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Preliminary Investigation and Analysis of Different Pipe Geometries with 60 Degree Helix Angle in a Two-Pipe Parallel Flow Heat Exchanger

Abul Bashar

All Saints College of Technology

ABSTRACT

Warm exchanger may be a device or hardware, which is utilize to exchange warm between two liquid which may be in coordinate contact or circuitous contact. We discover parcels of applications of warm exchangers in our day nowadays life. For illustration condensers and evaporators are utilized in boilers, condensers, discuss coolers and chilling towers etc. Moreover, warm exchangers are utilized in automobiles segments are within the frame of radiators and oil coolers interior motors. The straight copper tube, steel tube warm exchanger is made in warm & mass exchange lab and this explore held at college lab. Straight copper tube and steel tube is the most portion of the Down to earth setup of same length of 1.5 meter made by copper metal tube and steel metal tube of 10 mm inward distance across and 12 mm external distance across of both tube. In my inquire about work i will discover out from test perception for viability, Logarithmic cruel temperature distinction and generally warm exchange coefficient, variety due to cold water and hot water mass stream rates.

Effectiveness diminishes with increment in mass stream rate of hot water. Adequacy increment when mass stream rate of hot water is consistent for all the tubes. Normal adequacy of folded tube is more prominent than the straight steel tube and straight copper tube. In both the cases LMTD of all the tubes increment and the esteem of LMTD of layered tube is more noteworthy than the straight steel tube and straight copper tube. In general warm exchange coefficient of layered tube continuously increments with increment in mass stream rate of hot water and its esteem is higher at 90 LPH.

1. INTRODUCTION: -

Heat exchanger may be a gadget or gear, which is utilize to exchange warm between two liquid which may be in coordinate contact or backhanded contact. We discover parts of applications of warm exchangers in our day to day life. For illustration condensers and evaporators are utilized in boilers, condensers, discuss coolers and chilling towers etc. Moreover, warm exchangers are utilized in automobiles divisions are within the frame of radiators and oil coolers interior motors. Warm exchangers are moreover utilized broadly in chemical divisions and handle segments for transmitting the warm between two liquids which are at a single or two states.

1.1. Different sorts of warm exchangers:

1.1.1. Concurring to Warm exchange process

1. Coordinate Contact Sort Warm Exchanger

2. Exchange Sort Warm Exchanger

3. Recovery sort Warm Exchanger

1.1.2. Agreeing to Constructional Highlights

1. Tubular Warm Exchanger

2. Shell and Tube Warm Exchanger

3. Finned tube Warm Exchanger

1.1.3. Agreeing to relative course of fluid,

1. Parallel stream

2. Counter flow

3. Cross flow

According to Warm exchange Process:

1. Coordinate CONTACT Sort Warm EXCHANGER: - Coordinate contact sort warm exchangers are that sort warm exchanger in which two immiscible liquids are specifically blended with each other to transmit warm between two liquids. The proficiency of this sort of warm exchanger is more as compared to other sort warm exchangers. Cooling towers, fly condenser, de-super radiators, open bolster water radiator are cases.

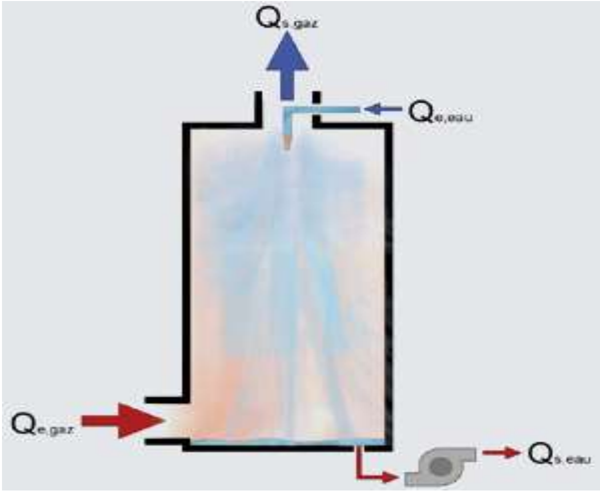

Fig.1.1: Direct contact type heat exchanger

1. Exchange Sort AND RECUPERATOR Sort: - Exchange sort or Recovers sort warm exchanger are those sort of warm exchangers in which two liquids stream at the same time through two tubes isolated by dividers.

