Experimental Investigation of Horizontal Rectangular Fin Array with Rectangular Triangular Notch and With Augmentation of Heat Transfer Area

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Abstract - **Heat transfer due to free convection of air from notched, compensatory, full rectangular fin array have been investigated experimentally. For study purpose brief fin array has been selected which show single chimney flow pattern. Middle element of fin array will become ineffective due to low temperature distinction between getting into air & fin surface. So in existing study, middle portion is removed by way of cutting rectangular notch and introduced where extra sparkling air come in contact with fin surface area. Results have been acquired over vary of spacing from 12mm to 25mm and heat enter from 25W to 100W. Length & top of rectangular fin array used to be saved constant. Comparison has been made between full, Compensatory & notched rectangular fin array. It is determined that notched array carried out better as expected.**

Keywords- **Fin arrays, Grash of number, Rayleigh number, Heat transfer coefficient, Free convection, Spacing.**

I. INTRODUCTION

Starner and McManus, Harahan and McManus, Jones and Smith, Mannan have studied the familiar trouble of free convection heat transfer from rectangular fin arrays on a horizontal surface experimentally and theoretically by means of Sane and Sukhatme. During their investigations, flow visualization studies have also been carried out and it has been determined out that the single chimney float pattern was once preferred from the heat transfer stand factor and was current in most of the lengthwise quick arrays used in practice.

The existing paper is consists of an experimental find out about on horizontal rectangular short fin arrays with notch, without notch at the core & compensatory region on fin surface dissipating heat by using free convection. In case of a single chimney float pattern, the chimney formation is due to cold air getting into from the two ends of the channel flowing in the horizontal route and creating a vertical two velocity flow of air as it reaches the center portion of fin channel resulting in the heated plume of air going in the upward route Notched fin arrays are investigated with Unique spacing & heat inputs.

Optimum spacing for Notched fin arrays are decided in accordance to Rayleigh number. This study additionally leads to concept of most advantageous notch profile for the given range of base heat flux.
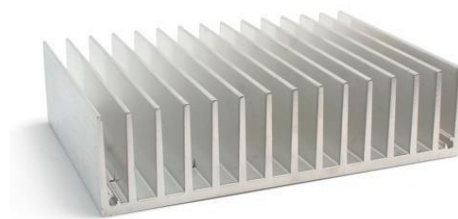

Fig.1 Rectangular fin array.

II. EXPERIMENTATION

The following process is used for the experimentation:

- The fin arrays are assembled by gluing the required wide variety of fin plates by means of the usage of epoxy resign and positioning the thermocouples at the gorgeous locations.
- Cartridge heaters (02 numbers) are placed in their position, linked in parallel with power circuit.
- Assembled array as above is positioned in the slotted C4X insulating block.
- Thermocouples are placed in the C4X block for measuring conduction loss. The assembled array with insulation is placed at middle of an enclosure.
- The determined heater enter is given and saved regular through connecting to stabilizer, which is furnished with dimmer stat voltage.
- The temperatures of base plate at one-of-a-kind positions, C4X brick temperature and ambient temperature are recorded at the time intervals of 15 min.

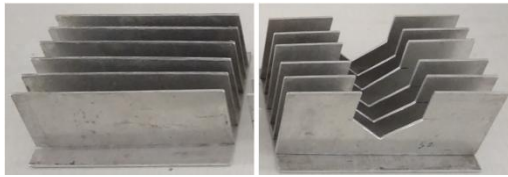up to consistent condition. (Generally it takes 2 to three hours to reap regular country condition).

Fig.2 Rectangular Triangular Fin Assembly.

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		
14	50	120	40
18	75		
25	100		

Readings were recorded on reading table when the steady state was reached. Readings were taken at least four times for four different configuration and heater input to ensure the validity and repeatability of readings. It is decided that variables for experimental work are spacing, heater input, and geometry. Spacing are 12mm, 14mm, 18mm and 25mm. Heater inputs are 25watt, 50watt, 75watt & 100 watt. The results were obtained from the observations.

Experimental Calculations

- Conduction Loss $= KA \frac{dT}{dx}$
- Radiation Loss $= \in \sigma A\ [Ts4\text{-}\ T\infty4]$
- Heat Transfer Coefficients $= \frac{Q}{A\Delta T}$
- Nusselt Number $= \frac{hL}{K}$
- Grashof number $= \frac{g\beta(Ts - T\infty)Lc^3}{U^2}$

III.RESULT & DISSCUSSION

Results have been obtained in terms of average heat transfer coefficient, base heat transfer coefficient, Average Nusselt number, Base Nusselt number, Rayleigh number.
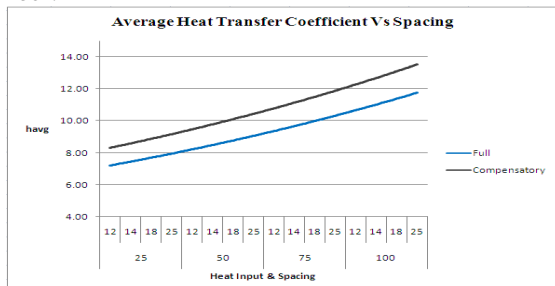

Fig.3 Graph of Average heat transfer coefficients Vs spacing.

Fig. 3 show 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 absolute best value 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 increase in ha and as a result in the Nusselt number with fin spacing is determined in case of the notched array also with enlarge in ha values at each point. The notched configurations yield higher values, consequently indicating superiority over full fin arrays. Also fig.3 indicates the relative overall performance of fin array with notch and that of barring notch.

