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Heat Transfer in Horizontal Copper Tube Heated by Electric Heating Process

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ABSTRACT

Heat transfer from electrical and electronics component is essential for better performance of that electrical system, The maximum heat transfer from that system results long period durability. In most of the system base provided for equipments are very small and placed in a very complicated position. so heat transfer by forced convection is not easy for that purpose. The heat transfer by natural convection is the familiar technique used in electronics cooling; there is huge group of apparatus that lends itself to natural convection. This category consist of stand-alone correspondence such as modems and small computers having an array of printed circuit boards (PCB) accumulate within an area. Natural convection heat transfer in heated horizontal duct drive away heat from the interior surface is offered. The duct is open-ended and round in cross section. The test section is heated by provision of heating coils, where constant wall heat flux mentioned. Heat transfer experiment is carried out for channel of 50 mm. internal diameter and 4 mm thickness with length 600 mm. Ratios of length to diameter of the channel are taken as $L/D = 12$. Wall heat fluxes maintained at $q'' = 300 \text{ W/m}^2$ to 3150 W/m^2 . A methodical investigational record for the local steady state natural convection heat transfer activities is obtained. The wall heating condition on local steady-state heat transfer phenomena are studied. The present experimental data is compared with the existing theoretical and experimental results for the cases of vertical smooth tubes.

1. Introduction

Heat transfer by Natural convection is a consistent, commercial way for the rapid rising electrical and electronic manufacturing industries, in electrical and electronics systems number of heat producing elements are provided on a little base. need It is required to cool, as that components heated first, if proper cooling

method will not provided then that total base will damage, It is found that in some places that base are provided in very complicated position, so in these cases natural convection heat transfer is best suitable, as forced convection by provision of fans are not possible.

In Natural convection heat transfer by density difference, density changes with temperature as volume changes by temperature. when air heated by some external

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source heating its density decreases and moves up, that empty space filled by cooled air from surroundings.

Therefore information on heat transfer by natural convection surge from end to end limited spaces has been found helpful particularly in the thermal fluid structure. For its significance, the heat transfer by natural convection case has usual growing notice in the literature in current years. The intention of this exertion is to learn the concept and basic by theoretically and experimental the natural convection flow through pipes at various heat flux levels. Heat transfer experiment is conceded for channel 50 mm. internal diameter and 4 mm thick having length 600 mm. Relative amount of length to diameter of the pipe is taken as $L/D = 12$. Constant Wall heat fluxes maintained at $q// = 300 \text{ W/m}^2$. Wall heating condition on local steady-state heat transfer phenomena are studied. The basic aim of this experiment to find temperature profile and to indicate the variation of temperature along length of the pipe.

Number of work on natural convection heat transfer was there, it found that there was maximum intension on natural convection heat transfer through heated vertical tubes. But our work on natural convection heat transfer through heated horizontal tube.

Alawi et.al.^[1] studied heat transfer through horizontal annulus found that outcome for the normal Nusselt numbers are match up to with prior works and illustrate good conformity. Mallik and Sastri^[2] deliberate experimentally the natural convection heat flow over an range of spread out distinct upright plates and originate that the use of discrete vertical plates in comparison with continuous plates gives rise to enhancement of natural convection heat flow. Nayak et al.^[3-4] calculated datas by experimental examination on natural convection heat flow in heated vertical tube and found that enhancement of heat transfer, Nayak et.al.^[5] studied on natural convection heat transfer in heated vertical tubes with and without internal rings and compared the data found from the work with existing and theoretical. Sparrow and Prakash^[6] have examined the free convection through a stagger assortment of discrete vertical plates. They match up to the concert of a staggered array of discrete vertical plates with that of a parallel flat channel, allowing for the wall at consistent temperature. Their outcome indicate that better spacing, shorter plate and smaller heights of the control provide improvement of heat transfer. Tsuji^[7] from his work found that there is maximum heat transfer of the turbulent natural convection boundary layer can be significantly accomplish in a ample area of the turbulent natural convection boundary layer by utilize several column rip heat flow promoters. It may be predictable that the heat flow enhancement in excess of approximately 40% can be accomplished by put in

that type promoter.

