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Design and Analysis of Trible Tube Heat Exchangers with Fins

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Abstract :*The experimental setup is find the heat transfer rating and system performance. The triple tube heat exchanger consist of three tube in various diameters as connect to concentric method and the circular fins are fix in over the pipe. This fins are arranged in vertically to the circumference of the outer tube and the circular fins are located in periodic distance. Hot and cold fluids are enters opposites direction. Hot fluid flow in the inside of the tube and cold fluid flow to outside of the tube. The coolant fluid flow to the middle of tube only. These fluids are regulated as laminar flow in all inside of the tubes. This type flow is to increase the effectiveness of heat transfer rating with compact size. The experimental setup is used calculate the convective and conduction heat transfer of the tubes and fins of the heat exchanger. This arrangement is especially used to reduce the distance of tube length and to increase the heat transfer of this arrangement.*

Key Words: *Triple tube, Hot and cold fluids, circular fins and effectiveness.*

List of symbols

A Area in m^2

At Area of tube in m nf Number of fins
Vf Velocity of fluids m/sec

K Thermal conductivity in W/mK Lt Length of the tube in m
h Heat transfer co effeicient in
W/m^2K

m mass flow rate in kg/sec
U Overall Heat transfer

Heat transfer in tubes Watts Q

Effectiveness

I. INTRODUCTION

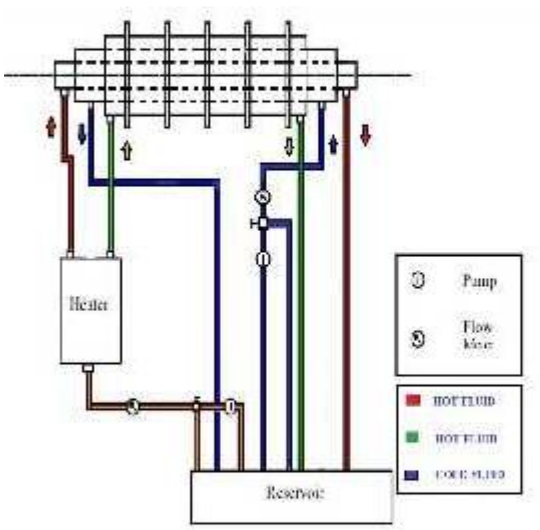
Heat transfer, heat exchange with compact size are very important to thermal field. Need to large amount of heat transfer and two or three terminal with parallel or counter flow condition is implement for triple tube heat exchanger is used. Heat exchanger effectiveness is based on the fluid flow, type of fluid, size and etc.,Elenbaas [1] conducted an experimental study on heat dissipation of parallel plates by free convection for wide range of Rayliegh numbers, viz., 0.2< Ra <10 . He determined that in the limit of small gap width, Nusselt number varies proportional to the channel Rayliegh number (Ra). Experimental work on horizontal fin arrays was studied by Guvenc A. and Yuncu H [2,]. Numerical work on horizontal fin arrays was studied by Leung C.W and Probert S.D.Experimental [3] work on vertical fin arrays was studied . Numerical work on vertical fin arrays was studied and downward facing fin arrays was studied by Dyan *et al.*, discussed. Nancy D. Fitzroy [4] did an experimental investigation of free convection heat transfer from rectangular fin arrays. Average heat transfer coefficients were presented for four fin arrays positioned with the base vertical, 45 degrees, and horizontal while dissipating heat to surrounding fluid. Rammohan Rao and Venkateshan S. P. [5] did an experimental study on Natural Convection/ Radiation Heat Transfer from highly populated pin fin Arrays. Saikhedkar N.H. and Sukhatme S. P.Experiments [6] were performed to determine the combined mode of natural convection/ radiation heat transfer characteristics of highly populated arrays of rod like cylindrical fins i.e., pin fins. They found that, if the number of fins were increased for fixed values of the other parameters, the heat transfer increased at first, attained a maximum and then decreased. Venkateshan S.P and Seetharamu K.N. [7] For conventional design methods of heat exchangers, such as the logarithmic mean temperature difference (LMTD), efficiency–number transfer unit(ε- NTU), etc., the value of fluid properties is usually supposed to be constant. Sparrow E.M and Vemuri S.B. [8]For fluids which have physical properties that show no significant changes with temperature variation, such as non-saturated water, the physical parameters may be assumed to be constant and to equal their mean value. Starner K.E. and McManus Jr. [9] Treatment can usually satisfy the design requirements. Nevertheless, it is not consistent with the reality of the heat transfer process. In particular, in many engineering applications the fluid properties in heat exchangers experience significant variation with temperature and pressure, such as in the petrochemical industry. In these cases, to make the physical parameters take their mean values gives rise to inaccurate design results. Sujatha K.S. and Sobhan C.B. [10] low temperature heat exchangers, there are relatively large temperature differences between their inlets and outlets, so the variation of fluid properties cannot be ignored. Yuncu H. and Anbar G. [11] The optimum procedure for fin shapes is of great interest for many engineering topics. For common fin shapes, the optimum dimensions of rectangular fins and cylindrical pin fins were investigated. Baskaya S and Sivrioglu M. [12]The optimization of rectangular profile circular fins with variable thermal conductivity and convective heat transfer coefficients was discussed . The optimization of a convective and radiating annular fin under thermally symmetric condition was reported . Also, optimization of the unique shape of the fin has been presented. Skoglund T, Arzen K-E, Dejmek P. [13] reported the geometric (constructal) optimization of T-shaped fin assemblies, where the objective is to maximize the global conductance of the assembly, subject to total volume and fin-material constraints. Recently, elliptical disk fins were analyzed and optimized using a semi-analytical technique. In these optimum procedures for the unique fin shape, fin base temperature is given as a constant for the fin base boundary condition.