It is evident from the design that ha increases with the heater input, keeping the superiority of notched array. It is clear that for the given heater input ha of notched array is 7 to 35% higher than corresponding full fin array. Average warmth transfer coefficient of Notched fin array is 35% higher than full fin array for 12mm spacing. Also it is clear that for the given heater input ha of notched fin array is 15 to 35% greater than corresponding compensatory fin array. Average heat transfer coefficient of Notched fin array is 15% greater than full fin array for 14mm spacing. By doing facts analysis, Percentage increase in common warmth switch coefficient of notched fin array in contrast with full fin array is reduced as the spacing increases. It is shown that 12mm spacing is greater fine when contrast has been made between Notched & Full fin array.
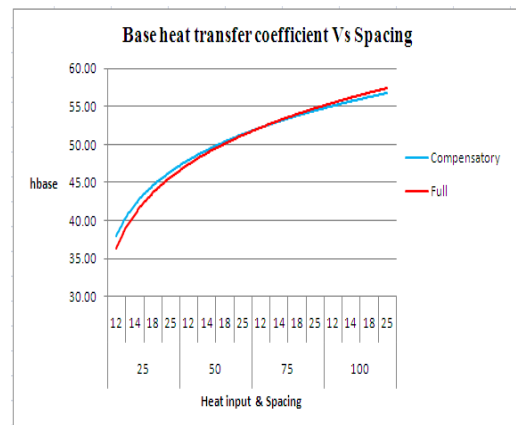

Fig.4 Graph of Base heat transfer coefficients Vs Spacing.

Fig. 4 exhibits the impact of fin spacing on hb with heater input as the parameter. From the figure it is clear that the values of hb decreases as fin spacing increases. It begins to its minimal fee at fin spacing about 12 mm and once more decreases gradually. This style can be attributed to restriction of entry of air in the channel at smaller fin spacing. The fashion of extend in base heat switch coefficient with the maxima at a fin spacing of 14 mm is

discovered in case of the full fin array. It is consequently concluded that performance of full fin array is bettering terms of base warmness transfer coefficient. At the spacing of 18mm, hb is almost 63 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.
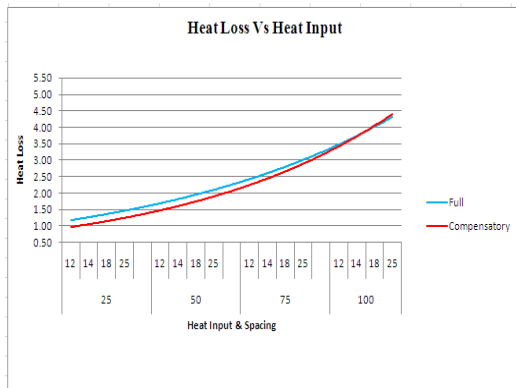

Fig.5 Graph of Heat loss Vs Heat input.

As Fig. 5 suggests Heat enter & spacing verses Heat loss. There are two losses 1) Conduction loss 2) Radiation Loss. Heat loss is at once proportional to heat input & Spacing. It shows that Notched fin array has 2% more warmth loss as examine to full fin array for spacing 25mm. But for spacing of 12mm notched fin array has 5% less heat loss as examine to full fin array. Heat loss for compensatory fin array is in between notched & full fin array. It is concluded that notched fin array dissipated greater warmness by way of conduction & radiation to surrounding as compare to full fin array.
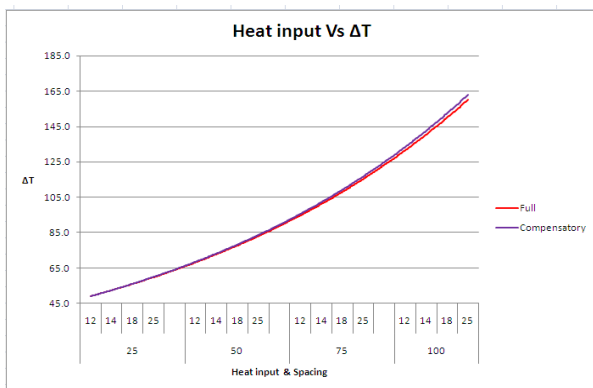

Fig.6 Graph of ΔT Vs Heat input.

Temperature distinction between ambient & Base plate is without delay proportional to heat enter & spacing. According to Newton's regulation of Cooling, ΔT having large cost then Convection heat transfer is large. From fig.6, it is proven that notched fin array has giant temperature difference evaluate to full & compensatory fin array as spacing is increased.

But for 12mm spacing notched fin array has much less temperature distinction as examine to full & compensatory fin array. This shows that much less spacing strengthen obstruction to float of air over fin & ineffective part due to identical temperature of fin & ambient. Best fin spacing be 18 to 20 mm for which temperature difference is large. So heat is transferred to surrounding is large.

IV. CONCLUSION

The problem 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 said to be desired via in the past investigators is retained in the notched fin arrays as properly by performing simple smoke test.
- Study suggests that notched horizontal rectangular triangular fin array is extra positive than that of full fin array.
- Rise in ha for Compensated fin arrays exhibit 2-36% higher than corresponding full fin array configuration.
- Average Nusselt quantity for notched fin arrays is 10-30% greater than corresponding full fin array.
- hb & Base Nusselt wide variety is continuously reducing with amplify in spacing for notched & compensatory fin array.
- Grashof number & Rayleigh quantity for notched fin array is 5-18% greater than corresponding full fin array.
- Results show that Grashof quantity is much less than 109. Therefore, free convection heat transfer with laminar waft of air is confirmed.

Nomenclature
A Cross Sectional Area of C4X bricks
dt/dx Temperature Gradient along bricks
∈ Emissivity of Brick
σ Stefan Boltzmann's constant
g Acceleration due to gravity
β Coefficient of volume expansion
Ts Average Temperature of fin surface
T∞ Temperature of Air
U Kinematic viscosity of air
K Thermal Conductivity of C4X bricks

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