Review on Triangular Perforated Fins in Staggered Arrangement

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Abstract— The performance of many engineering devices from power electronics to gas turbines is limited by thermal management. Heat transfer between a surface and the fluid surroundings commonly augmented by attaching extended surface called fins Since the use of extended surfaces has been often more economical ,convenient and trouble free ,most proposed applications are adding fins to the surfaces in order to achieve the required rate of heat transfer through increased surface area and turbulence. this review paper investigate how the fin arrangement (staggered or in-line), orientation, perforation and geometry affect heat transfer and friction characteristics of convective heat transfer in a force convection.

Key words: Fin arrangement, Fin geometry, Force convection, Perforation

I. INTRODUCTION

The heat generated while operating several engineering system may cause severe over heating problems and consequently leads to failure of the systems. So it is imperative to add superior heat transfer elements having smaller weights, volumes and cost. The heat generated in a system such as transformers, refrigerators, boiler super-heater tubes, condenser coils, electronic components, compressors, air cooled engines, gas turbines etc. must be dissipated to its surroundings in order to maintain the system functioning at its recommended working temperatures and operating effectively and reliably.

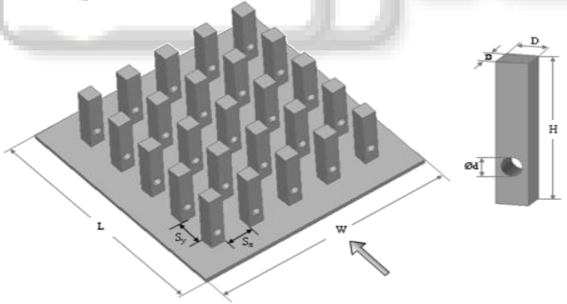

Fig. 1: Square perforated fin in inline arrangement

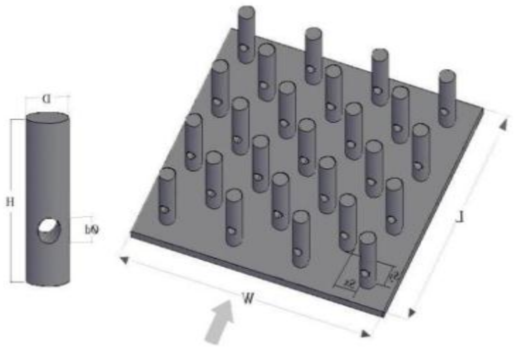

Fig. 2: Cylindrical perforated fin in staggered arrangement

The addition of fins causes to extend the initial price, weight, and pumping power needed under forced convection conditions. For this reason, there are numerous researches within the literature already concerned within the optimum fin arrangement, fin geometry and dimensions. Fins are attached to the primary heat transfer surface to increase the heat transfer rate at the air side principally by increasing the air side heat transfer area. Although adding numerous fins increase the surface area, they may resist the air flow and cause boundary layer interferences which affect the heat transfer negatively so this paper present how different researchers dovetail different arrangement, geometry, degree of perforation for enhancing the heat transfer from primary surface area for the flows through various channels.

II. LITERATURE REVIEW

Bayram Sahin, Alparslan Demir studied [1] the heat transfer enhancement and the corresponding pressure drop over a flat surface equipped with square cross-sectional perforated pin fins in a rectangular channel. The channel had a cross-sectional area of 100–250 mm2. The experiments covered the following range: Reynolds number 13,500–42,000, the clearance ratio(C/H) 0, 0.33 an 1, the inter-fin spacing ratio (Sy/D) 1.208, 1.524, 1.944 and 3.417. Correlation equations were developed for the heat transfer, friction factor and enhance efficiency. The experimental results showed that the use of the square pin fins may lead to heat transfer enhancement. Enhancement efficiencies varied between 1.1 and 1.9 depending on the clearance ratio and inter-fin spacing ratio. Both lower clearance ratio and lower inter-fin spacing ratio and comparatively lower Reynolds numbers were suggested for higher thermal performance. Using the Taguchi experimental design method, optimum design parameters and their levels was investigated. The Nusselt number and friction factor were considered as performance parameters. $AnL_9(3^3)$ orthogonal array was selected as an experimental plan. First of all, each goal was optimized, separately. Then, all the goals were optimized together, considering the priority of the goals. Finally, the optimum results were found to be Reynolds number of 42,000, fin height of 50mm and stream wise distance between fins of 51mm

R. Karthikeyan , R. Rathnasamy [2] studied the heat transfer and friction characteristics of convective heat transfer through a rectangular channel with cylindrical and square cross-section pin-fins attached over a rectangular duralumin flat surface. The pin-fins were arranged in in-line and a staggered manner. Various clearance ratios (C/H=0.0, 0.5 & 1.0) and inter-fin distance ratios (Sy/d and Sx/d) were used. The experimental results showed that the use of square cross-section pin-fins may lead to an advantage on the basis of heat transfer enhancement. For higher thermal performance, lower inter fin distance ratio and clearance ratio and comparatively lower Reynolds numbers should be preferred for in-line and staggered arrangement. the staggered pin-fin array significantly enhanced heat transfer as a result turbulence at the expense of higher pressure drop in the wind tunnel. Square pin-fin array performance is slightly higher than the cylindrical array with the penalty of pressure drop