II. METHODOLOGY

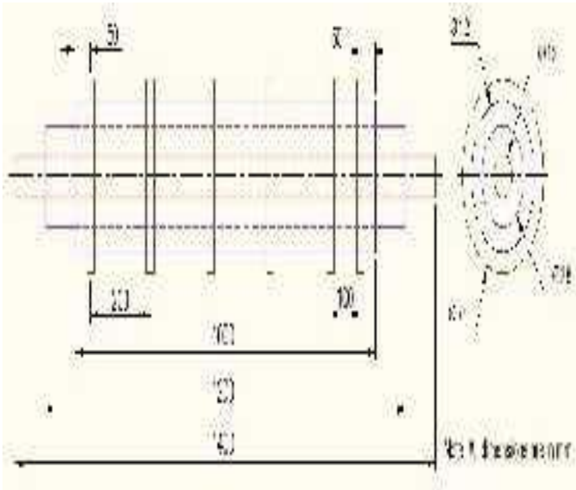
The conducting experiments setup on Triple tube heat exchanger consist of three tube in concentric method. It is tube materials and diameters are in different. Flow arrangement is turbulent conditions. Fluid as taken for water. The experimental set-up and determination of heat transfer coefficient and Effectiveness of heat exchanger in overall and individual tubes.

III. EXPERIMENTAL SET-UP

The experimental setup consists of three tubes in different material. Main components of fluid pumps, heater, flow meters, safety valves and thermo couples are arranging in properly.



Fluid flow in counter flow at centre, outer tube flow to the hot fluid and coolant is flow to middle tube. The circular fins are fixed in over the outer tube only. It is hot fluids flow in same direction at two pipes and coolant fluid flow to opposite direction in middle tube.



This set up is taken to the fluid in water is initially as hot and cold conditions. Fluid velocity and mass flow rate is control by the control valve and temperature is measured by thermo couple with thermo meters. The *Figures 1*, and *2* show the schematic diagram and the actual experimental set-up respectively.

IV. CALCULATION OF HEAT TRANSFER COEFFICIENT

The average heat transfer coefficient values, system overall heat transfer and effectiveness are determined. Mass flow rate and velocity are control by flow meter. Conduction of the circular fins and convective heat transfer are calculated to three tubes. System performance analysed by theoretical and experimental is involved. For heat exchangers other than parallel flow heat exchangers, the log-mean temperature difference does not perfectly describe the mean average temperature difference. For those other configurations, the formula is modified by multiplying the formula by a correction factor
F. Correction factors for common heat exchanger configurations such as single and multi-pass heat exchangers. The variable condition of heat transfer, overall heat transfer and effectiveness are find out the experimental setup.

V. DIMENSIONS OF TUBES

Length of theInner tube
(L_1) = 1000 mm
Length of the
Centertube(L_2) = 1200 mm
Length of theOuter tube (L_3) = 1400 mm
Diameter of theInner tube (D_1) =12 mm
Diameterof theCenter tube(D_2) = 28 mm
Diameter of the Outertube (D_3) = 42 mm
Heat transfer $Q = (hPkA)^{0.5}$ (Tb - T∞) tan h
(mLf) ….. (1)
q = m air. Cp air (T air out – T air in) = m water. Cp. Water (T water in – T water out.) - (2)

= UL/v
Where,
U = velocity in m/s
L = length in m
V = μ/ρ kinematic viscosity in m^2/s
Newtons Law of Convection Heat transfer from the moving fluid to surface,
Q = h.A. (Tw - Ta)

This equation is reffered on Newtons Law of cooling.

ffectiveness

E

= 1 – exp{ (1/Cr NTU 0.22) (exp(-Cr NTU 0.78) - 1}

ε

VI. RESULT AND DISCUSSION

In this experimental work the of the triple tube heat exchanger has been arrived. The new idea

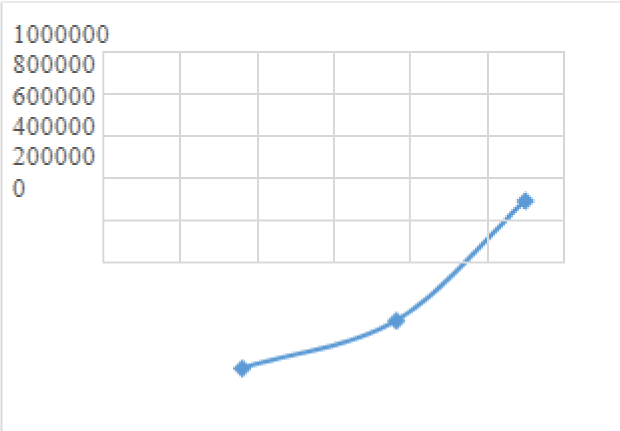


Figure.1. Diagram for Velocity and Heat transfer.

ELOCITY VS HEAT TRANSFER

Where P = Perimeter
A = A a re
m = $\sqrt{\frac{hP}{kA}}$
Temperature distribution

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

(( )

Reynolds numbers (Re)

= Inertia force/Viscous force

0 0.5 1 1.5 2 2.5 3

for Triple tube heat exchanger to increase heat transfer area with fins and reduce the cooling time and increases the effectiveness with compact size. The determination as variable temperature, mass flow rate of fluid as taken. Maximum effectiveness of the heat exchanger is 72%. So recommended to implement in this new design compact size in industries. The result given from experiments present in the Table.1.

	Velocity in m/sec	Mass flow rate in Kg/sec	Heat Transfer in Watts
Centre Pipe	0.753	0.85	14259
Middle Pipe	1.759	1.083	240296
Outer Pipe	2.6	3.6	806920

Table 1:Result for experimental setup in Heat Transfer Value, Velocity and mass flow rate.

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