3. REGENERATIVE Sort Warm EXCHANGER: - The hot and cold liquid stream then again on same surface. Amid the hot liquid exchange through the divider of exchanger gets warmed and when the cold liquid stream through it, this warm passed by the divider of the warm exchanger to the cold liquid so that the temperature of cold liquid increments. The common cases are pre-heaters for steam control plant, impact heater etc.

2 According to Constructional Features

1. TUBULAR Warm EXCHANGERS: - In these sort of Warm Exchangers tubes are situated concentric to each other and two liquid streams in two tubes isolated by divider. These are by and large utilized in most of the building application.

2. SHELL AND TUBE Sort Warm EXCHANGER: - In these sorts of Warm Exchangers comprises of shell and parts of parallel tubes. The warm transmission takes put when one liquid stream through the tube and other liquid stream exterior the tube interior the shell of the exchanger this sort of warm exchanger have huge surface region to volume. Confuses plates are given to upgrade the turbulence thus increments the warm exchange rate.

3. FINNED TUBE Warm EXCHANGER- For moving forward the warm exchange rate balances are put on the external surface of the warm exchangers. These are for the most part utilize in gas to fluid sort warm exchanger and blades are for the most part set in gas side. These are utilize in gas turbines, automobiles, plane, warm pump etc.

2. LITERATURE REVIEW TABLE

Author	Title	Year	Work
Zaid S. Kareem	A Computational Fluid Dynamics	2015	Determination of the thermal performance of unique smooth corrugation profile
Xuemei Su	Corrugated stainless steel horizontal tube are investigated	2015	Heat transfer is enhanced
Ki JungRyu	Analysed the performance of heat exchanger	2015	Heat transfer rate increases
HamedSadighiDizaji	Experimentally investigated that the outcome of heat flow	2015	Both of the energy loss and dimensionless energy loss increase with the increase of coil side inlet temperature and decrease of shell side inlet temperature
MortezaKhoshvaght -Aliabadi	In this paper, fluid flow and heat transfer characteristics of Cu–water nano fluid inside five serpentine tubes with variable straight section lengths are experimentally investigated	2015	Thermo-physical properties of the nano fluids required for the analysis are systematically measured

VamsiMokkapati	To investigate gas to liquid heat transfer performance of concentric tube heat exchanger with twisted tape inserted corrugated tube	2014	To maximize the heat recovery rate by optimizing the design of twisted tape insert
Ji Chan Park	It analyzed, copper catalyst coated metallic foam and heat exchanger type reactor was developed with the consideration of the severe heat and mass transfer limitations in the Fischer–Tropsch synthesis reaction	2014	The CO conversion decreased, but the C5+ selectivity increased
Dillip Kumar Mohanty	Analysis of heat exchanger fouling	2014	The developed fouling prediction model provides a picture about the fouling
Cong Chen	Analyzed for enhanced heat transfer of mixed molten heated salt in corrugated tubes with three different sets of structural parameters	2013	The drag coefficient for transversally corrugated tubes is larger than that for smooth tubes
Shriram S	Al2O3is a promising candidate for the enhancement of overall convective heat transfer coefficient of water	2013	Heat transfer characteristics of nano fluids improve
Zan Wu	For both laminar flow and turbulent flow, no anomalous heat transfer enhancement was found	2013	Heat transfer rate increased
XuXiu-qing	Corrosion rate	2013	Maximum
CarstenSchroer	Metal recession was assessed	2012	Results are satisfactory
NavidParnian	Cause of the failure	2012	The cracks were examined at the seam weld, heat affected zone (HAZ), and U-bend areas
S. Pethkool	Investigated experimentally heat transfer enhancement and friction factor with nine helically corrugated tube with three different pitch –to-diameter ratios (p/DH=0.18,0.22, and 0.27)and three rib-height to diameter ratios(e/DH=0.02,0.04 and 0.06).	2011	It is found that the friction factor and thermal performance factor increase with increasing the Pitch ratio (P/DH) and the rib-height ratio (e/DH)
Zachar	Had done the experiment to improve the inside heat transfer rate by examine of different geometrical parameters of helical corrugation on the outer surface of helically coiled-tube heat exchangers	2010	Heat transfer rate is almost independent from the inlet temperature and the outer surface temperature
Milind V. Rane	Analysed by tube-tube and double wall tubular heat exchanger two or more tubes are placed side-by-side and bonded thermally using thermal bonding material (TBM) for effective heat transfer	2005	Experimental results indicate that there is a definite optimum for a number of bends for a particular application

3. METHODOLOGY

This lesson bargains with the exploratory technique, strategy for calculating viability, LMTD and in general warm exchange coefficient equations utilized in calculation given in this portion. Numerical calculation and esteem picked up for straight copper tube parallel stream, Straight Steel tube parallel stream and straight Folded tube parallel stream at 600 are appears in appendix.

