Enhancement of Natural Convection Heat Transfer Characteristics from Horizontal Rectangular Fin Array with Rectangular Triangular Notch at Middle

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Abstract – Heat transfer due to free convection of air from Notched, full rectangular fin array have been investigated experimentally. For study purpose short fin array has been chosen which exhibit single chimney go with the flow pattern. Middle component of fin array turns into ineffective due to low temperature difference between coming into air & fin surface. So in current study, middle component is eliminated by cutting rectangular triangular notch and added where extra sparkling air come in contact with fin floor area. Results have been acquired over vary of spacing from 12mm to 25mm and heat input from 25W to 100W. Length & peak of rectangular fin array was saved constant. Comparison has been made between full, notched rectangular fin arrays. It is located that Notched rectangular fin array performed higher as expected.

Keywords: Fin arrays, Average Heat transfer coefficient, Free convection, Spacing.

I INTRODUCTION

Starner and McManus, Harahan and McManus, Jones and Smith, Mannan have studied the frequent trouble of free convection heat transfer from rectangular fin arrays on a horizontal surface experimentally and theoretically via Sane and Sukhatme. During their investigations, float visualization studies have additionally been performed and it has been observed out that the single chimney flow pattern used to be favored from the heat transfer stand factor and was current in most of the lengthwise quick arrays used in practice. The current paper is consists of an experimental study on horizontal rectangular short fin arrays with notch, besides notch at the center & dissipating heat with the aid of free convection. In case of a single chimney flow pattern, the chimney formation is due to bloodless air entering from the two ends of the channel flowing in the horizontal route and creating a vertical velocity go with the flow of air as it reaches the center element of fin channel ensuing in the heated plume of air going in the upward direction Full & Notched fin arrays are investigated with unique spacing & warmness inputs.

Fig.1 Exploded view of fin array

Experimental setup is developed on the basis of simplicity and practicability. Fin arrays are assembled & manufactured using 2 mm thick commercially accessible aluminum sheet. Size of sheet is 120X40. It is found meticulously that all the fin apartments are reduce to the same dimension simultaneously. All fins are glued to base plate with help of adhesive backing which maintain for high temperature. Holes had been drilled for setting cartage heater in base plate.

II EXPERIMENTATION

The following procedure is used for the experimentation:
1. The fin arrays are assembled by using gluing the required variety of fin plates via the usage of epoxy resign and positioning the thermocouples at the appropriate locations.
2. Cartridge heaters (02 numbers) are positioned in their position, related in parallel with power circuit.
3. Assembled array as above is positioned in the slotted C4X insulating block.
4. Thermocouples are positioned in the C4X block for measuring conduction loss. The assembled array with insulation is positioned at middle of an enclosure.
5. The determined heater enter is given and stored steady by means of connecting to stabilizer, which is provided with dimmerstat voltage.

6. The temperatures of base plate at extraordinary positions, C4X brick temperature and ambient temperature are recorded at the time intervals of 15 min. up to constant condition. (Generally it takes 2 to 3 hours to gain consistent state condition).

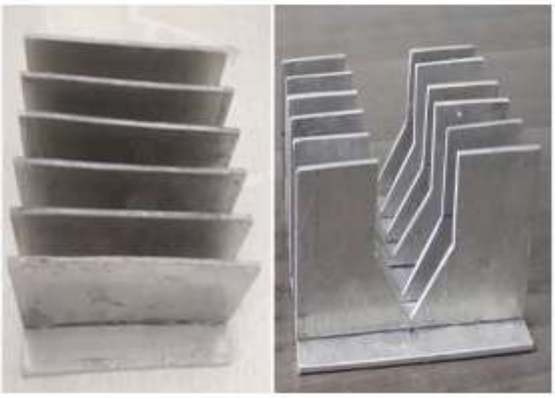

Fig.2 Assembly of Rectangular Triangular fin array

Table.1 Parameters of Experimentation

Spacing in mm	Heater input in watt	Length of fin array in mm	Height of fin array in mm
12	25	120	40
14	50		
18	75		
25	100		

Readings were recorded on reading table when the constant state used to be reached. Readings had been taken at least four instances for 4 specific configuration and heater enter to make sure the validity and repeatability of readings. It is determined that variables for experimental work are spacing, heater input, and geometry. Spacing are 12mm, 14mm, 18mm and 25mm. Heater inputs are 25watt, 50watt, 75watt & one hundred watt. The consequences had been obtained from the observations.

Experimental Calculations

1. Conduction Loss =KA $\frac{dT}{dx}$

2. Radiation Loss = $\in\sigma A\,[Ts4- T\infty 4]$

3. Heat Transfer Coefficients = $\frac{Q}{A\Delta T}$

4. Nusselt Number = $\frac{hL}{K}$

5. Grashof number = $\frac{g\beta(Ts-T\infty)Lc^3}{\upsilon^2}$

III RESULT & DISSCUSSION

Results have been obtained in phrases of common heat transfer coefficient, base heat transfer coefficient, Average Nusselt number, Base Nusselt number, Grashof number etc.

