A Review on Thermal Performance Analysis for Annular Fins of Various Profiles using Ansys

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Abstract

The annular fins acts as best heat sink for liberating heat energy generated during operation of various components used in thermal devices.. Enhancement in heat transfer rate can be achieved by different methods like perforation of different shapes, increasing the surface area as convective heat transfer depends on surface area. Increasing no of perforation & area of perforation to optimum value also has positive effect in achieving increased heat transfer rate. Heat transfer rate enhancement for different profiles of annular fin using perforation has been review in this paper.

Keywords: *Natural convection, forced convection, annular fins; Perforation, Convective Heat transfer coefficient, pressure drop.*

I. INTRODUCTION

In this modern age, there is a need of efficient cooling device with less investment to construct and operate them. Annular fin is considered best for liberating heat during operation of thermal devices by Convective mode. Since the available space for condenser is very small so there will be need of compact and efficient condenser. Annular fins liberate heat to surrounding by natural convection. Annular fins are used to increase surface area. Heat transferred by fins is depends on spacing , shape and size , no of fin used, Diameter of fin, Diameter of perforation, temperature difference between fin and fluid.

A. Importance of perforation

Annular fins are used to dissipate heat generated during operation of condenser by convection mode. The rate of heat transfer depends upon surface area available. Perforation implies to create hole of any geometry from fin in longitudinal or lateral direction. Perforation interrupts the fluid flow which helps to improve heat dissipation rate. Perforations also reduce the weight, cost, and overall size of heat sink.

II. LITERATURE REVIEW

M. Sudheer et.al.[1] A detailed work has been carried out to develop a finite element methodology to estimate the temperature distribution for steady-state heat transfer and thermal stresses induced by temperature difference in a silicon carbide (SiC) ceramic finned-tube of the heat transfer equipment. Finite element methodology (FEM) was used to calculate the temperature and also the stress fields. An extensive study was carried out using ANSYS, a strong platform for finite element analysis. Results obtained were presented in a series of temperature and thermal stress distribution curves for annular fins with rectangular, trapezoidal and triangular profiles for a large variation in of radius ratios. it had been found that the radius ratio and fin profiles are the significant parameters affecting the temperature and thermal stress distribution in annular fins.

Chen. et al.[2] A quick assessment of the performance loss in association with material saving amid rectangular and trapezoidal fin is analytically investigated and through an experiment verified novel dimensionless parameter – r_t representing the ratio of the fin tip to base thickness – is used to modify the fin equation. A dimensionless differential equation is derived based on the formulation and the corresponding closed form solution of the dimensionless temperature and fin efficiency is given. it is found that the performance drop depends on varied r_t ratios, The performance drop depends on varied r_t ratios, and therefore the most pronounced performance difference occurs in the region between M = 1.7 and 2.5.

M.T. Darvishi et.al.[3] An annular fin of hyperbolic profile with temperature dependent thermal conductivity is studied by pseudospectral methodology A comparison of the obtained numerical results is made with the closed form analytical solution available in the literature for the case of constant thermal conductivity the thermal conductivity will increase with temperature, the effect is to elevate both the temperature distribution in the fin and therefore the fin efficiency.

Kiran b. et.al.[4] A detailed work has been carried out to develop a finite element methodology to estimate the temperature distribution for steady-state heat transfer and thermal stresses evoked by temperature difference in Al finned-tube of the warmth transfer equipment. Finite element method (FEM) was accustomed calculate the temperature and the stress fields. an extensive study was carried out by ANSYS, a strong platform for finite element analysis. Results obtained were conferred in a series of temperature and thermal stress distribution curves for annular fins with rectangular, trapezoidal and triangular profiles for a wide range of radius ratios. The stress distribution curve is optimum with trapezoidal fin with wide range of radius ratio. it had been found that the radius ratio and fin profiles are the significant parameters affecting the temperature and thermal stress distribution in annular fins.