Abdel-Aziz and Sedahmed^[8] studied heat flow at horizontal spiral tube by natural convection and found that natural convection give a great agreement to the rate of transfer than forced convection. Blaszcuk and Jagodzic^[9] studied Heat transfer feature in an exterior heat exchanger with horizontal pipe bunch and found that the standard HTC raise with a diminish of the Sauter mean element span and with the enlarge of the fluidizing figure as an effect of high-quality addition dynamics in suspension stage (i.e. emulsion wall contact time, bubble fraction in the bed). base on the heat transfer information, experiential relationship are planned for forecast a heat transfer coefficient from fluidized bed to flat tube bundle. Aldoori, and Ahmed^[10] studied The result of altering tube diameters on improvement heat flow by forced convection from end to end a horizontal tube and found that the ideals of the local Nu (LNu) are forever reduce and achieve its lowest value at the tube way out section of the imposed HF. For all pipes, the outcome illustrate that an enlarge in the pipe diameter outcome rising in Nuav. Nemati et.al^[11] studied Natural convection heat flow from horizontal annular finned pipe based on customized Rayleigh Number variety of Ra offer a absolute image of natural convection over round annular finned pipes, specially at comparatively small Ra. Finally, the conclusion behaviors of the planned relationship were contrast with those of obtainable correspondence. Gogonin studied Heat transfer at boiling of liquid film irrigating a flat bundle of irregular tubes and found that Heat flow at steaming on these tubes is clearly more strong than that on a smooth tube. Zhang et.al^[12] studied property of inactive air on concentration heat flow over a horizontal pipe and found that inactive air was a main factor that affect the heat and mass transfer consistency of vapor. Unlike in clean vapor condensation, the temperature dissimilarity among the top and bottom division of the condensation pipe augmented when the mole part of stagnant air was fewer than 0.17, whereas it reduced when the mole fraction of inactive air was better than 0.47. The increase in the mole fraction of inactive air abridged the temperature dissimilarity along the perimeter of the condensation tube wall. Nayak.et.al.^[13] validate his experimental work with theoretical.

2. Experimental Procedure

The generally investigational system shows in figure1, it contains the whole equipment and major apparatus. The investigational arrangement has a test section, an electrical circuit consists of measuring system like thermocouple, milli voltmeter. The investigation system is a cylindrical open ended pipe. The cross-sectional outlook

of the horizontal tube is given in Figure 2. In this work a hollow cylindrical tube is made of copper having 50 mm in diameter and 4 mm thickness. nine Copper-Constantan thermocouples are used to observe temperatures on the internal surface of the horizontal tube and also at exit, at entrance locations of the pipe shown in the figure 2. Holes are drilled on horizontal surface of the pipe, where thermocouples are inserted. After inserting thermocouple holes are filled by providing good thermal conductivity material, seven numbers of thermocouples are provided on horizontal surface and two thermocouples at entrance and exit to measure the inlet and exit air temperature.

After providing thermocouples on surface of horizontal pipe, an electric heating coil is provided on surface of the tube, the heating coil is heated from external electric circuits by provision of transformer and other electric equipments, after that the copper tube is insulated by number of insulating layers, a layer of glass wool (10mm thick) is provided on the outer surface of the tube. A layer of phenolic foam of 15mm thickness is provided over the glass wool and then the Then a layer of aerogels 20 mm thickness is wound over the phenolic foam. a very thin aluminum foil may be used for reducing the radiation heat transfer.