3.1. Test Methodology:

Flow rates within the tube and within the shell were shifted. The taking after Six levels were utilized: 15, 30, 45, 60, 75 and 90 LPH. All conceivable combinations of these stream rates in shell and the interior the tube were tested.

These were done for three warm exchangers “Straight steel tube, Straight Copper tube warm exchangers and layered tube warm exchanger” in parallel stream arrangement.

The Temperature information utilized within the scientific calculation was after the framework had stabilized. The type-K thermocouples utilized for temperature esteem. All the thermocouples were developed from the same thermocouple wire, and thus the repeatability of temperature esteem was tall with temperature perusing changes inside ±0.3 °C.

Water properties utilized at cruel temperature of 450C.

3.2. Warm EXCHANGER STUDY:

Heat exchangers more often than not worked for long interval of time without alter in their working conditions. Hence, they can be demonstrated as consistent stream devices.

For such stream conditions, the mass stream rate of water remains unaltered. The water properties like temperature, speed etc, at gulf and exit too remains unaltered. The changes in active vitality, potential vitality, particular warm and conduction along the length of the tube are dismissed. The external surface of the outer tube is the warm exchanger is considered impeccably protects, so there's no warm misfortune to the environment and warm exchange occurs between two liquids only.

In specific, in the event that the water ate not experiencing the stage alter, the primary law of the thermodynamics states that the rate of warm transmission from the hot liquid be rises to the rate of warm exchange to the cold liquid.

The rate of heat transfer by hot fluid is given by:

$$Q = mh\, C_{ph}(T_{hi} - T_{ho}) \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

The rate of heat transfer to cold fluid is given by:

$$Q = mc\, C_{pc}(T_{co} - T_{ci}) \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

It is very simple to use LMTD method of heat exchanger study when inlet and outlet temperatures, mass flow rates for hot and cold water and overall heat transfer coefficient are available or easily be determines from specified relations. The heat transfer surface area and thus size of heat exchanger can easily be determined from given equation.

$$Q = UA\Delta T_{lm}$$

3.3. LMTD METHOD:

In tubular heat exchanger, the temperature difference between the hot and cold water varies with the position in the heat exchanger therefore it is convenient to determine log mean temperature difference ΔTlm

The total heat transfer rate between the hot and cold water can also be calculated by using overall heat transfer coefficient and surface area as:

$$\boldsymbol{Q} = \boldsymbol{UA}\Delta T_{lm}$$

Where,

$$\Delta T_{lm} = \frac{(\Delta T_2 - \Delta T_1)}{ln\left(\frac{\Delta T_2}{\Delta T_1}\right)} = \frac{(\Delta T_1 - \Delta T_2)}{ln\left(\frac{\Delta T_1}{\Delta T_2}\right)}$$

4 EXPERIMENTAL SETUP

This chapter covers the creation of Commonsense setups utilized to create the adequate information for comparative examination of straight copper tube, straight steel tube and layered steel tube warm exchangers. Adequate information was produced by shifting distinctive parameters over foreordained ranges. The instrumented utilized and the information collection strategy received are too talked about in this chapter.

4.1. Straight Copper tube, Straight Steel tube and Layered Steel tube Warm Exchanger:

The straight copper tube, steel tube warm exchanger is made in warm & mass exchange lab and this test held at college lab. Straight copper tube and steel tube is the most portion of the Viable setup of same length of 1.5 meter made by copper metal tube and steel metal tube of 10 mm internal breadth and 12 mm external breadth of both tube. The Commonsense set-up utilized for underneath examination is illustrated figure 4.1:

(a) and (b)

The set-up comprised of the taking after components:

1. Straight Copper Tube,

2. Straight Plain Steel Tube,

3. Corrugated Tube

4. Shell [G.I],

5. Heater,

6. Cold water source,

7. Flow measuring gadgets,

8. AC control supply,

9. Thermocouples.

Hot water stream from radiator and streams interior the copper tube where it lose warm by cold water streaming through shell. The channel and outlet of cold water in shell kept at beat so shell ought to be filled totally and total inward tube must be submerged in water. The stream of cold water is controlled by rotameter at the channel within the shell, this cold water at that point carries warm to waste. Hot water mass stream rate controlled after the outlet of internal tube.

