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A REVIEW ON HEAT TRANSFER ENHANCEMENT BY USING PERFORATED FINS

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ABSTRACT

The present review paper focus on the analysis of the heat transfer enhancement and the considerable pressure drop below a flat surface equipped with circular or square perforated fins in a rectangular channel. Recently fins are commonly used as heat exchange appliance to increase the heat transfer between the primary surface and surrounding fluids. Heat exchanger is mostly employed or equipped with fin. Fin plays an important role so that extensively used in industrial applications. Fins are available in various cross-sectional size such as rectangular, rounded, narrowing, ring shaped pin fins or mixture of other geometries. Short fins are mostly employed in gas turbine blades, electronics cooling and aerospace applications .In application where high heat transfer is drastic issue, there long fins are applicable. Fin increase heat transfer from a surface by exposing a larger surface area to convection and radiation without the use of a large primary surface area.

Keywords: Perforated Fins, Heat Transfer Enhancement

I. INTRODUCTION

In the field of thermal engineering the augmentation of the heat transfer is very substantive. The heat transfer from the surface may in general be enhance by rising the heat transfer between a surface and its surrounding by increasing the heat transfer area of surface .Rectangular fins, square fins and rounded fins are most applicable for the natural and forced convection of heat transfer. Ranging from similarly shapes like orthogonal, ring shaped, cylindrical, and narrowing or pin fins, to a mixture of other geometries have been used as other modes of heat transfer exchanging fins. Fins surfaces are recently employed in various sectors to increase heat transfer and they often enhance the rate of heat transfer from surface. The car radiator is the best example equipped with fin surface. The thin metal sheets are closely packed placed on hot water tubes to increase the surface area and thus convective heat transfer rate from the tubes to the atmosphere. A variety of innovative fins design is available in the market and they seem to limited only by imagination. When the fin has been analyzed we consider steady. Operation with no heat generation in the fin, various methods to be used for heat transfer augmentation. External power needed by the system to increase heat transfer is known as active method. Effects pulsating by camps, reciprocating pump-piston are various specimens of active techniques and the system which does not requires external power is known as passive method. In passive techniques fins are commonly used in variety of industrial usage to increase the rate of heat transfer centrally initial surface and ambient liquid. There are two best ways to enhance the rate of heat transfer by increasing the convection heat transfer coefficient or by increasing surface area. To increase the convection heat transfer coefficient may require the usage of pump or fan. Besides it may not be sufficient to use. Other way is to increase the surface by attaching the perforated fins made of highly conductive material such as aluminum.Byusing extruding, welding, or wrapping a thin metal sheet no a surface are the processes employed for manufacturing of finned surface to increase heat transfer from a surface by exposing a larger surface area to convection and radiation.

II. LITERATURE REVIEW

Kavita H. Dhankawade et al. [1] the paper review that the heat enhancement is a extreme issue to tackle due to continued integration, miniaturization, compacting and lighting of equipment. Heat dissipation are not only chosen for their thermal performance, but also based on design parameters that contains weight, cost and reliability, depends on particular application. In experimental study to investigate enhancement of heat transfer over horizontal flat surface with rectangular fin arrays with lateral square and circular perforation using forced convection. Fin arrays of material aluminum varying geometry also size of perforation as well as varying Reynolds number from 21×10^4 to 8.7×10^4. It indicates that the Reynolds number and size perforation have a larger impingement on Nusselt number for the both types of perforations.

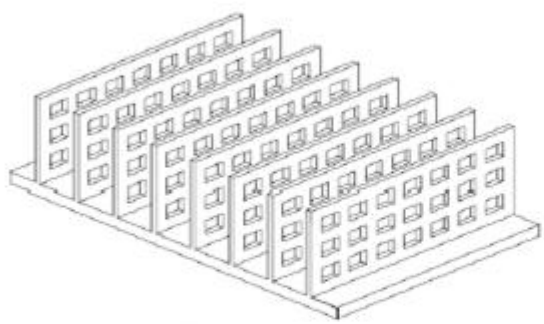

Fig.:1 Square perforated fin arrays[1]

Bayram Sahin et al.[2] this paper describe the heat transfer enhancement and corresponding pressure drop over a flat surface equipped with circular perforated pin fins in a duct of rectangular cross-section having sectional area of duct 100-250 mm^2 . The experiment insures the following ranges; Reynolds number 135002-42000, clearance ratio(C/H) 0, 0.33 and1 and inert fin spacing ratio ($S_{y,}$D) 1.208, 1.524, 1.944 and 3.417. The heat transfer, friction factor and efficiency of enhancement has been carried by correlation equations. The experimental results show that, the heat transfer enhancement lead by using circular cross section pin fins. The clearance ration and inter fin spacing ratio is based on the efficiency of enhancement varied between 1.4 and 2.6.

