International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 04 | Apr-2016 www.irjet.net p-ISSN: 2395-0072

CONSTRUCTION AND ANALYSIS OF TUBE IN TUBE TYPE HEAT EXCHANGER

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Abstract - *This paper is concerned about the study of heat transfer of hot water with different types of cooling fluids used in horizontal tube in tube type Heat Exchanger of 1.6m length. Aim of this study is to compare and plot results for parallel and counter flow in Heat exchanger for different cooling fluids. Cooling fluid used in this experiment for taking readings is water. Water as a coolant play an important role in many industry sectors including power generation, chemical production, air-conditioning, transportation and microelectronics. Also this experiment will give heat transfer rates for different flow rate of hot water and cooling fluid.*

***Keywords*: Nano particles, thermal conductivity, viscosity, specific heat and velocity.**

List of Symbols:-

Symbol	Description	Unit
Nomenclature		
A_{so}	Surface area of outer pipe	m^2
A_{si}	Surface area of inner pipe	m^2
D_{1o}	OD of Outer pipe	m
D_{1i}	ID of Outer pipe	m
D_{20}	OD of inner pipe	m
D_{2i}	ID of inner pipe	m
C_p	Specific heat	J/Kg k
h	Heat transfer coefficient	W/M^2K
K_c	Thermal cond. of copper	W/M K
M_h	Mass flow rate of hot water	Kg/s
M_c	Mass flow rate of cold water	Kg/s
T	Temperature	K
V	velocity	m/s
Greek symbols		
ρ_w	Density of water	Kg/m^3
Abbreviations		
LMTD	Log mean temperature difference	^oC
NTU	Net Transfer Unit	-
SS	Stainless steel	-
Cu	Copper	-
in	Inlet	-
out	Outlet	-

1.INTRODUCTION

From many years industries are using Heat exchangers for adding and removing heat or moving from one process stream to another and it has become a major task for industrial necessity. The improvement or enhancement of heating or cooling in industrial process may result in saving lots of energy, reduce process time, raise thermal rating, and lengthen the working life of equipment. Some processes even affected by small improvements in heating or cooling devices.

In this paper we will study how the heat transfer rate can be increased by changing cooling medium or changing the flow rate of hot or cold fluid. Heat transfer rates are calculated for both parallel flow and counter flow of fluid. For parallel flow both hot and cold fluids are passed from same end of the pipe and for counter flow hot and cold fluid are passed form opposite end of the pipe.

For this experiment tube in tube type Heat exchanger is used. In this Copper tube and stainless steel tube use as inner and outer tube respectively which are placed in concentric manner and sealed by welding at the end in order to eliminate any leakages. Copper used as an inner tube is because of its higher thermal conductivity so that there will be more heat transfer. Stainless steel has thermal conductivity less than copper as there should not be heat transfer between SS surface and atmosphere. But, still heat transfer takes place between SS surface and atmosphere, to overcome this problem thick insulation of glass wool is provided on the surface of Stainless still which minimises heat transfer from surface to large extent. Stainless steel tube used is having 26 mm standard outer diameter and 22 mm inner diameter with 1600 mm length. Copper tube is having 12 mm and 10 mm standard outer and inner diameter respectively with 1600 mm length.

2. EXPERIMENTAL SETUP

Experimental setup consist of tube in tube type heat exchanger mounted on supports, geyser, bucket heater, reservoir, 6 RTD's, temperature indicator, pipe lines for flow of fluid.

Geyser, reservoir, bucket heater and temperature indicators are together placed in a 2 feet*2feet box which is manufacture by welding of mild steel 1 inch angles. And heat exchanger is placed in front of the whole box.

3. CONSTRUCTION

To manufacture tube in tube type heat exchanger, tubes of SS and Cu are cut to required length. In this main task is to place Cu tube exactly concentric to SS tube, for which we have taken small disc of SS with hole at the centre with diameter equal to Cu tube outer diameter. Discs are welded at both the ends of SS tube by inserting Cu tube through it. To avoid any kind of leakage Small Grommets of required size are used. Over the time due to hot water flowing through copper tube grommet may wear, so for more protection to avoid water leakage sealing is provided with the use of proper sealing material which will not undergo any type of deformation or which will not form cracks in it over the time due to hot or cold water flow.

To provide inlet and outlet port to stainless steel tube two proper holes of required shape are drilled which lies on same plane. Two small pieces of SS tube are cut and welded at both the inlet and outlet port's drilled hole. Plastic tube is used for circulation of cooling fluid through outer tube. To measure inlet and outlet temperature of cooling fluid RTD no. 4 is placed at the inlet and RTD no.5 is placed at outlet of outer tube. To measure inlet and outlet temperature of hot fluid RTD no. 2 is placed at the inlet and RTD no.3 is placed at outlet of outer tube. Inlet to Cu tube is directly connected from outlet of reservoir which stores the hot water. To avoid the heat transfer from reservoir surface to atmosphere thick insulation of foam and thermocole is provided. Reservoir is given a arrangement for placing bucket heater in it and also hole is drilled at a particular height and a drain tube is provided at that hole which will drain the water if it tries to go above specified level. The whole setup is covered with aluminium sheet from all side so that there will not be any problem of water spilling, any damage to temperature indicator and RTD's, electrical connections.

