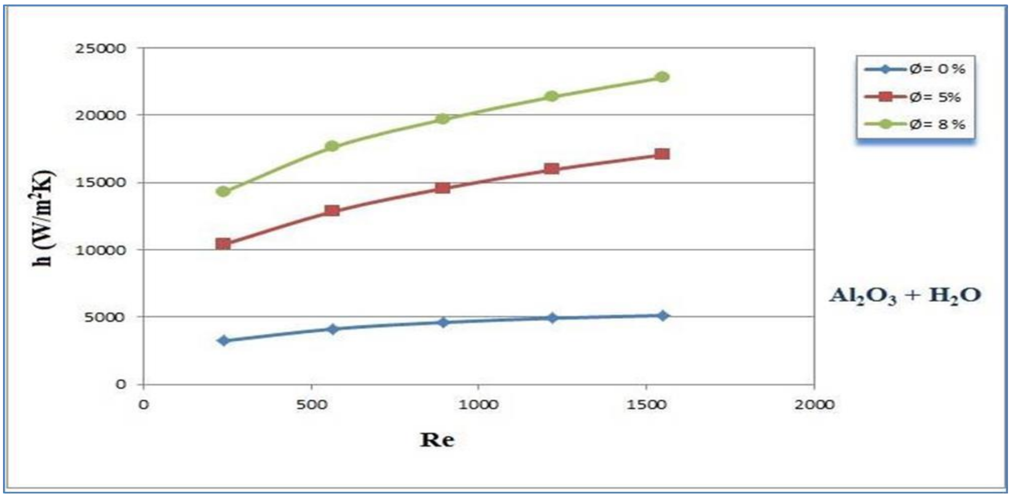

Fig.2Effects of change in Reynolds number and concentration of Al_2O_3 using base-fluid water: On local heat transfer coefficient.

8% volume percentages are considered. Simulation results for water, ethylene glycol and water + 20 % Ethylene glycol [EG20] base fluids were discussed. All calculations were done on midsection (z= 25mm.) and local values were considered. Numerical simulation is performed and by calculations with required equation following results were noted. Calculations were performed at midsection and local properties were considered so as to avoid the cumbersome handling of data at various sections with different Reynolds number and concentrations. Values of local heat transfer coefficient h are noted in and graphical representation is shown in Fig.2. It can be noted that for simple cooling with water (i.e Ø= 0%) h shows less responsiveness or less variation with respect to Re. Also for Ø=5% and 8% a variation in values of h w.r.t Re can be seen. Although for 5% maximum increment in h w.r.t Re is noted.

IV FUTURE WORK

From the present research study, we have found that the importance of nanofluids flow in mini-channels for cooling of high-performance Integrated Circuit Chip in electronics devices. The effect of crucial parameters such as selection of effective Re for nanofluids, concentration of nanoparticles, velocity of flow, viscosity of flow, nanoparticles size on heat transfer characteristics and power required to operate a pump is studied. The future works proposed from the light of present study are: 1. Effects of other available base fluids and liquid metal used as nanofluids and its properties. 2. Investigating the effects of Re on different nanoparticles. 3. Simulation of different nanoparticle using two phase approach. 4. Conducting experimental study to validate the results obtained from numerical studies. 5. Investigating the combine impact of higher concentration and varying size of nanoparticles in nano-fluids above 10 percentages on heat transfer characteristics. 6. Find the thermal stress regions and hot spots on IC chip devices and try to minimize it.

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