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This is done to urge parallel stream course of action. Four thermocouples are utilized to note down temperature at channel and outlet of hot and cold water streams individually. Taking after fig. appears the Down to earth setup.

Similarly, Hot water stream from radiator and streams interior the Steel tube where it lose warm by cold water streaming through shell. The gulf and outlet of cold water in shell kept at beat so shell ought to be filled totally and total steel tube must be drenched in water. The stream of cold water is controlled by rotameter at the channel within the shell, this cold water then carries heat to drainage. Hot water mass stream rate controlled after the outlet of steel tube. This can be done to induce parallel stream course of action. Four thermocouples are utilized to note down temperature at channel and outlet of hot and cold water streams individually. Commonsense setup is illustrated in figure 4.1 (a) and (b).

4.2. Folded Tube Warm Exchanger:

The folded tube warm exchanger is created in warm exchange lab. The schematic of the Commonsense set-up utilized for the show work is illustrated figure 4.1. The set-up comprises of the taking after components:

4.2.1. Layered Tube:

Corrugated tube warm exchanger was accessible in warm exchange lab. With small support it is brought to working condition. Layered tube warm exchanger with 600 helix point comprises of 10 mm interior breadth, 12 mm exterior distance across and 1.5 m length layered tube. These tubes were interior shell of 10 mm interior breadth and thickness 2 mm. The hot water stream rate was measured and controlled with rotameter; so also cold water stream rate was measured and controlled by another Rotameter. Schematic of Folded tube warm exchanger with 600 helix point warm exchanger is as illustrated figure 4.2.

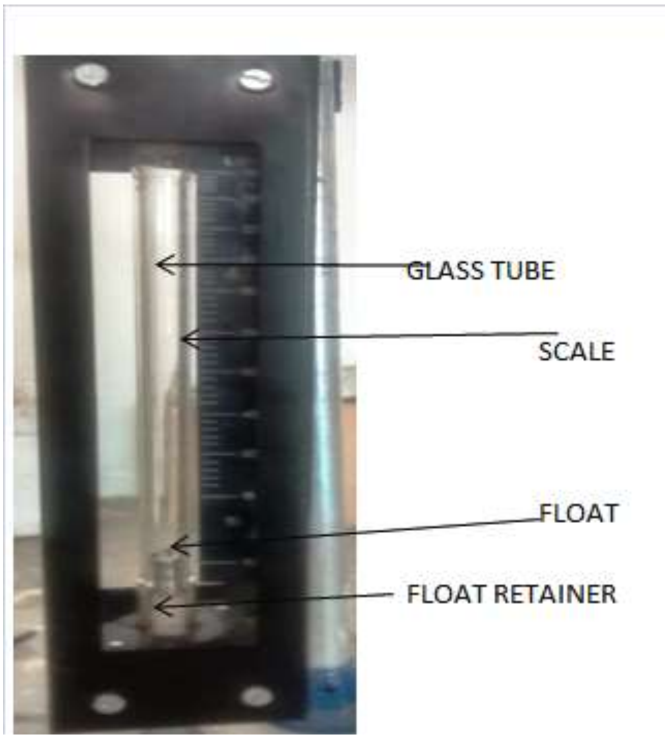


Figure 4.7: Glass Rota meter (reference- heat engine lab all saints college of technology)