Cheng-Hung Huang et al.[3] in this paper a 3-D inverse design problem is studied, the work employing general purpose commercial code CFD-ACE+ and Levenberg-Marquardt Method. The analysis includes of three cases. In design #1, Using 5 design variables to approximate the optimal perforation diameters and the aim are to reduce ambient temperature and pressure drop of the pin fin array. In design #2, four design variables to define the optimal perforation diameters depend on the minimization of ambient temperature and pressure drop. In design #3, all the perforation diameter are decided identical and use only one parameter to define optimal perforation diameter depending on the reduction of ambient temperature and pressure drop. The numerical design concluded that, for all six design considered here the design optimal heat sinks result in the lowest average base plate temperature decreasing from 6.3% to 7.3% when compared with solid pin fin array.

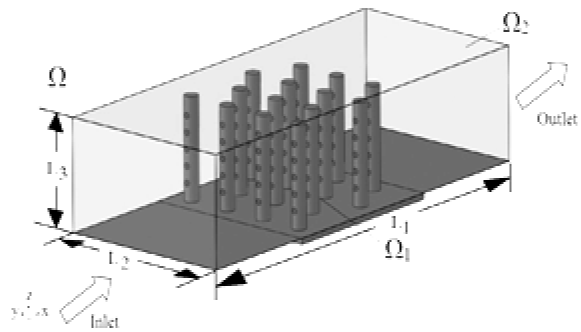

Fig.:2 Perforated pin fin configuration[3]

N. Souidi et al. [4] this paper reports that countercurrents gas-liquid flow in narrow rectangular channels simulated by plain and perforated fins is analyzed. Different flow patterns dependent on flow rates or observed with visualized in the channels. Flooding velocities and pressure drops are calculated. The previous experimental data in rectangular channels is compared with results. The paper result shows that two particular types of flooding phenomenon that occurring at the column base and attached to plugging and that at the top, attached to rentrainment. A further set of experiment using perforated fins surpridengly focus on a greater tendency to flooding of the perforated fins. However there are significant differences for the two types of fins and explanation may be the two distinct flooding existences.

Aashique Alam Rezwan et al. [5] the paper reviewed that the air process heater is the essential equipment of many industries. Process heater use in Baking, Drying, Laminating Metal Working, Packaging, Soldering, Shrink Fitting, Synthetic. Now the present research on heat transfer enhancement in an air process heater was investigated both numerically and experimentally. A circular duct with 5-semi circular hollow baffles and 4 cartridge electric heaters was designed for process heating. Air was supplied from wind tunnel at 3.17×10^{4} Reynolds number.

Md. Farhad Ismail et al. [6] it reviews that fins having the square and circular perforation along the fin length to raise the cooling performance of heat sink. The 3-D fluid flow and convective heat transfer from an array of solid and perforated fins that are mounted on flat plate has been investigated. It shows that fins of circular perforations have remarkable heat transfer growth and less pressure drop. This study result in designing micro heat sinks for heat dissipation from electronic devices.

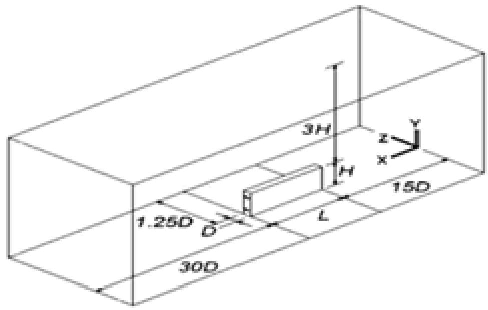

Fig.3: Square perforated domen[6]

Withada Jedsadaratanachai et al. [7] the paper focuse on the analysis of laminar periodic flow and heat transfer characteristics in a constant temperature surface with different features having square channels 30^0 angle baffles. A finite volume method in the simple algorithm implication is computed. Reynolds number based on the channel hydraulic diameter ranging from 100-2000 is characteristic or for the fluid flow and heat transfer. The angled baffles situated rapidly on lower and upper channels walls inline arrangement to generate a pair stream wise counter rotating vortex flow. A single baffle height ratio of 0.2 has drastic effect on heat transfer and pressure loss in the channel with various pitch ratios has been studied.