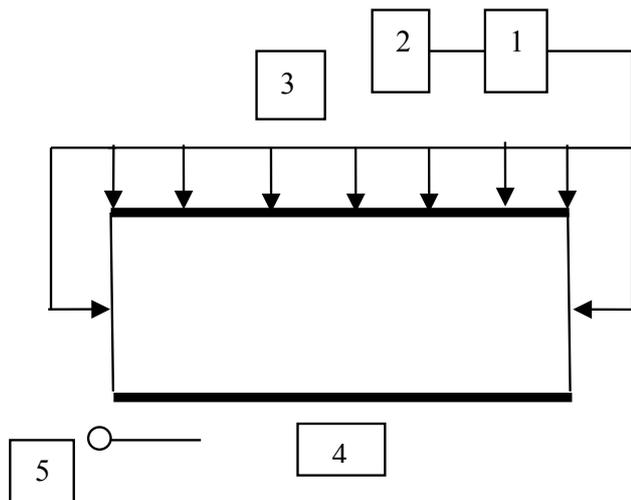


Figure 1. Experimental Set-up. 1. Selector switch, 2. Milli voltmeter, 3. System of thermocouples, 4. Test section, 5. Thermometer

The figure 2 shows cross sectional view of the test section, where points marks on surface of horizontal copper tube shows the position of thermocouples, copper tube heated by electric heating coils, heated air flow from one side of horizontal tube to another side, heat from copper tube is not allowed to outside by provision of insulating layers, temperature on surface of tube at various locations throughout its length are measured by thermocouples,

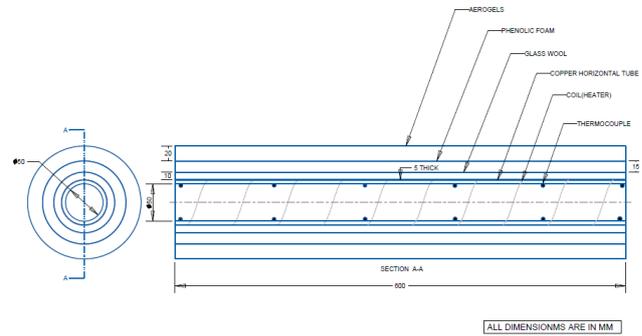


Figure 2. Cross-sectional view of the Test section

3. Results

Test was carried out for smooth tubes of different L/D proportion as 12, and for different heat fluxes are exposed in design and shown in figure 3, where length of horizontal tube was taken as in abscissa (X-axis) and Temperature measured from thermocouple are shown in Y-axis, heat fluxes are taken from range of 409 W/m² to 3150 W/m².

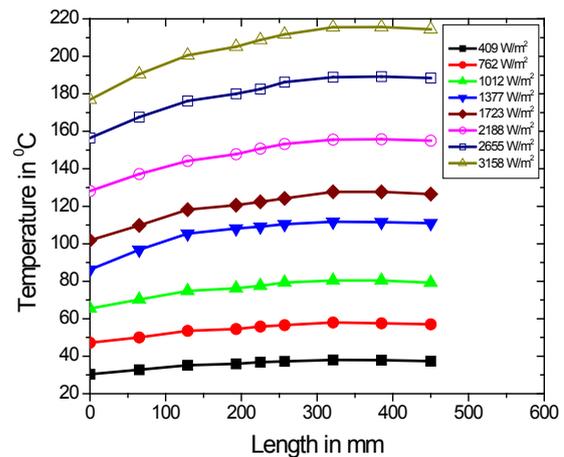


Figure 3. Confined wall temperatures for L/D ratio 12, L=600mm

Characteristic axial distinction of confined temperatures on wall of the horizontal copper tube for L/D ratio as 12 and for various heat fluxes range of 409 W/m² to 3150 W/m². are given in plotted figure 3 for smooth pipe of diameter 50 mm, length 600mm . It found from experimental plot that increase of temperature by the side of the length of the cylinder. But a little shrink at the end, which is due to loss of heat from the end of the pipe.

4. Conclusions

(1) Confined temperature of wall amplify by the side of the length of the pipe but diminish a little at the end,

which is due to heat loss from the last part of the pipe.

(2) Channel outlet temperature is least at the middle of the test section and enlarge towards the length of the test section for cases measured in this investigational analysis.

(3) Typical heat loss rate from the inside face of the heated horizontal pipe extend with provision of inner rings.

(4) Typical heat loss rate augment with mounting the ring with greater thickness up to a convinced limits, away from which it reduce.

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