International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Special Issue - AMET-2018

A Review Paper on Analysis of Different Parameters of Heat Sink under Forced Convection

Rahul Pawar[1], Sanjay N. Havaldar[2]

[1]Post Graduate Student, [2]Associate Professor, Mechanical Engineering, MAEER's MIT College of Engineering, Kothrud, Pune, Maharashtra, India.

Abstract

Heat sink is a passive heat exchanger which transfer the heat generated from electronic or mechanical device to fluid medium, often air or liquid where it dissipated away from the devices. Study is to be conducting on enhancing the heat transfer rate by analyzing the different parameters of heat sink. The proposes of the research and practical work is to finding the effect of different parameters on heat sink heat transfer under force convection. Also suggest some parameters that's help to enhance the thermal performance.

Keywords: Heat sink, Forced Convection, Heat transfer enhancement

I. Introduction

A heat sink transfers the thermal energy generated by an electronic assembly or component into a cooling medium. The heat is transferred from a higher temperature region to a lower temperature region by conduction, convection, radiation or by a combination of these heat transfer methods.

The performance of this passive heat exchanger is determined by many factors including the velocity of the coolant fluid, the thermal conductivity of the material, the thermal interface material, and the attachment method. For a specific application, the parameters of a heat sink can be determined through modeling and analysis.

The study of the heat transfer undoubtedly has a great deal of research efforts for generating heat exchanger devices. The gas turbine engines which are used for military airplanes required a very efficient technique to cool the turbine blades. One can achieve it through the application of forced convection to a square-fin array configuration inside the blade. Another area where heat transfer augmentation is required is the area of microminiaturization of component for digital computers and the instrumentation of modern aircraft.Also Geometries and parameters that provide maximum heat dissipation are obtained by analyzing different heat sink models**.**

II. Literature Review

Nowadays Heat transfer enhancement is an important field, many researcher works on it. They are use different techniques for enhancing heat transfer performance by varying different parameters.

Chou et al. [1] studied about how to increase the heat transfer by fins. They found that the heat flow choking could take place in the case of simple plate fins as well. Although choking

is usually caused by the accommodation of a cluster of fins at the fins tips.

Jubranet al. [2] have done some experiment to analyze the effects of inter-fin spacing, shroud clearance, and missing pin on the heat transfer from cylindrical pin fins arranged in staggered and in-line arrays. The effect of missing pins on in-line and staggered arrays with various inter-fin spacing are negligible but staggered array is more sensitive to the missing pin with a 7% reduction in the heat transfer.

Ledezma et al. [3] studied the heat transfer on a pin finned plate exposed to an impinging laminar air stream, which showed that by selecting the fin-to-fin spacing (S)the thermal conductance between the plate and the air stream can be maximized. Also they offered two empirical correlations for the behavior of the optimal spacing and maximum thermal conductance.

Sparrow et al. [4] studied to measure the per-slat heat transfer coefficient for an array of co-planar slat-like surfaces which face upstream into an oncoming flow. By studying that, they found that the dependency of the Nusselt number on the Reynolds number was the same for all investigated array configurations and the influence of the array geometry can be very well represented by a power law.

Sparrow and Liu [5], after studying laminar heat transfer and pressure drop characteristics from arrays of in-line and staggered plate segments came to conclusion that, the heat transfer for the segmented arrays exceeds that for the parallel plate channel and the staggered arrays yield better performance than the inline array.

Davalath and Bayazitoglu [6] performed a numerical study for two-dimensional problem of conjugate heat transfer for laminar incompressible flow over multiple rectangular blocks with uniform distributed heat sources.

Molki et al. [7] carried out an experimental investigation to study heat transfer in the entrance region of an array of rectangular heated blocks. They presented two empirical correlations for the adiabatic heat transfer coefficients and thermal wake effects for the entrance region.

BejanandMorega [8] studied the optical geometry of an array of pin and staggered parallel plate fins that minimized the thermal resistance between the substrate and the flow forced through the fins. The effects of array configuration and pin-end wall fillet on the heat transfer and pressure drop of short pin-fin arrays, was experimented by chyu[9].

Metzger et al. [10] investigated the heat transfer and pressure loss characteristics for two families of pin-fin array geometries. Their results showed that the use of circular pins with array orientation between staggered and in-line can in some cases increase the heat transfer while the pressure drop decreases.

III. Factors mainly considered while designing heat sink.

a) Power that needs to be dissipated from heat sink
b) Maximum component temperature.
c) Area of heat sink.
d) Power density.
e) Air Flow parameters.
f) Pressure Drop should minimum.
g) Cost of sink.

