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Natural Convection Heat Transfer from Horizontal Rectangular Fin Array with Vertical Ellipse Notch

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Abstract - *Heat transfer due to natural convection of air from notched, compensatory, full rectangular fin array have been investigated experimentally. Rectangular fins are fabricated of aluminum material because it has low cost & high thermal conductivity. Orientation of rectangular fin array is horizontal because it is more effective than other orientations such as vertical or inclined. For study purpose short fin array has been selected which show single chimney flow pattern. Length of rectangular fin array is 120mm. Fin thickness is kept constant, fixed at 2mm. Middle portion of fin array becomes ineffective due to low temperature difference between entering air & fin surface. So in present study, middle portion is removed by cutting vertical ellipse notch and added where more fresh air come in contact with fin surface area. Results have been obtained over range of spacing from 12mm to 25mm and heat input from 25W to 100W. Length & height of rectangular fin array was kept constant. Experimental set has been developed with control panel, dimmer stat, thermocouples with temperature indicator. Eleven thermocouples are used for recording of temperatures. Forty eight different fin configurations were tested. Parameters like average heat transfer coefficient, base heat transfer coefficients, Nusselt number, Grashof number & Rayleigh number are calculated for notched, compensatory, full rectangular fin array from observations. The separate roles of fin spacing and base to ambient temperature difference were investigated. The results of experiments have shown that the convective heat transfer rate from fin arrays depends on geometric parameters and base to ambient temperature difference. Comparison has been made between full, Compensatory & notched rectangular fin array. It is found that notched array performed better as expected. It was observed that with increase in Grashof number, average Nusselt number increases. Similarly average Nusselt number increases with spacing whereas base Nusselt number decreases with spacing. Rayleigh number also increases with spacing.*

INTRODUCTION

This Rectangular shaped fin arrays with vertical & horizontal orientation find applications in many cooling problems of various engineering disciplines i.e.

1. Electrical Engineering: Electrical Machines
2. Electronics Engineering: Heat Sinks
3. Mechanical Engineering: Engines, Compressor, Vacuum pump etc.

Fig-1 Simple Exploded view of Rectangular heat Sink

LITERATURE REVIEW

Narve and Sane [1] studied experimentally heat transfer characteristics of natural convection heat flow through vertical symmetrical triangular fin arrays and compared with rectangular fin arrays. Results were generated for spacing 0.015, 0.03,0.045 & 0.105 and Gr_H= 2×10^7 to 5×10^7. Study Shows that rectangular fin array is more effective than triangular fin array.

Starner and Mcmanus [2] determined average heat transfer coefficients for four fin arrays positioned with base vertical, at 45° and horizontal. Study Shows that for horizontal arrays they observed single chimney flow pattern when the ends were kept open and down and up flow pattern when the ends were closed.

EXPERMENTAL PROCEDURE

1. The fin arrays are assembled by gluing the required number of fin plates by using epoxy resign and positioning the thermocouples at the appropriate locations.
2. Cartridge heaters (02 numbers) are placed in their position, connected in parallel with power circuit.
3. Assembled array as above is placed in the slotted C4X insulating block.
4. Thermocouples are placed in the C4X block for measuring conduction loss. The assembled array with insulation is placed at center of an enclosure.

5. The decided heater input is given and kept constant by connecting to stabilizer, which is provided with dimmer stat voltage.
6. The temperatures of base plate at different positions, C4X brick temperature and ambient temperature are recorded at the time intervals of 15 min. up to steady condition. (Generally it takes 2 to 3 hours to attain steady state condition).
7. Record observations.

CONCLUSIONS

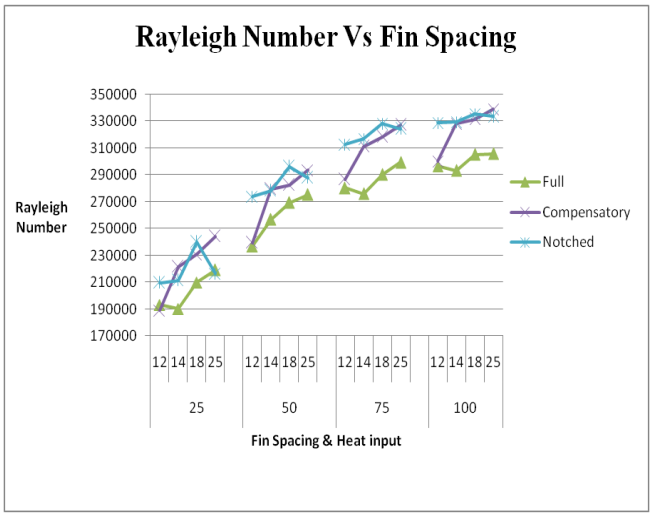

Fig-2 Rayleigh Number Vs Fin Spacing

The important findings of the experimentation are as follows:

1. Study shows that notched horizontal rectangular fin array is more effective than that full fin array.
2. Average Nusselt number for notched fin arrays is 10-30% higher than corresponding full fin array.
3. Nusselt number is continuously decreasing with increase in spacing for notched & compensatory fin array.
4. Grashof number & Rayleigh number for notched fin array is 8-15% higher than corresponding full fin array.
5. Results show that Grashof number is less than 109. Therefore, Natural convection heat transfer with laminar flow of air is confirmed.

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