Gaurav A. et.al.[5] The steady-state natural convection heat transfer from vertical rectangular fins extending perpendicularly from vertical rectangular base was investigated experimentally. The results of perforations and base-to-ambient temperature difference on the heat transfer performance of fin arrays have been seen and optimum worth of perforation is suggested. The results of experiments have shown that the convection heat transfer rate from fin arrays depends on all percentage of perforation and base-to-ambient temperature difference. The effect of these parameters was also examined, and it was realized that for a given base-to-ambient temperature difference, the convective heat transfer rate from the fin array is maximum for 30% perforated fin array.

Abdullah H.et.al.[6] A study examined heat transfer enhancement from a horizontal rectangular fin embedded with square perforations under natural convection compared to the equivalent solid (non perforated) fin. The parameters considered were geometrical dimensions and thermal properties of the fin and of the perforations. It showed also that for certain range of square dimension and spaces between perforations there is an improvement in perforated fin heat dissipation over that of the equivalent solid one. The heat transfer enhancement of the perforated fin increases as the fin thickness is increased.

Han-Taw Chen et.al.[7] The finite difference technique in conjunction with the least-squares theme and experimental temperature knowledge is used to predict the average heat transfer coefficient and fin efficiency on the fin of annular-finned tube heat exchangers in natural convection for various fin spacing. The radiation and convection heat transfer coefficients are simultaneously taken into consideration in the present study. The heat transfer coefficient on this annular circular fin is assumed to be non-uniform. so the entire annular circular fin is split into many sub-fin regions so as to predict the common heat transfer coefficient h and fin efficiency from the knowledge of the ambient temperature, tube temperature and fin temperature recordings at several chosen measurement locations. The results show that the h value increases with increasing the fin spacing S, and the fin efficiency decreases with increasing the fin spacing S. However, these two values respectively approach their corresponding asymptotical values obtained from a single fin . The fin temperature departs from the best isothermal situation and decreases more rapidly away from the circular center with increasing the fin spacing. In order to validate the accuracy of the present inverse scheme, a comparison of the average heat transfer coefficient on the fin between the present estimates.

Qasem Isam H. E. et. al. [8] various types of fins, starting from comparatively easy shapes, like rectangular, square, cylindrical, annular, tapered or pin fins, to a mixture of various geometries, are used. A three-dimensional numerical study is formed for turbulent fluid flow associate degreed convective heat transfer around an array of rectangular solid and new style of perforated fins with completely different numbers and two different sizes of perforations. during this study, the fin efficiency of perforated fins is set and compared with the equivalent solid fin. The orientation of those perforations is delineated as they need two sides parallel to the fin sides The one-dimensional answer thought-about as Bi-ot range is extremely tiny (less than 0.01), keeping constant dimensions, thermal physical phenomenon, base temperature and close temperature for each fins and studied the impact of perforation. Results show that new perforated fins have higher heat content transfer and wide weight reduction compared with solid fins.

Malekzadeh et.al.[9]: Extended surfaces (fins) are one among of the heat exchanging devices that are used extensively to enhance heat transfer rates. The surface area of fin is responsible for rate of heat transfer rate of heat transfer. Radial or annular fins are one among the most common choices for exchanging the heat transfer rate from the first surface of cylindrical shape. To enhance the convection heat transfer coefficient (h) might need the usage of pump or fan. Besides it should be enough to use. Different manner is to extend the surface by adding the perforated fins made of highly conductive material such as aluminum (Al). Compact heat transfer equipment with high performance and light weight has been used in various industrial applications. For these purposes, finned extended surfaces has been used to provide a sufficient increase in the heat transfer.
Iqbal et. al. [10] analyzed the optimal configurations of finned annulus with parabolic fins by employing trust-region and genetic algorithms for maximum convection. Flow is considered to be laminar, steady, incompressible and fully-developed subjected to constant heat flux boundary condition. Finite element method (FEM) is employed to compute field variables for optimization

providing function values. Comparison has been done all situations and for all criteria the optimal configurations of parabolic fins with those of a triangular fin and trapezoidal indicates that no single fin-shape is best.