IV. Factors which affect on Thermal performance

a) Number of fins

When increase number of fins on array the heat transfer performance is also increase up to certain level and then decrease. So, we have to select optimum number of fins on array to enhance thermal performance.

b) Shape of pin fin

The heat transfer in circular array is better in inline arrangement but there is more pressure drop. The elliptical fins have 20% more heat transfer as compared to circular pin fins but it has reduction in pressure 100%.

c) Geometrical parameters

The length of fin has more effect on heat transfer performance as compared to diameter of fins. When diameter of fin change by 25% then there is only 6% change in thermal performance of fin. Fins having aspect ratio more than 4 have better heat transfer performance. Fin efficiency is mainly depends on the height of fin. With increase in hydraulic diameter heat transfer performance is also increase.

d) Effectof FinPitch (Pin fin)

Heat transfer is more when pitch is less. The longitudinal pitch (S_2) has larger effect on heat transfer performance as compared to transverse pitch (S_1). In case of circular and square heat sink if transverse pitch decrease their will decrease in thermal resistance and increase in pressure drop. Transverse pitch has larger effect than longitudinal pitch in case of array pressure drop.

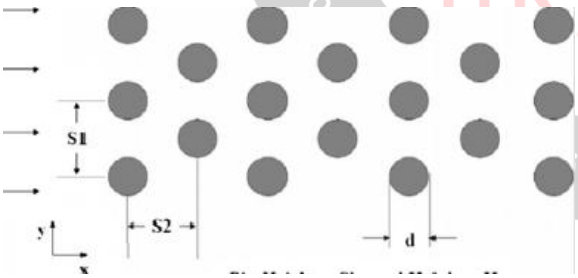
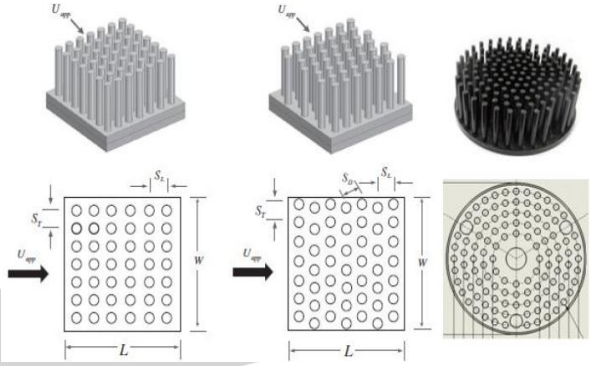


Fig 1. Effect of fin Spacing

e) Arrangement of fin array

In case of inline pin fin array each pin fins are in straight line horizontally and vertically placed in a rectangular manner. In case of staggered array fins are not in straight line they are randomly oriented. In case of radial pin fin array fins are along radial direction in circular channel.



a. Inline b. Staggered c. Radial

Fig 2.Different type of pin fin array

f) Material of fin

The material used for fin should have high thermal conductivity. Due to high thermal conductivity of copper (398 w/m^{0}k) it has good thermal performance than aluminum (298 w/m^0 k). Due to low weight and low cost of Al is commonly used as fin material.

g) Nature of flow

Force convection has better thermal performance than natural convection. In natural convection due to buoyancy effect flow of air take place over heat sink. While in forced convection we can adjust the flow speed of air by fan.

h) Type of flowing fluid

Air is commonly used as fluid due to its low cost and easily available in nature. Sometime special gases used to improve the thermal performance of heat sink.

i) Surface finish of the fins

Surface finish plays an important role in heat transfer enhancement. Smooth surface have less heat transfer performance due to less friction between air and fin surface. If we use rough surface instead of smooth surface then

 DOI : 10.18231/2454-9150.2018.1445

will get enhancement in heat transfer performance.

j) Inclination of fins

Due to inclination of fin the flow of fluid over fin surface get disturb. Hence more time fluid and fins in contact with each other. Inclination of fins plays an important role in heat transfer enhancement.

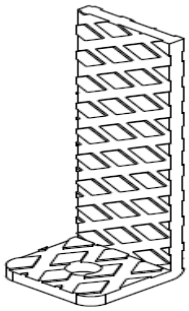
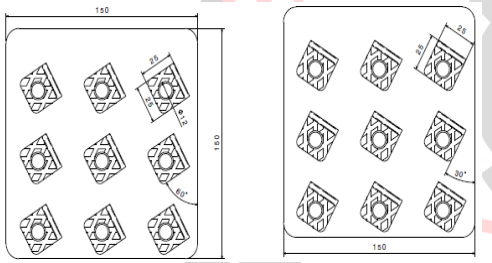


Fig 3. Fin with rough surface



60^0 inclined 30^0 inclined

Fig 4. Fin with different inclination

V. Conclusion

1) In the present study, the analysis of different parameter of heat sink is explained on the basis of some previous researchers.
2) The main Focus is given on the fins geometry and surface modification of fin. Also the effect of rough surface and inclination of fin on heat transfer enhancement.
3) Some relations related to fins geometrical parameter also mention which mainly affecting on heat transfer performance.
4) The relations are useful for better design of heat sink with maximum heat transfer performance and minimum pressure drop.

VI. Future scope

Now days many researchers work on the heat transfer enhancement. We need to find some effective method to enhance heat transfer performance.

We can design a heat sink with maximum effectiveness and minimum pressure drop with considering different parameter that mainly effect.

Also we can try to reduce the weight of heat sink by using the proper material and some modification in design. We have scope to use rough fin surface with different inclination on heat sink.

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