Sr. No.	Mass flow Rate of Hot Water (M_h) (LPH)	Massflow Rate of Hot Water M_h (Kg/Sec)	M_h X C_{Ph} (W)	T_{hot}(inlet) (ºC)	T_{hot} (Outlet) (ºC)	ΔT_{ho} (Th_i – Th_o)	Mass flow rate of Cold water (M_c) (LPH)	Mass flow rate of Cold water M_c (Kg/Sec)	Mc X CPC (W)	T_{cold}(inlet) (ºC)	T_{cold} (Outlet) (ºC)	ΔTC (Tc_{in} – Tc_{out})	Effectiveness (ϵ)	Logarithm mean Temperature Difference (LMTD) $\frac{(\Delta T1-\Delta T}{\ln(\frac{\Delta T1}{\Delta T2})}$	Overall heat Transfer Co-efficient
1	45	0.0125	0.052	66.5	56.8	9.7	15	0.0041	0.0174	31.2	52.2	21.0	0.23	15.06	504.2
2	45	0.0125	0.052	66.5	53.5	13	30	0.0083	0.0035	31.2	44.8	13.6	0.32	18.99	551.3
3	45	0.0125	0.052	66.5	53.5	13	45	0.0125	0.0523	31.2	41.3	10.1	0.32	21.74	491.7
4	45	0.0125	0.052	66.5	51.7	14.8	60	0.0166	0.0674	31.2	41.1	9.9	0.41	20.53	666.3
5	45	0.0125	0.052	66.5	49.7	16.8	75	0.0208	0.0870	31.2	37.3	6.1	0.38	21.88	569.7
6	45	0.0125	0.052	66.5	49.6	16.9	90	0.0250	0.1046	31.2	36.4	5.2	0.38	22.46	562.3

5. RESULTS AND DISCUSSION

Table: 5.1. Straight Steel Plain Tube Heat Exchanger When hot Water is Fixed at 45 LPH in Parallel Flow Arrangement

Table: 5.2. Straight Steel Plain Tube Heat Exchanger When Cold Water is Fixed at 45 LPH in ParallelFlow Arrangement:-

Specific heat of Water (CP) =4.18 KJ/Kg.k

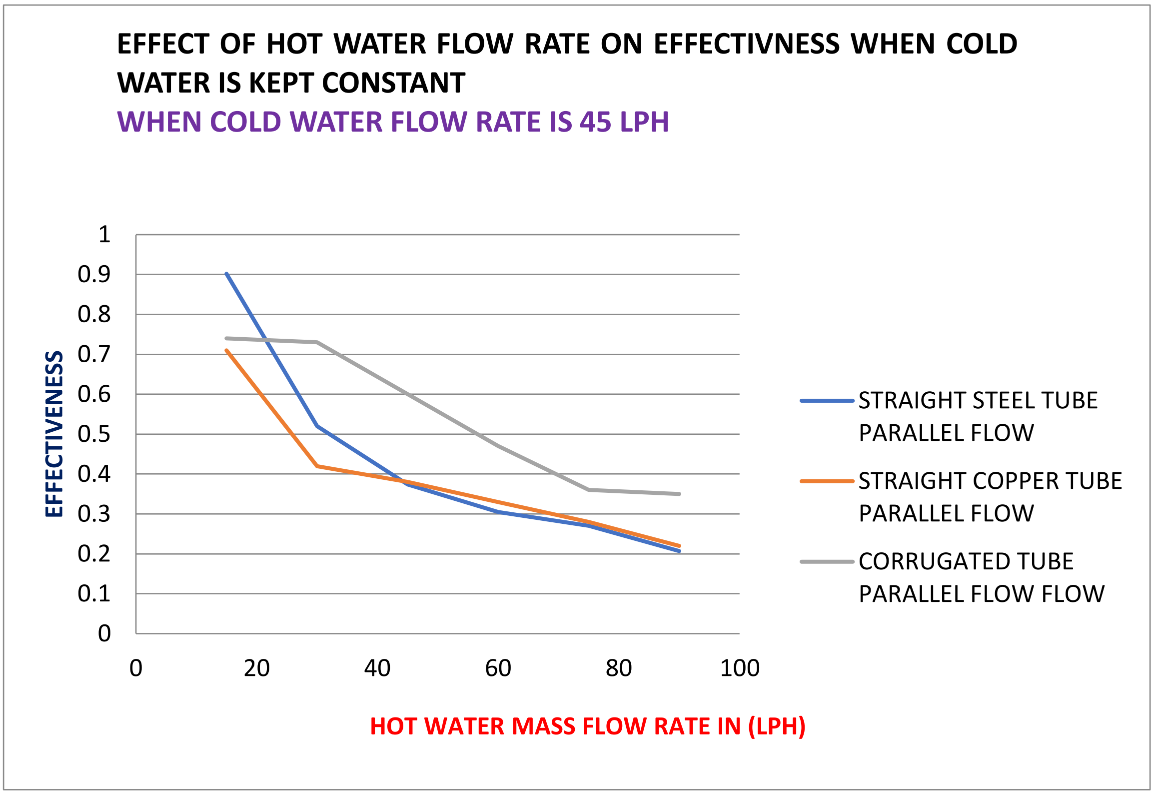
Sr. No.	Mass flow Rate of cold Water (M_c) (LPH)	Mass flow Rate of cold Water M_c (Kg/Sec)	M_c X C_{Pc}(W)	T_{cold} (inlet) (ºC)	T_{cold} (Outlet) (ºC)	ΔT_{cold} = (Tcout – Tcin)	Mass flow rate of Hot water (M_h) (LPH)	Mass flow rate of Hot water M_h (Kg/Sec)	M_hXCPh(W)	T_{hot} (inlet) (ºC)	T_{hot} (Outlet) (ºC)	ΔTh =(Th_{in} – Th_{out})	Effectiveness (ϵ)	Logarithm mean Temperature Difference (LMTD) $\frac{(\Delta T1-\Delta T2)}{\ln(\frac{\Delta T1}{\Delta T2})}$	Overall heat Transfer Co-efficient
1	45	0.0125	0.052	31.5	49.3	17.8	15	0.0041	0.0171	66.5	57.8	8.7	0.902	18.72	511.31
2	45	0.0125	0.052	31.5	47.3	15.8	30	0.0083	0.0347	66.5	53.9	12.6	0.520	17.02	658.31
3	45	0.0125	0.052	31.5	44.3	12.8	45	0.0125	0.0523	66.5	53.1	13.4	0.374	18.97	555.60
4	45	0.0125	0.052	31.5	37.6	6.1	60	0.0166	0.0695	66.5	49.7	16.8	0.305	21.56	609.40
5	45	0.0125	0.052	31.5	43.4	11.9	75	0.0208	0.0870	66.5	54.7	11.8	0.270	20.96	696.09
6	45	0.0125	0.052	31.5	40.6	9.1	90	0.0250	0.1046	66.5	55.7	10.8	0.207	29.61	454.85