Mehedi Ehteshum et al.[8] the paper review that in designing heat exchanger equipment heat removal and reduction of fin size becomes major task. The present paper focus on experimental analysis to evaluate the turbulent heat transfer performance of rectangular fin arrays, both solid end circular perforation along the length of the fins. Experiment carried out with variation in the size and number of circular perforation in a horizontal wind tunnel with force draft fan. the Reynolds no is taken between 6×10^4 through 25×10^4.Thermal performances and effectiveness of perforation compared with solid fin arrays have been evaluated result in remarkable heat transfer augmentation, lower thermal resistances, pressure drop and higher efficiencies ,effectiveness for perforated fin with increasing the perforation number in addition to the considerable reduction in weight compared to solid fin arrays.

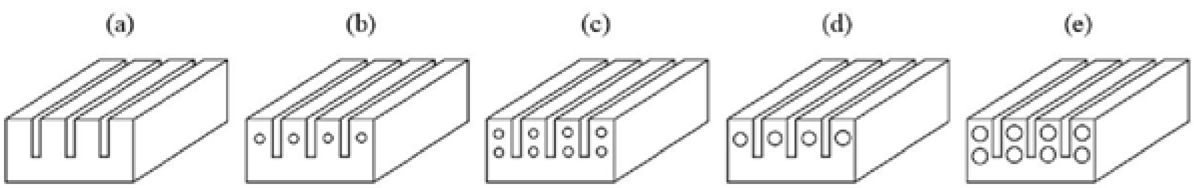

Fig.4: Fin arrays (a)solid fin (b)one perforation with 2mm (c)two perforation with 2mm (d)one perforation with 3mm (e)two perforation with 3mm [8]

Amnart Boonloi et al. [9] the paper present that the flow configuration and heat transfer characteristics isothermal square channel with 30^0 double V-Baffles. The influences of blockage ratios (b/H, BR =0.05-0.25) and pitch ratio (L/H, PR=1-2) was investigated for Reynolds numbers, Re=100-1200. The 30^0 double V-Baffles are situated on both two opposite walls of the square channel within line arrangement and each V-tip pointing downstream. The accuracy validations, flow structures, heat transfer enhancements and performance analysis are numerically presented. It is concluded that using the double V-Baffles result in higher heat transfer enhancement and pressure drop compared to the smooth channels with no baffles.

M. R. Shaeri et al. [10] in this paper a 3-D array of fins with rectangular perforation are arranged in lateral surface of fins in which the fluid flows and conjugates conduction-convection heat transfer are studied numerically. Investigations are carried out using Navier-Strokes equations and RNG Reynolds number of 2000-5000 for solid and gas phases are computed. With previous experimental studied has been validated by numerical model and good agreements were observed, with a valid model. To find fluid flow and temperature distribution for various arrangement numerical solutions is conducted. Determination is done for each type, fin efficiency of perforated fins and compared with equivalent solid fins. It result in higher heat transfer with new perforated fins and there is considerable weight reduction compared to solid fins.

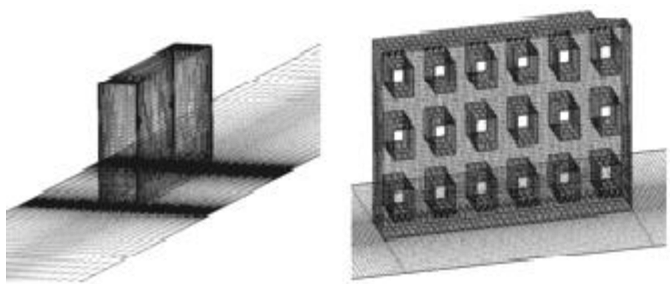

Fig.:5 Solid fin and fin with 18 perforations[10]

M. Yaghoubi et al. [11] the paper present that fluid flow of 3-D and heat transfer enhancement from array of solid and perforated fins attached to flat plate has been investigated numerically. Working fluid such as incompressible air using Navier-Stroke equation and RNG based K.έ turbulent model is employed to predict turbulent flow parameters. Solving rare conduction equations temperature field inside the fins occurred. Differential equation for both solid and gas plate are calculated by using finite volume procedure. Small channels with square cross section perforations are setup stream wise along the fins length and their numbers varied from 1-4. Flow and heat transfer characteristics are presented for Reynolds number from 2×10^4 to 4×10^4 compared to length of fin and prandtl number is taken Pr=0.71.It is found that with perforation along the fin have increase in heat transfer enhancement and with considerable reduction in weight.

