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Study and Reviewing the Recent Development of the Performance of Heat Sink

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ABSTRACT

The main aim for the paper is to review what all advancement in technology was done for increasing the heat flow rate with the help of heat sink. The competative research is going on in this field in which researcher using various types of configuration in their model for getting best results.This study reveals that the heat transferred by the fins is mainly dependent on the fins profile (type and shape), length, angle, and surface area. Fins are divices which is mounted on heat sink for increasing the surface area for maximum transfer of heat arround the surrounding. Various types of fin geometries with copper and aluminum as heat sink materials have been simulated in both natural convection and forced convection conditions. More feasibility study and optimization has to be carried out for various types of fins in heat sink.

Key words: Heat Sink, Fins, Heat Transfer, Pressure Loss, Temperature Drop, Velocity.

Introduction:

A heat sink is a device that absorbs heat generated on the processor of a computer system and dissipates it into the atmosphere by forced convection process to protect processor from excess amount of temperature. Heat sink acts as in a semiconductor device to transfer maximum amount of heat. So, the thermal conductivity of heat sink should high, so that maximum amount of the heat must be dissipated into atmosphere. The thermal conductivity of heat sink depends on the property of material by which it is manufactured. For example aluminium has better thermal conductivity, so commonly heat sinks are made up of aluminium. It has good manufacturing and economic to assemble or to optimized for better heat transfer during the work of processor to dissipate the heat in maximum amount to atmosphere. According to the configuration of heat sink, it is classified as follows:

1. **Rectangular channel heat sink:** It is commonly used on CPU for their better heat transfer rate and good thermal conductivity, these type of shaped heat sinks are made up of aluminium.
2. **Circular fin heat sink:** It is basically used in complex type of geometry. The fin shape is in the form of circle which are fabricated on circular platform to absorb excess amount of heat flux. Due to the circularity, the surface area of heat sink is increased which leads to the increase in heat transfer rate and decrease in the temperature of system.
3. **Stamped heat sink:** These type of heat sink consists of a rectangular channel type configuration with edge, fillet to resist the concentration of heat for maximum heat dissipation.
4. **Annular fin shaped heat sink:** These heat sinks are designed in shape of annulus. The one end of annular shaped configuration is interfaced with heat generating device and another side of annular shaped is free to the atmosphere. The side of annulus which is exposed to the atmosphere is optimized in the form of rectangular shaped, circular shaped tip for better heat transfer rate.
5. **Zigzag shaped heat sink:** These heat sinks are configured in zigzag shaped to increase the surface area, which increases nusselt number and decrease the thermal boundary layer effect for better heat dissipation.

Technical Terms Influencing Forced Convection Type of Heat Sink:

Pressure Drop: Velocity increases in channel, pressure decrease. Thus, it also depends on turbulent intensity of fluid and its hydraulic diameter. So, when pressure drop increases, thermal resistance also decreases gradually. Hence it is defined as the difference of velocity at inlet and outlet.

$$\Delta p = p_{in} - p_{out}$$

Where p_{in} = pressure at inlet on heat sink

p_{out} = pressure at outlet on heat sink

Thermal Resistance: It is a ratio of temperature difference to the heat flux. Thus, heat flux increases, thermal resistance also decreases suddenly**.**

$$R_{th} = \frac{\Delta T}{Q}$$

Where ΔT = temperature difference on heat sink

Q = constant heat flux

Profit Factor : It shows the performance of heat flux and pumping power as pumping power increases profit factor decreases thus due to this thermal hydraulic performance is improved, profit factor is a ratio of heat flux and pumping power.

$$J = \frac{Q}{E}$$

Where J = profit factor

E = Pumping power

Pumping Power: Pumping power is a product of an inlet velocity, pressure drop and area of plate pin fin.

$$E = U_{in} A_p \Delta p$$

U_{in} = inlet air velocity

A_p = area of plate pin fin

Δp = pressure drop on heat sink

Thermal boundary layer effect on heat sink: In plate fin heat sink the effect of thermal boundary layer is high compared to optimized heat sink because in commonly plate fin heat sink the effect of convection is less but in optimized type heat sink, the optimization work is done in the form of creating pins on closed channel, to increase turbulence intensity of fluid and to decrease the pumping and also to decrease the effect of thermal boundary layer for better heat transfer rate and also to reduce the thermal resistance on heat sink.

Numerical and Experimental Investigation

Huashuai Zhang et. al. 2015 - In this study, this method is used to predict the heat transfer performance of the new heat sink with woven fabric structure, called fabric pin fin heat sink. Effect of the fin length and the material types made of heat sink on the thermal-structure response of the pin fin was investigated under forced convection. The results show that the minimum temperature of heat sink decreases with an increase of pin fin length but the decreasing amplitude has decreased.