Table: 5.3. Corrugated steel Tube Heat Exchanger with 60^0 Helix Angle When Hot Water is fixed at 45 LPH in Parallel Flow arrangement:

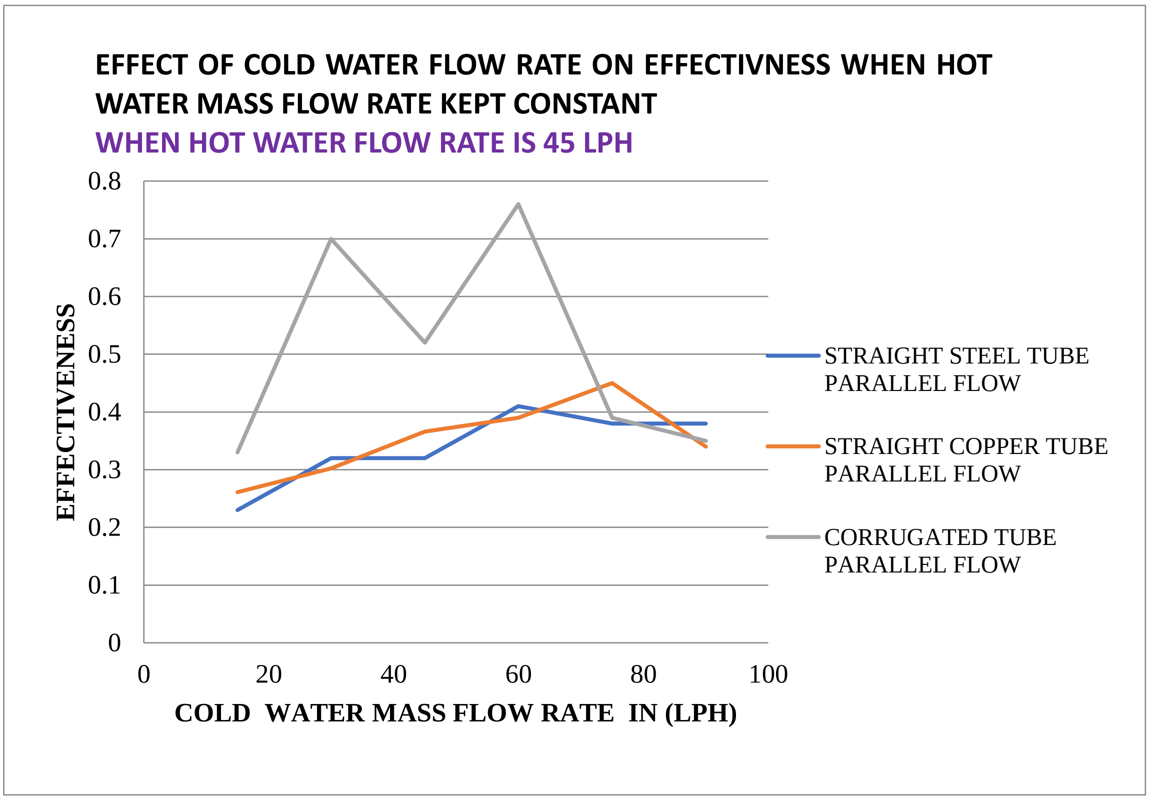
Specific heat of Water (CP) =4.18 KJ/Kg.k