III. CONCLUSION

Augmentation of heat transfer is very crucial in many industrial purposes. Recently a great challenge for design for heat exchanger equipment is very agile heat removal from heated surface reducing material weight as well as cost. Recent techniques fabrication of heat exchangers is required to modernize of heat exchanger to exchange agile amount of heat between extended surfaces and ambient liquid. Today need in electronics engineering have implicated changes in size and density of high performances chips. In case of perforated fins there is higher contact area with fluid in comparison with solid fins result in average friction drag force for perforated fins compare to solid fins and also increase by adding perforations. There is drop in temperature from fin base to fin top surface increases with number of perforations .Increasing perforations, weight reduction is remarkable and this economical benefit is along with more enhancement heat transfer rate.

REFERENCES

[1] Kavita H. Dhanawade, Vivek K. Sunnapwar and Hanamant S. Dhanawade., Thermal Analysis of Square and Circular Perforated Fin Arrays by Forced Convection, E-ISSN 2277 – 4106, P-ISSN 2347 - 5161 ©2014 INPRESSCO®, all rights reserved by International Journal of Current Engineering and Technology.

[2] Sahin, B., Demir, A., Performance analysis of a heat exchanger having perforated square fins. Appl. Therm. Eng. 28, 621–632.

[3] Cheng-Hung Huang, Yu-Chen Liu, Herchang ,The design of optimum perforation diameters for pin fin array for heat transfer enhancement, International Journal of Heat and Mass Transfer 84(2015)752–765.

[4] Souidi N., Bontemps, Countercurrent gas–liquid flow in plate-fin heat exchangers with plain and perforated fins. Int. J. Heat Fluid Flow 22,450–459.

[5] Aashique Alam Rezwan, Sarzina Hossain, S M Ashrafur Rahman and MA Islam., Heat transfer enhancement in an air process heater using semi-circular hollow baffles, Procedia Engineering 56(2013)357–362,5th BSME International Conference on Thermal Engineering.

[6] Md. Farhad Ismail, M.O. Reza, M.A. Zobaer, Mohammad Ali., Numerical investigation of turbulent heat convection from solid and longitudinally perforated rectangular fins, Procedia Engineering 56(2013)497–502, 5th BSME International Conference on Thermal Engineering.

[7] Withada Jedsadaratanachai, Supattarachai Suwannapan., Numerical study of laminar heat transfer in baffled square channel with various pitches,Energy Procedia 9(2011)630-642.

[8] Mehedi ehteshum,mohhamd ali,Md.quamrul islam,muhsia Tabassum, thermal and hydraulic performance analysis of rectangular fin arrays with perforation size and number 6th BSME international conference on thermal engineering(ICTE2014)procedia engineering 105(2015)184-191.

[10] M.R. Shaeri, M. Yaghoubi, heat transfer analysis of lateral perforated fin heat sink, Applied Energy 86(2009)2019-2029.

11] M.R. Shaeri, M. Yaghoubi, Numerical analysis of turbulent convection heat transfer from an array of perforated fins, International Journal of Heat and Fluid Flow 30(2009)218–228.

[12] Juan Li, Xiang Ling , Hao PengField synergy analysis on convective heat transfer and fluid flow of a novel triangular perforated fin, International Journal of Heat and Mass Transfer 64 (2013) 526–535.

[13] Rasim Karabacak, Gülay Yakar, Forced convection heat transfer and pressure drop for a horizontal cylinder with vertically attached imperforate and perforated circular fin, Energy Conversion and Management 52 (2011) 2785–2793.

[14] Tabish Alam[a] , R.P. Saini[a], J.S. Saini[b], Experimental investigation on heat transfer enhancement due to V-shaped perforated blocks in a rectangular duct of solar air heater, Energy Conversion and Management 81 (2014) 374–383.

[15] O.N. Sara, T. Pekdemir, S. Yapici, H. Ersahan , Thermal performance analysis for solid and perforated blocks attached on a ¯at surface in duct flow . Energy Conversion & Management 41 (2000) 101-1028.

[16] Farhad Sangtarash, Hossein Shokuhmand , Experimental and numerical investigation of the heat transfer augmentation and pressure drop in simple, dimpled and perforated dimpled louver fin banks with an in-line or staggered arrangement, Applied Thermal Engineering 82 (2015) 194e205.