4. EXPERIMENT

Readings are taken for parallel as well as counter flow of fluids. For parallel flow both cold and hot fluid are supplied from one end and flow rate for both the fluids are measured. For parallel flow, when water is used as coolant, T2 and T3 shows inlet and outlet temp of hot water also T4 and T5 shows inlet and outlet temp of cold water. Similarly for counter flow $(T_{in})_{hot}$ and $(T_{out})_{hot}$ are shown by T2 and T3 respectively. $(T_{in})_{cold}$ and $(T_{out})_{cold}$ are shown by T4 and T5 respectively.

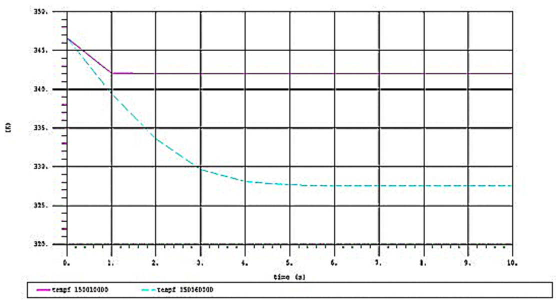
When water is used as coolant readings are taken for 40%, 60%, 80%, and 100% opening of inlet valve of hot water keeping flow rate of cold water constant. After taking all the readings for water same procedure is repeated for Ethylene glycol and cutting fluid as a coolant but for only 100% opening of hot water inlet valve.

5. OBSERVATIONS AND READINGS

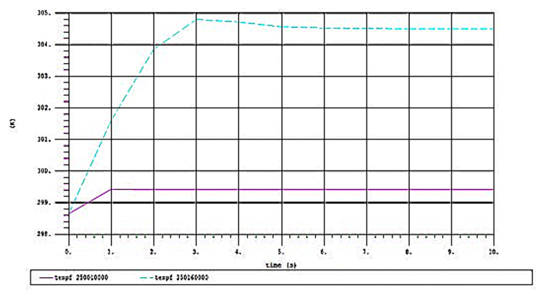
A. Coolant = water.
For parallel flow.

1. 40% opening of hot water inlet valve.
M_h= 0.04986 kg/s M_c=0.14202 kg/s
T1= 75°C   T6=30.1 °C

Sr. No.	T2 $(T_{in})_{hot}$	T3 $(T_{out})_{hot}$	T4 $(T_{in})_{cold}$	T5 $(T_{out})_{cold}$
1.	70.2	54.39	25.8	31.35



Hot water



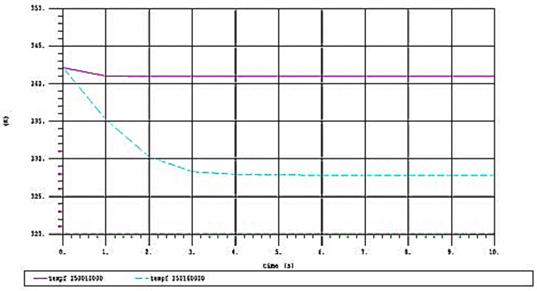
Cold Water

2. 60% opening of hot water inlet valve.

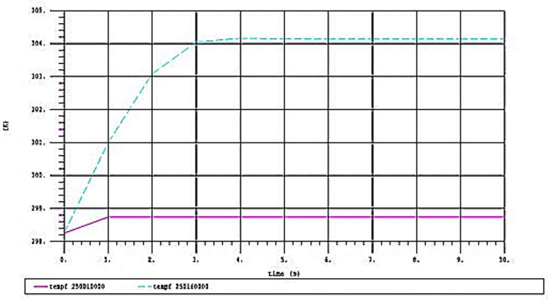
M_h=0.05830 kg/s M_c=0.14202 kg/s

T1= 74.5°C T6=30.1 °C

Sr. No.	T2 $(T_{in})_{hot}$	T3 $(T_{out})_{hot}$	T4 $(T_{in})_{cold}$	T5 $(T_{out})_{cold}$
2.	69	54.68	25.1	31



Hot water



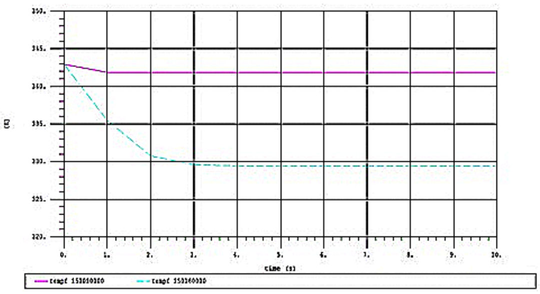
Cold Water

3. 80% opening of hot water inlet valve.