Sudheer et. Al [11]. Comparative study to estimate the temperature distribution for steady-state heat transfer and thermal stresses induced by temperature drop in a silicon carbide (SiC) ceramic finned-tube of the heat transfer equipment. Finite element method (FEM) has been used to compute the temperature and the variation in stress fields. The comparative study has been carried out using ANSYS, a powerful platform for finite element analysis. Results obtained have been presented in a series of temperature and thermal stress variation curves for annular (radial) fins with rectangular, trapezoidal and triangular profiles for a various range of radius ratios. It has been found that the radius ratio and annular fin profiles are the considerable parameters affecting the temperature and thermal stress variation in annular fins.

III.CONCLUSIONS

1) Temperature Distribution for different profiles and different radius ratio is also analyzed and temperature variation depends upon distance from base.
2) Heat transfer will also be depend upon no of annular fin used for a fixed length of tube .
3) Variation is such that Nusselt number increases with increasing number of perforations on Annular fin heat sink .As less as Reynolds No ,It will give higher efficiency.
4) The fins having perforations are considered better.
5) The heat transfer coefficient for perforated annular fin is higher than solid annular fin.
6) The heat transfer enhancement is depends on radius ratio, fin dimensions, the perforation geometry, and number of perforation and thermal conductivity of material.
7) The surface area for different annular fin is varied as per profile of geometry.
8) The perforated annular fin is economical.
9) Weight of the perforated fin is less in compared to solid fin.

REFERENCES

[1] M.Sudheer et.al.“ Finite element analysis of thermal characteristics of annular fins with different profiles” ARPN Journal of Engineering and Applied Sciences 2012

[2] Chen. et al. “Analytical analysis and experimental verification of trapezoidal fin for assessment of heat sink performance and material saving” Applied Thermal Engineering 98 (2016) 203–212

[3] M.T. Darvishi et.al. “Numerical investigation for a hyperbolic annular fin with temperature dependent thermal conductivity” Propulsion and Power Research 2016;5(1):55–62

[4] Kiran b. et.al. “Performance and Optimization of Annular Fins by Using Finite Element Analysis” International Journal of Latest Trends in Engineering and Technology (IJLTET) Vol. 3 Issue 4 March 2014

[5] Gaurav A. et.al. “Effect of Percentage of Perforation on the Natural Convection Heat Transfer from a Fin Array” International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-3, Issue-2, February 2015

[6] Abdullah H.et.al.“ Augmentation of Fin Natural Convection Heat Dissipation by Square Perforations” Journal of Mechanical Engineering and Automation 2012, 2(2): 1-5

[7] Han-Taw Chen et.al. “Estimation of heat transfer coefficient on the fin of annular-finned tube heat exchangers in natural convection for various fin spacings” International Journal of Heat and Mass Transfer 50 (2007) 1750–1761

[8] Isam H. E. Qasem and Abdullah H. M. AlEssa “One Dimensional Finite Element Analysis of Heat Dissipation from Rectangular Fin with Longitudinal Hexagonal Perforations” 2015

[9] Hong-Long Chen et.al. “Analytical analysis and experimental verification of trapezoidal fin for assessment of heat sink performance and material saving” Applied Thermal Engineering 98 (2016) 203–212

[10] Iqbal, Z., Syed, K.S., and Ishaq, M., 2011 Optimal convective heat transfer in double pipe with parabolic fins, International Journal of Heat and Mass Transfer, Pages, 5415–5426

[11] Sudheer, M., Shanbhag, G. V., Kumar, P., and Somayaji, S., 2012. finite element analysis of thermal characteristics of annular fins

[12] Karan sehgal et al. “Method to maximise the heat transfer Through fins.” IJRDO-Journal Of Mechanical And Civil Engineering.

[13] M.Eren, et al. “Effect of grooved pin-fins in a rectangular channel on heat transfer augmentation and friction factor using Taguchi method. International Journal of Heat and Mass Transfer 102 (2016) 1108–1122

[14] H.Singh et al. “ Convective Cooling of Electronic Components.” Experts from proceeding of the COSMOL conference in Boston

[15] V.Karthikeyan et al “Design and Analysis of Natural Convective Heat Transfer Coefficient Comparison between Rectangular Fin Arrays with Perforated and Fin Arrays with Extension.” International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 2, February 2015