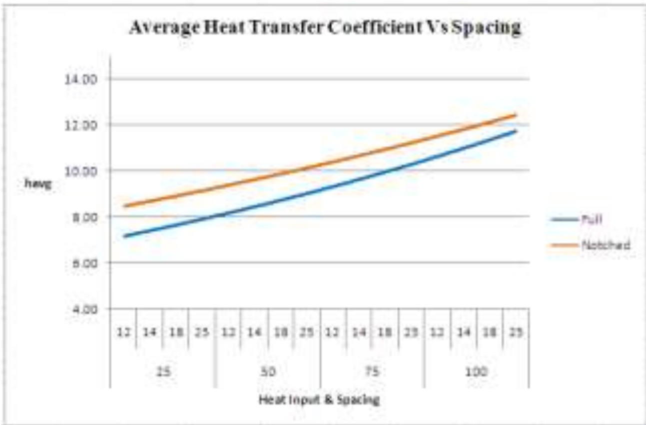

Fig.3 Graph of Average heat transfer coefficients Vs spacing

Fig. 4 exhibit the effect of fin spacing on ha with heater input as the parameter. As the fin spacing will increase ha will increase for full fin array, as expected. The best possible cost of ha is 13.95 W/m2 K at the spacing of 25 mm. The growing style is steep up from spacing about 18 mm. Before which there is a gradual rise. The style of make bigger in ha and for this reason in the Nusselt wide variety with fin spacing is observed in case of the notched array additionally with increase in ha values at every point. The notched configurations yield greater values, as a result indicating superiority over full fin arrays.

Also fig.4 suggests the relative performance of fin array with notch and that of without notch. It is evident from the plan that ha increases with the heater input, preserving the superiority of notched array. It is clear that for the given heater input ha of notched array is 7 to 29% higher than corresponding full fin array. Average heat transfer coefficient of Notched fin array is 30% higher than full fin array for 12mm spacing.. Average heat transfer coefficient of Notched fin array is 15% greater than full fin array for 14mm spacing. By doing data analysis, Percentage enlarge in average heat transfer coefficient of notched fin array in contrast with full fin array is multiplied as the spacing increases. It is proven that 12mm spacing is extra high-quality when contrast have been made between Notched & Full fin array.

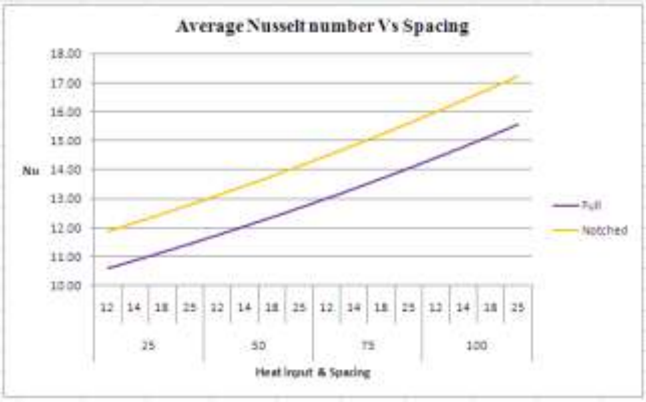

Fig.4 Graph of Average Nusselt number Vs Spacing

It is clear from the fig.5 that as spacing will increase the common Nusselt wide variety Nua will increase for the notched fin array. The growing vogue is gradual up to a spacing of 14 to 18 mm. After that the rise is sudden. The notched configurations yield greater values, hence indicating superiority of notched fin array over Notched & full fin array. The absolute best Nua is about 18 W/m2 K for the notched fin array at heater input of 100 W. In widespread it is located that the Nua will increase with amplify in fin spacing, this is due to reason that with expand in spacing, the fluid can float more freely via the fin channel. This may additionally be attributed to the phenomenon of lateral boundary layer interference at lower fin spacing. Nua dimensionless range increases from eleven to 18 with enlarge in warmth enter from 25 to a hundred W for notched fin array which is greater than that of full fin array. Best fin spacing is above 18 to 25 mm.

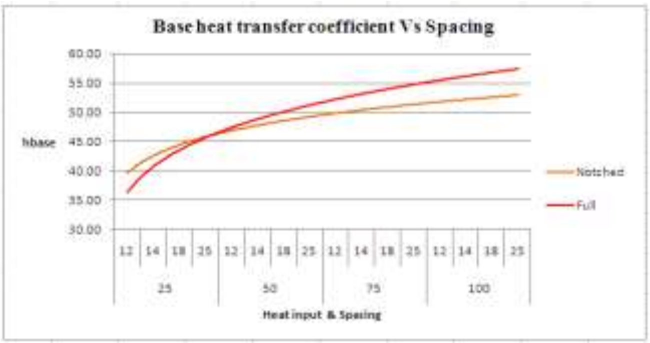

Fig.6 Graph of Base heat transfer coefficients Vs Spacing

Fig. 6 exhibits the impact of fin spacing on hb with heater enters as the parameter. From the parent it is clear that the values of hb decreases as fin spacing increases. It starts to its most value at fin spacing about 12 mm and once more decreases gradually. This vogue can be attributed to limit of entry of air in the channel at smaller fin spacing. The fashion of make bigger in base heat transfer coefficient with the maxima at a fin spacing of 14 mm is located in case of the full fin array. It is therefore concluded that overall performance of full fin array is bettering terms of base heat transfer coefficient. At the spacing of 18mm, hb is almost 61 W/m2 K for the full fin array and is of the order of 55 W/m2 K for the notched fin array. This is due to minimize in heat transfer area.

