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Design and Analysis of Pipe Heat Exangers with Inside Fins

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ABSTRACT: *The experimental setup is analysis of heat transfer rating and system performance. The pipe heat exchanger consist of single pipe with circular fins. This fins are arranged in vertically across the inside of the pipe in periodic distance with opposite sides. The fins immersed to inside of the pipe up to semi-circular and remaining part project to over the pipe. Hot fluid enters to one end and leave the cold fluid another end. The hot fluid flow with turbulent flow of inside of the pipe. This flow is increase the effectiveness of heat transfer rating due to more contact surface. Calculate the convective heat transfer with conduction on the pipe with fins. This arrangement is especially to increase heat transfer area, change the flow direction and reduce the cooling time with compact size. The design values are theoretically calculated then fabricate, analysis by standard parameter of existing heat exchanger.*

Key Words: *Heat transfer, circular fins, and effectiveness.*

List of symbols

A	*Area in* m^2
At	*Area of tube in m*
Nf	*Number of tubes*
Vt	*Volume of tube in* m^3
Mf	*Mass flow rate kg/sec*
Vf	*Velocity of fluids m/sec*
K	*Thermal conductivity in W/mK*
Na, Nw	*Air and water Number of transfer unit respectively*
Lt	*Length of the tube in m*
h	*Heat transfer co effeicient in* W/m^2K

I. INTRODUCTION

The heat exchanger involve heating or cooling of a system in fluid stream of concern and evaporation or condensation of single or multicomponent fluid streams. In other applications, the objective may be to recover reject heat, or sterilize, pasteurize, fractionate, dis till, concentrate, crystallize, or control a process fluid. In a few heat exchangers, the fluids exchanging heat are in direct contact. In most heat exchangers, heat transfer between fluids takes place through a separating wall or into and out of a wall in a transient manner. The special arrangement of experimental setup is consist of pipe with circular fins. This fins are immersed to partially in inside of the pipe. Arrangement of the pipe heat exchanger is highly heat transfer and effectiveness are get in from the experiment.

To improve the design of heat exchangers, especially the shell-tube heat exchangers, some new ideas wereproposed in Cheng L, Luan T, Du W J, et al.[1]. The optimized designs of heat exchangers were investigated in Guo J F, Xu M T, Cheng L., Guo J F, Xu M T, Cheng L. [2-3], but there is still significant scope for improving the description of the heat exchange process in the heat exchanger. Thus, how to account for the variation of the physical parameters with the temperature is not only one important approach for improving heat exchanger design, but also an important measure for the design of highly efficient and low-consumption radiators. Taking into account the dependence of fluid properties on temperature inside heat exchangers, Chato proposed the temperature transfer matrix method for rating heat exchanger Chato J C, Leverman R J, Shah J M [4]. Paffenbargeranalyzed the heat transfer process in the counter flow plate-fin heat exchangers with variable fluid properties using the finite element method Paffenbarger M. [5]. Roetzel and Spang gave a step-by-step procedure for computing the overall heat transfer coefficient when the specific heat at constant pressure varies with the temperature [6]. Later, based on the ε-NTU method, Shah and Sekulić improved this method and put forward a numerical method for checking heat exchanger design which considered the non-uniformity of fluid velocity and variation of fluid properties with temperature Sekulć D P, Shah R K. [7-8]. Skoglundetal.Applied the finite volume method to the numerical analysis of the flow and heat transfer in heat exchangers with variable fluid properties Guo J F, Xu M T, Cheng L [2]. In this set up, based on the LMTD method, a segmented heat exchanger design method is proposed taking into account the dependence of the specific heat at a constant pressure on the temperature. The thermal design of counter and parallel flow heat exchangers are discussed. Extended surfaces or fins are widely used to increase heat dissipation between a solid surface and its adjoining fluid in many engineering and industrialapplications such as the cooling of combustion engines, electronic equipment, many kinds of heat exchangers, and so on. As a result, a great deal of attention has been directed to fin problems and many studies on various shapes of fins have been presented. The most commonly studied fins are longitudinal rectangular, triangular, trapezoidal fins and the annular or circular fins. For example, the rate of heat loss from a rectangular fin governed bythe power law-type temperature dependence was studied [9] while heat conduction in an array of triangular fins with an attached wall was analyzed by the finite element method S. Abrate and P. Newnham, [10]. An analysis of the heat transfer characteristics of a circular fin dissipating heat from its surface by convection and radiation was made S. Sikka and M. Iqbal, [11].