Sandip Shah et. al. 2015 - A one-dimensional conduction heat transfer model is formulated to evaluate the effectiveness of preliminary design of practical PCM-based energy storage units. In this model, the phase-change process of the PCM is divided into melting and solidification subprocesses, for which separate equations are written. The equations are solved sequentially and an explicit closed-form solution is obtained.

R. Muthu kumuran et.al. 2016- An experimental investigation was performed to study the heat transfer and pressure loss characteristics in a horizontal rectangular wind tunnel having attachment of cylindrical, grooved cylindrical and perforated pin fins over a horizontal based pin fin assembly.Behzad Fani et.al. 2014[28]- in this study the rise of nano particles , volume fraction was analysed on heat sink , to determine viscous dissipation and pressure drop.

Hansaem Park et.al. 2016 - in this investigation the organic rankine cycle heat transfer concept was applied on heat sink to determine the thermal performance.

Z. Azizi et.al. 2016- in this study a nano particle of mass fraction was used experimentally on heat sink to determine the Nusselt number by varying Reynolds number.

Lei Chai et.al. 2016- a numerical investigation was analysed on micro channel conductor heat sink for conjugate heat transfer and viscous heating.

S. Ravikumar et. al. 2017 – The design of heat sink for improving the thermal performance is experimented. This project utilizes thermal analysis to identify a cooling solution for a desktop computer, which uses a 5 W CPU. The design is able to cool the chassis with heat sink joined to the CPU is adequate to cool the whole system. This work considers the circular cylindrical pin fins and rectangular plate heat sink fins design with aluminium base plate and the control of CPU heat sink processes.

Xiang Wanga et. al. 2018 - This study aims to find out the optimized solution for coupled effects of parameters. Different turbulence models were studied and RSM (Response Surface Methodology) was the most appropriate one to deal with optimization of target and investigate interaction of different parameters. In design height and diameter of cylindrical pin-fin was adopted as control parameters, according to numerical simulation the thermal resistance and pressure loss of pin-fin heat sink indicated improving tendency with increasing the both parameters.

E. Siva Reddy et. al. 2019 - Various types of fin geometries with copper and aluminum as heat sink materials have been simulated in both natural convection and forced convection conditions. Various fin arrangements such as inline & staggered arrangements in combination with variation in pin fins geometries have been simulated. Fin geometries such as Rhombus prism and Rhombus pyramid. Heat sink with Rhombus prism pin fins (HS-RPPF) is found to be more effective in dissipating heat compared to other configuration of fins, this is observed mainly due to the higher surface area. Rhombus tapered pins have lower heat transfer rate compared to all the other pin fins which have been simulated, considering the complexity of manufacturing involved, more feasibility study and optimization has to be carried out for these type of fins to be used.

Senthil kumar 2020 - This study reveals that threaded surface pin heat sink is 18.13% higher heat transfer than plain pin heat sink. In terms of specific performance consideration, threaded surface textures pin fins shows impending substitute design to plain circular pin fins. The threaded surface texture pin has decreased aerodynamic consequence compared to plain circular pin. The threaded texture increases surface area, flow turbidity and delays flow separation and these factors enhances the heat transfer.

S.Senthur Prabhu 2021 - In this present study, the systematic review is carried out by critically analyzing the different types of fin profile such as plain rectangular fin, wavy fin, circular pin fin, and rectangular pin fin to increase the fins efficiency. The outcome from this study reveals that the heat transferred by the fins is mainly dependent on the fins profile (type and shape), length, angle, and surface area. Alongside the orientation of the fins, porosity, thermo-geometry also affects the fins' efficiency.

Ozgur Ozdilli 2021 - This work aims to develop an alternative heatsink to replace a conventional heat sink for cooling a LED. Heat sinks were designed in two different geometries, such as wavy pin-fin (WPF) and square pin-fin (SPF). The heat dissipation performance of each heat sink, which has the same number of fins and weights, was analyzed using computational fluid dynamics software at 5 W, 10 W, and 15 W thermal power.

Yacine Khetib et. al.2021- This study numerically investigates a micro-pin-fin heat sink (MPFHS) to improve cooling capability and productivity of MPFHS. It was assumed that the flow is turbulent, steady, and incompressible. It is found that the RS configuration possessed maximum heat transfer while yielding the maximum pressure drop. Smaller distances between the pins improved heat transfer but enhanced the convective heat transfer coefficient and increased pressure drop.

S Sushma et.al. 2021 - To enhance heat transfer by using different shaped heat sinks.The results from the experimental forced convection are compared for different heat sinks like honeycomb-shaped, radial-shaped, and flared shaped.

Conclusion:

Through going on detailed study from above papers it is clear that all work for the enhancement of heat transfer rate by heat sink by increasing the surface area. Lots of work is carried out on design, configuration of fins and material of fins and checking on different conditions**.**

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