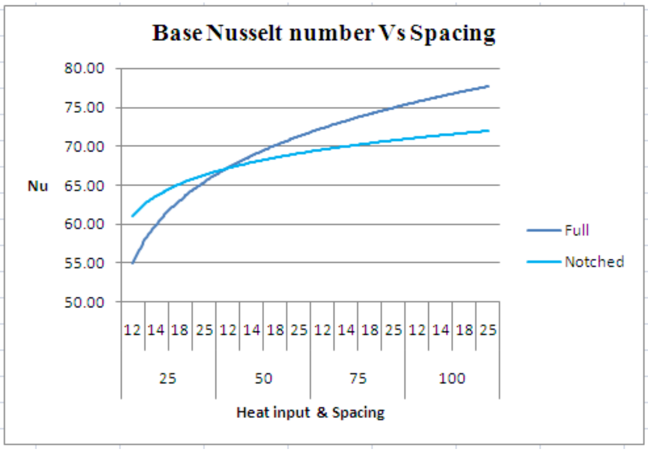

Fig.5 Graph of Base Nusselt number Vs Spacing

Fig. 7 shows variation of base Nusselt wide variety with fin spacing for notched fin array & Full fin array. It is clear that as the value of Nub decreases as fin spacing increases. It reaches to its most value and once more decreases. The cause for decrement in Nub may be due to less floor area at greater spacing. So that full configurations yield barely higher values, for that reason indicating superiority over notched fin array. It is considered that base Nusselt range is reducing up to 18 mm spacing & after that it is increasing for notched fin array. Therefore, Best fin spacing is above 18 mm. Nub dimensionless wide variety will increase from 60 to 70 with increase in warmness input from 25 to one hundred W for Notched fin array which is higher than that of full fin array.

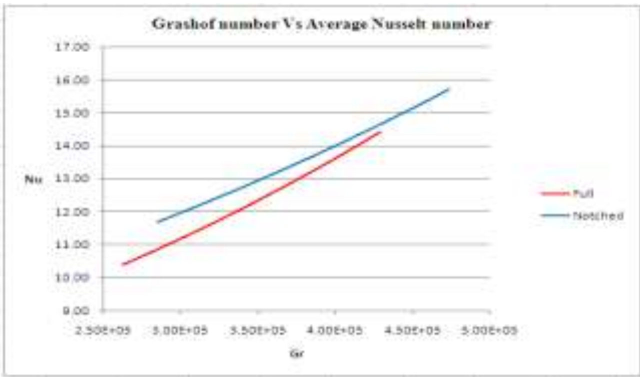

Fig.7 Graph of Grashof number Vs Nusselt number

Fig.8 represents Graph of common Nusselt number with Grashof variety for notched fin & full fin array. It can be investigated that with the will increase in Grashof number, common Nusselt range will increase for a given spacing. The extend in common Nusselt wide variety for notched fin array is greater than the equivalent full rectangular fin array.

IV CONCLUSIONS

The trouble of free convection heat transfer from horizontal rectangular fin array has been the situation of experimental as nicely as theoretical studies. The vital findings of the experimentation are as follows:
• Single chimney flow pattern stated to be favored by way of in the past investigators is retained in the notched fin arrays as well through performing simple smoke test.
• Study suggests that notched horizontal rectangular fin array is extra tremendous than that full fin array.
• Rise in ha for Notched fin arrays exhibit 7-29% higher than corresponding full fin array configuration.
• Average Nusselt variety for notched fin arrays is 8-32% greater than corresponding full fin array.
• hb & Base Nusselt number is continually decreasing with amplify in spacing for notched & full fin array.
• Grashof range for notched fin array is 8-15% greater than corresponding full fin array.
• Results show that Grashof wide variety is less than 10^9. Therefore, free convection heat transfer with laminar go with the flow of air is confirmed.

Nomenclature

A Cross Sectional Area of C4X bricks

$\frac{dt}{dx}$ Temperature Gradient along bricks

$\in$ Emissivity of Brick

σ Stefan Boltzmann's constant

g Acceleration due to gravity

β Coefficient of volume expansion

T_s Average Temperature of fin surface

T_∞ Temperature of Air

υ Kinematic viscosity of air

K Thermal Conductivity of C4X bricks

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