II. METHODOLOGY

Since the conducting experiments setup on pipe heat exchanger with similar to shell and pipe setup. It is specially fins are arranged in vertical on the pipe with semi-circular part of the fins are immersed in inside of the pipe upto horizontal axis of the pipe. Inside of the flow as turbulence with low velociaty.so heat transfer is high as possible. Calculate the conduction with convective heat transfers of the heat exchanger and overall effectiveness is read from the experiment.

Experimental Set-up

The experimental setup consists of pipe heat exchanger with circular fins. This fins as located in two row as top and bottom of the pipe axis. Fins are arranged in vertical up to the semi-circular of the fins.

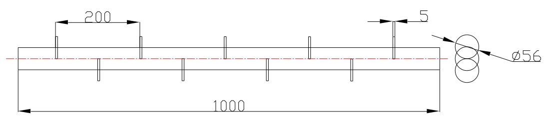

Figure.1. Schematic diagram for Pipe heat exchanger

Pipe Heat exchanger one end is connected to hot fluid and other is connect to cold fluid. The mass flow rate of fluid pump as 0.5 Kg/sec and variable volume with velocity flow rate control from flow meter.

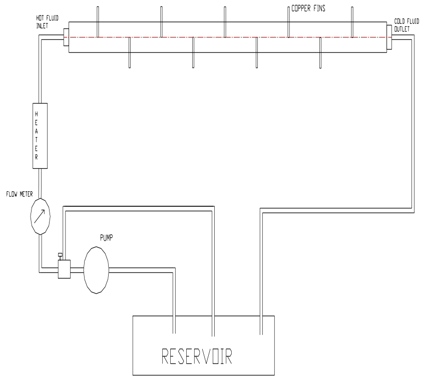

Figure.1. Schematic diagram for Experimental setup in Pipe heat exchanger with components.

Main heating source for heater working based on electric energy. Initially the hot and cold fluid as supply to water only. But all fluid supply and accept to the determination of heat transfer rate as possible.Normally this heat exchanger highly heat transfer with high effectiveness as get in from this experimental setup.Mass flow rate of fluid is control from the control valve and temperature are measure by using thermo couples.

Figure 3.Experimental setup for Pipe Heat Exchanger with circular fins.

Calculation of Heat Transfer Coefficient

The determine value of average heat transfer coefficient values, *h*, is required to characterize the effect of cooling air. These h values will indicate the amount of heat transferred bydraw a conclusion on the heat transfer augmentation. In the analysis, the flows on the fin surfaces may be treated as flow between parallel plates. Calculate the conduction of heat transfer and convective heat transfer for air andvariable fluid flow velocitycondition.This condition of heat transfer Q and overall heat transfer are find out the experimental setup. By conducting experiments in such a way that steady-state conditions are Obtained, the heat transfer coefficient values may be determined by using the well-knownNusselt correlation for flow fluid to a circular pipe with fins. the temperature variation from the based on the various inlet temperature condition.

CALCULATION PARAMETER

Heat transfer $Q = (hPkA)^{0.5} (Tb - T\infty) \tan h (mLf)$ ….. (1)

Where P = Perimeter
A = Area

$m = \sqrt{\frac{hP}{kA}}$

Temperature distribution

$$\frac{T-T\infty}{Tb-T\infty} = \frac{\cosh h\, m\,(Lf-x)}{\cosh (mLf)}$$

The hydraulic diameter D hydraulic = $\frac{4A\ tube}{P\ tube}$

The velocity of the water V water = $\frac{Q\ water}{N\ tube\ .\ A\ tube}$

Reynolds Number

Re water = $\frac{\rho\ water\ .\ V\ water\ .\ D\ hydraulic}{\mu\ water}$

Convective Heat Transfer Coefficient for Water Flow

h water = $\frac{Nu\ water\ .\ K\ water}{D\ hydraulic}$

Nusselt Number

Nu air = $0.664\,(Re.\ air)^{0.5}.\ (Pr.air)^{0.333}$

Convective Heat Transfer Coefficient for Air Flow

$$h\ air = \frac{Nu\ air\ .\ K\ air}{W\ tube}$$

Overall Heat Transfer Coefficient

$$UA = 1/\left\{\frac{1}{\eta o.\ hair\ .A\ external} + \frac{1}{h\ water\ .A\ internal}\right\}$$