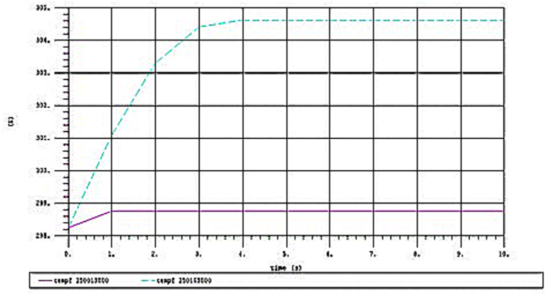
M_h=0.06690 kg/s M_c=0.14202 kg/s

T1= 74°C T6=30.1 °C

Sr. No.	T2 $(T_{in})_{hot}$	T3 $(T_{out})_{hot}$	T4 $(T_{in})_{cold}$	T5 $(T_{out})_{cold}$
1.	69.8	56.28	25.1	31.48



Hot water



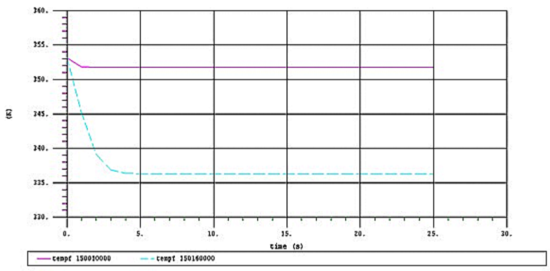
Cold Water

4. 100% opening of hot water inlet valve.

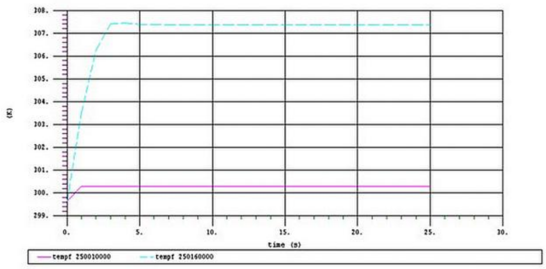
M_h=0.064878 kg/s M_c=0.14202 kg/s

T1= 88°C T6=30.1 °C

Sr. No.	T2 $(T_{in})_{hot}$	T3 $(T_{out})_{hot}$	T4 $(T_{in})_{cold}$	T5 $(T_{out})_{cold}$
1.	80	63.13	26.5	34.23
2.	83.5	58.6	25.5	32.32



Hot water



Cold Water

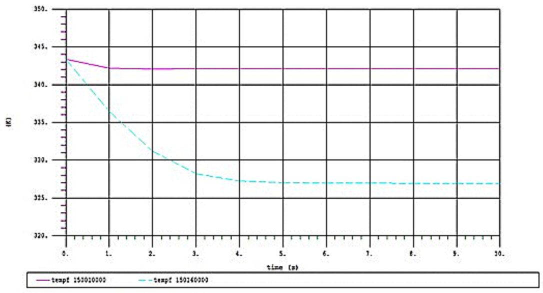
B. Coolant = water.
For counter flow.

1. 40% opening of hot water inlet valve.

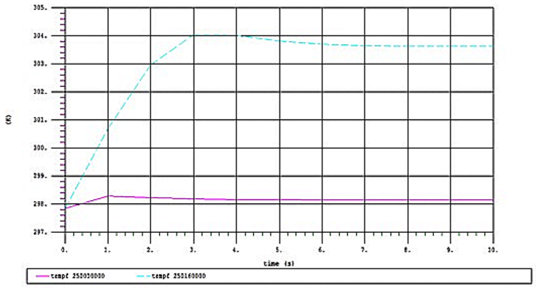
M_h=0.04986 kg/s M_c=0.14202 kg/s

T1= 75°C T6=30.1 °C

Sr. No.	T2 $(T_{in})_{hot}$	T3 $(T_{out})_{hot}$	T5 $(T_{in})_{cold}$	T4 $(T_{out})_{cold}$
1.	70.2	53.77	24.7	30.13



Hot water



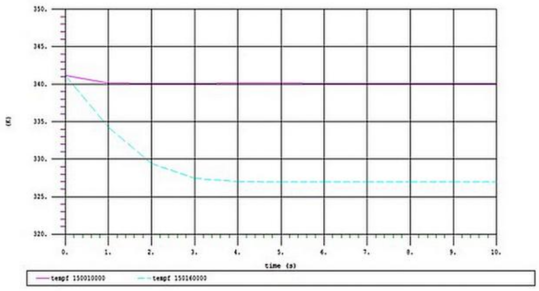
Cold Water

2. 60% opening of hot water inlet valve.