Tzer-Ming Jeng, Sheng-Chung Tzeng [3] studied the pressure drop and heat transfer of a square pin-fin array in a rectangular channel. The variable parameters are the relative longitudinal pitch (XL = 1.5, 2, 2.8), the relative transverse pitch (XT = 1.5, 2, 2.8) and the arrangement (in-line or staggered). The result shows that The in-line square pin-fin array has smaller pressure drop than the in-line circular pin-fin array at high XT (XT = 2.0 or 2.8) but an equivalent (or even slightly higher) pressure drop at low XT (such as XT = 1.5). Additionally, the staggered square pin-fin array has the largest pressure drop of the three pin fin arrays (in-line circular pin-fins, in-line square pin-fins and staggered square pin-fins). Most in-line square pin-fin arrays have poorer heat transfer than an in-line circular pin-fin array, but a few, as when XL = 2.8, exhibit excellent heat transfer at high Reynolds number. For instance, when XL = 2.8, XT = 1.5

Giovanni Tanda [4] studied Heat transfer and pressure drop experiments were performed for a rectangular channel equipped with arrays of diamond-shaped elements. Both in-line and staggered fin arrays were considered, for values of the longitudinal and transverse spacing's, relative to the diamond side, from 4 to 8 and from 4 to 8.5, respectively. The height-to-side ratio of the diamonds was 4. Thermal performance comparisons with data for a rectangular channel without fins showed that the presence of the diamond-shaped elements enhanced heat transfer by a factor of up to 4.4 for equal mass flow rate and by a factor of up to 1.65 for equal pumping power.

G. J. Vanfossen and B. A. Brigham [5] studied the heat transfer by short pin-fins in staggered arrangements. According to their results, longer pin-fins (H/d = 4) transfer more heat than shorter pin-fins (H/d = ½ and 2) and the array-averaged heat transfer with eight rows of pin-fins slightly exceeds that with only four rows. Their results also established that the average heat transfer coefficient on the pin surface is around 35% larger than that on the end walls.

Metzger et al. [6] investigated the effects of pin-fin shape and array orientation on the heat transfer and the pressure loss in pin-fin arrays. According to their results, the use of cylindrical pin-fins with an array orientation between staggered and in-line can sometimes promote the heat transfer, while substantially reducing pressure. When oblong pin-fins are used, heat transfer increases of around 20% over the circular pin-fins were measured, but these increases were offset by increases in the pressure loss of around 100%. Their estimate indicated that the pin-fin surface coefficients were approximately double the end wall values.

R. F. Babus'Haq et al. [7] reported that the optimal ratio of the inter-fin pitch to the pin fin diameter in the transverse direction was 2.04 for all pin-fin systems. However, the optimal ratios in the longitudinal direction were 1.63, 1.71 and 1.95 for polytetrafluoroethene pin-fins, mild-steel pin-fins and duralumin pin-fins respectively

O.N. Sara et al.[8] reported another way to improve heat transfer rate is to employ attachments with (i) perforations, (ii) a certain degree of porosity or (iii) slots which allow the flow to go through the blocks. In the case of perforated attachments, the improvement in the flow (thus the enhancement in the heat transfer) is brought about by the multiple jet-like flows through the perforations Thus; the aim of this study is also to determine heat transfer and friction factor characteristics of the perforated staggered triangular fins. The heat transfer enhancement is achieved at the expense of the increased pressure drop. For many practical applications it may thus be necessary to determine the economic benefit for the heat transfer.

III. CONCLUSION

(1) The review reveals that very limited number of shapes have been investigated so there is wide area for investigating shapes like triangle, hexagon, drop, lancet etc.
(2) Most of the researchers conclude that the highest heat transfer can be achieved in staggered arrangement. So the staggered arrangement should be employed for further investigation of other shapes.
(3) Some researchers concluded that orientation could improve heat transfer and for a triangular geometry two orientations are possible a) vertex of the triangle facing the flow b) flat surface of the triangle facing the flow and perforation of fin will increased the surface area so further investigation in triangular perforated fin can enhance the heat transfer rate favourably.
(4) Triangular and drop shapes are almost similar so by investigating the triangular shape we can also predict the behaviour of drop shape.

REFERENCE

[1] Bayram Sahin, Alparslan Demir Performance analysis of a heat exchanger having perforated square fins, ELSEVIER, Applied Thermal Engineering 28 (2008), pp. 621–632.
[2] R. Karthikeyan* et al. / (IJAEST) International Journal of Advanced Engineering Science And Technology Vol No. 10, Issue No. 1, pp. 125–138.
[3] Tzer-Ming Jeng,Sheng-Chungzeng, ELSEVIER, International Journal of Heat and Mass Transfer 50 (2007), pp. 2364–2375.
[4] Giovanni Tanda, PERGAMON, International Journal of Heat and Mass Transfer 44 (2001), pp. 3529-3541
[5] G.J. Vanfossen and B.A. Brigham, Length to diameter ratio and row number effects in short pin fin heat transfer, ASME J. Eng. Gas Turbines Power 106 (1984), pp. 241–244.
[6] D.E. Metzger, C.S. Fan, S.W. Haley, Effects of pin shape and array orientation on heat transfer and pressure loss in pin fin arrays, J. Eng. Gas Turbines Power 106 (1984), pp. 252–257.
[7] R.F. Babus'Haq, K. Akintunde, S.D. Probert, Thermal performance of a pin-fin assembly, International journal of Heat Fluid Flow 16 (1995) , pp. 50–55.
[8] O.N. Sara, T. Pekdemir, S. Yapici, M. Yılmaz, Heat- transfer enhancement in a channel flow with perforated rectangular block, international journal of heat and fluid flow22 (2001), pp. 509–518.