Sr. No.	Mass flow Rate of Hot Water (M_h) (LPH)	Mass flow Rate of Hot Water M_h (Kg/Sec)	M_h X C_{Ph} (W)	T_{hot}(inlet) (ºC)	T_{hot} (Outlet) (ºC)	ΔT_{hot} (Th_{in} – Th_{out})	Mass flow rate of Cold water (M_c) (LPH)	Mass flow rate of Cold water M_c (Kg/Sec)	Mc X CPC (W)	T_{cold}(inlet) (ºC)	T_{cold} (Outlet) (ºC)	ΔTC (Tc_{in} – Tc_{out})	Effectiveness (ϵ)	Logarithm mean Temperature Difference (LMTD) $\frac{(\Delta T1-\Delta T2)}{\ln(\frac{\Delta T1}{\Delta T2})}$	Overall heat Transfer Co-efficient
1	45	0.0125	0.052	66.6	56.6	10	15	0.0041	0.0171	31.5	44.7	13.2	0.33	20.54	581.4
2	45	0.0125	0.052	66.6	55.0	11.6	30	0.0083	0.0347	3.51	30.3	6.8	0.70	25.13	521.0
3	45	0.0125	0.052	66.6	54.1	12.5	45	0.0125	0.0523	31.5	37.4	6.3	0.52	25.43	554.6
4	45	0.0125	0.052	66.6	54.2	12.4	60	0.0166	0.0695	31.5	38.3	6.8	0.76	24.32	575.4
5	45	0.0125	0.052	66.6	53.8	12.8	75	0.0208	0.0870	31.5	37.6	6.1	0.39	24.52	580.8
6	45	0.0125	0.052	66.6	52.8	13.8	90	0.0250	0.1046	31.5	36.9	5.4	0.35	24.32	639.3

Graph: 5.1. Comparative analysis of effectiveness when cold water is constant at 45 LPH for straight steel tube, straight copper tube and corrugated tube with 60^0 helix angle heat exchanger in parallel flow arrangement



Graph: 5.2. Comparative analysis of effectiveness when hot water is constant at 45 LPH for straight steel tube straight copper tube and corrugated tube with 60^0 helix angle heat exchanger in parallel flow and counter flow arrangement



CONCLUSION AND FUTURE SCOPE

OBJECTIVE OF CONCLUSION

An test think about on straight steel tube, straight copper tube and straight folded steel tube of groove point 600 was performed in warm exchanger test lab. Tubes utilized for the explore having same breadth and same length. Try carried out for all the tubes for same mass stream rate and the liquid utilized for the test was water.

6.1. CONCLUSION OF Display STUDY:

1. Adequacy diminishes with increment in mass stream rate of hot water

2. Adequacy increment when mass stream rate of hot water is steady for all the tubes

3. Normal viability of folded tube is more prominent than the straight steel tube and straight copper tube

4 in both the cases LMTD of all the tubes increment and the esteem of LMTD of folded tube is more prominent than the straight steel tube and straight copper tube

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