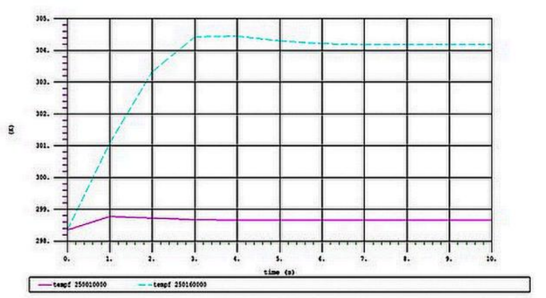
M_h=0.05830 kg/s M_c=0.14202 kg/s

T1= 73.5°C T6=30.1

Sr. No.	T2 $(T_{in})_{hot}$	T3 $(T_{out})_{hot}$	T5 $(T_{in})_{cold}$	T4 $(T_{out})_{cold}$
1.	68	53.8	25.2	31.03



Hot water



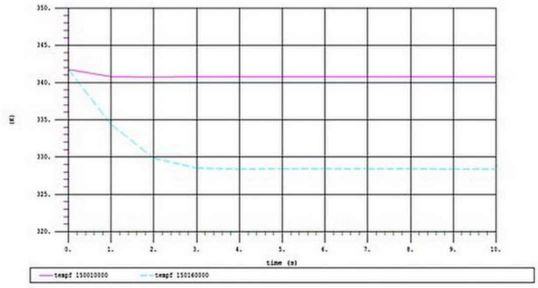
Cold Water

3. 80% opening of hot water inlet valve.

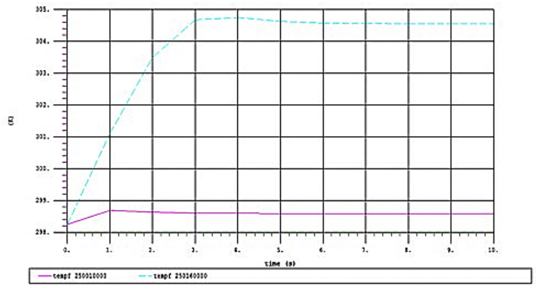
M_h=0.06690 kg/s M_c=0.14202 kg/s

T1= 74°C T6=30.1 °C

Sr. No.	T2 $(T_{in})_{hot}$	T3 $(T_{out})_{hot}$	T5 $(T_{in})_{cold}$	T4 $(T_{out})_{cold}$
1.	68.6	55.23	25.1	31.40



Hot water



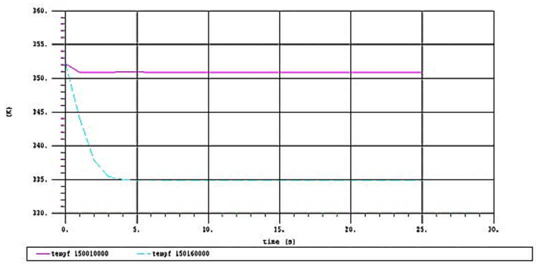
Cold Water

4. 100% opening of hot water inlet valve.

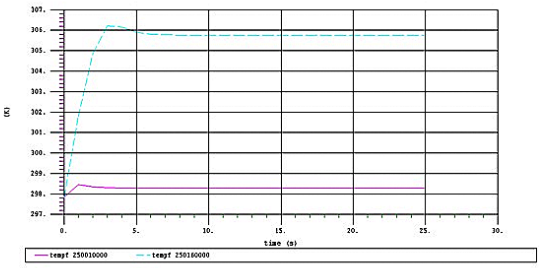
M_h=0.064878 kg/s M_c=0.14202 kg/s

T1= 78°C T6=30.1 °C

Sr. No.	T2 $(T_{in})_{hot}$	T3 $(T_{out})_{hot}$	T5 $(T_{in})_{cold}$	T4 $(T_{out})_{cold}$
1.	79	61.72	24.7	32.61
2.	73.5	58.08	24.5	31.56



Hot water



Cold Water

6. FUTURE SCOPE

The setup itself has a wide scope of alternations. We can give angle to the heat exchanger which will provide different heat transfer readings. Nano fluids can be used as cooling fluid in outer pipe. The inner pipe can be twisted to create whirl effect of hot water flow. A manometer can be introduced to measure the pressure drop of the system. More numbers of RTD's can be provided at different lengths of the heat exchanger to get more number of readings at different lengths.

7. CONCLUSION

As the flow rate of the cold and hot fluids changes, the heat transfer rate also change. Thus flow rates of both the fluids play an important role in heat transfer. When the temperature difference between hot and cold fluid increases the heat transfer rate also increases.

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