Number of Transfer Units

$$NTU = \frac{UA}{C\ min}$$

Max Heat Transfer Rate

$$q\ max = Cmin\ (T\ water\ in - T\ air\ in)$$

Dimensions Parameter

- Length of the pipe =1000mm
- diameter of the pipe =52mm
- Thickness of the pipe = 2.5mm
- Number of fins (n) = 09
- Diameter (Df) = 58 mm
- Thickness of fins (tf) = 05 mm
- Total area of fins(TAf) = 0.02187 m^2
- Arrangement of fins = Vertically
- Inlet and Outlet temperature for hot and cold fluid
  Ti = 98°C , To = 49°C

III. RESULT AND DISCUSSION

Experiments are conducted for normal conduction, heat transfer with heat exchange rating and effectiveness as variable hot fluid velocity conditions.Maximum effectiveness of the heat exchanger is 82% .The result given from experiments present in the Table.1.

Velocity m/sec	Heat transfer co efficient w/m^2k
2.5	76.36
3	98.45
3.6	134.32

Table 1: Average Heat Transfer Coefficient Value, for Different Velocity of hot fluid.

IV. CONCLUSION

The pipe heat exchanger highly heat transfer due to arrangement of fins and turbulence flow. Mainly this type of fin design reduce to high amount of heat transfer and reduce the length in compare the conventional model.This type heat exchanger to recommend the highly heat transfer area and the thermal industry.

REFERENCE

[1]. Cheng L, Luan T, Du W J, et al. Heat transfer enhancement by flow-induced vibration in heat exchangers. Int J Heat Mass Transfer, 2009, 52: 1053–1057
[2]. Guo J F, Xu M T, Cheng L. Principle of equipartition of entransy dissipation for heat exchanger design. Sci China Tech Sci, 2010, 53: 1309–1314
[3]. Guo J F, Xu M T, Cheng L. The entransy dissipation minimization principle under given heat duty and heat transfer area conditions.Chinese Sci Bull, 2010, 55: 3141–3146
[4]. Chato J C, Leverman R J, Shah J M. Analysis of parallel flow multistream heat exchangers. Int J Heat Mass Transfer, 1971, 14: 1691–1703

[5]. Paffenbarger M. General computer analysis of multistream plate fin heat exchanger. In: Shah R K, Krause A D, Etzger D M, eds. Compact Heat Exchanger-A Festschrift for London A L. New York: Hemisphere Publishing, 1990. 727–746
[6]. Roetzel W, Spang B. Design of heat exchangers. In: VDI, VDI-GVC. VDI Heat Atlas. Dusseldorf: VDI-Verlag, 1993
[7]. Sekulć D P, Shah R K. Thermal design theory of three-fluid heat exchanger. Adv Heat Exchanger, 1995, 26: 219–327
[8]. Shah R K, Sekulć D P. Nonuniform heat transfer coefficients in conventional heat exchanger design theory. ASME J Heat Transfer, 1998, 119: 520–525
[9]. A. K. Sen and S. Trinh, An exact solution for the rate of heat transfer from a rectangular fin governed by a power law-type temperature dependence,ASME J. of Heat Transfer 108 (1986) 457-459
[10]. S. Abrate and P. Newnham, Finite element analysis of triangular fins attached to a thick wall, Computers and Structures 57 (6) (1995) 945-957.
[11]. S. Sikka and M. Iqbal, Temperature distribution and effectiveness of a two-dimensional radiating and convecting circular fin, AIAA Journal 8 (1) (1970)101-106.