

DESIGN AND CFD ANALYSIS OF DOUBLE PIPE HEAT EXCHANGER BY USING VARIOUS NANO FLUIDS

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Abstract

Heat exchanger is a device used to transfer heat between one or more fluids. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. These exchangers provide true counter-current flow and are especially suitable for extreme temperature crossing, pressure, high temperature, and low to moderate surface area requirements.

In this thesis, water and different nano fluids mixed with base fluid water are analyzed for their performance in the double pipe heat exchanger. The nano fluids are Silicon Oxide and silver nano fluid at volume fractions 0.35%. Theoretical calculations are done determine the properties for nano fluids and those properties are used as inputs for analysis.

3D model of the double pipe heat exchanger is done in CREO parametric software. CFD analysis is done on the double pipe heat exchanger with water, silicon oxide & silver nano particle at different mass flow rates such as 0.32, 0.52, 0.72,0.92& 1.12 kg/sec. furthermore theoretical calculations done on the double pipe heat exchanger.

1. INTRODUCTION

Temperature may be characterized as how a lot electricity that a substance has. Heat exchangers are applied to transport that electricity starting with one substance then onto the next. In technique units controlling the temperature of approaching and energetic streams is essential. These streams can either be gases or fluids. Heat exchangers boost or decrease the temperature of these streams by means of transferring intensity to or from the circulate. Heat exchangers are a device that trades the depth between beverages of numerous temperatures which might be remoted by using a robust divider.

The temperature attitude or the distinctions in temperature work with this trade of depth. Move of depth happens by 3 guiding principle implies: radiation, conduction and convection. In the utilization of depth exchangers radiation happens. In any case, in comparison with conduction and convection, radiation does not expect a considerable component. Conduction takes place because the intensity from the better

temperature liquid goes via the strong divider.

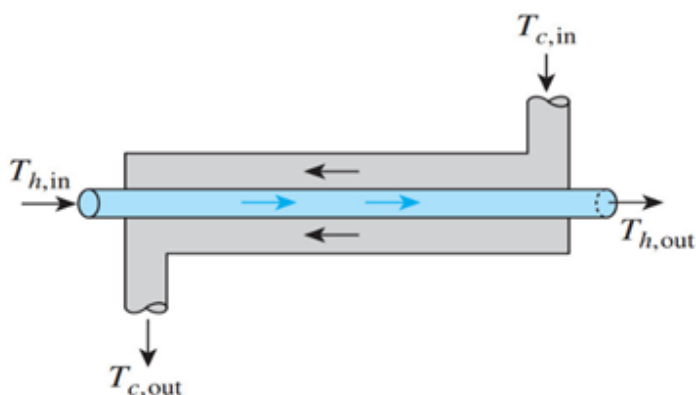


Figure 1: simplified diagram showing the operation of double pipe exchangers. Notice how the inner fluid (blue) is moving from left to right, but the outer fluid (grey) moves from right to left.

2. LITERATURE SURVEY

Han Xiaoxing et al. [1] (2108) researched on original concentric cylinder heat pipe heat exchanger. It transformed into planned and expected to be used in consolidated squander heat recuperating gear with better warmness move productivity at lower temperature warmth assets. The impacts affirmed that when the time of evaporator became 260 mm, the tendency viewpoint became 60° , the progression of cooling water changed into 0.5 m³/h, the cooling water temperature transformed into 30°C , the original warmth exchanger presented a higher intensity switch execution with most extreme warmness switch amount that is roughly 1600 W, and the normal warm opposition is 0.042°C/W .

N. Piroozam et al. [2] (2108) researched the warm in general execution and liquid attributes of counter drift warmness exchangers (CFHEs). In this reenactment, the effect of boundaries is examined and CFHEs are settled singularly the utilization of assorted mathematical systems. It has been inferred that each one systems will upgrade the performance of the CFHEs.

R. Whalley et al. [3] (2108) investigated the intensity exchanger powerfully. The overseeing way is presented through power dependability model yielding the framework and incomplete differential conditions. Multivariable, multidimensional, Laplace changed, apportioned boundary arrangement of intensity exchanger portrayals is provided. Suitable input oversee systems are analyzed for the glow exchangers.

Anas El Maakoul et al. [4] (2017) utilized a mathematical model to notice the thermohydraulic by and large execution of twofold line exchanger with helical confounds in the annulus feature the utilization of the product FLUENT. The three-layered Computational Fluid Dynamics model was utilized to find the helical puzzle results in the wake of approving the simple twofold line heat exchanger in assessment with observational relationships. Mathematical assessment executed for different assortment of Reynolds amount and perplex dispersing affirmed that the intensity switch accuse reached out of involving the helical bewilder in the annulus angle with sizable strain punishment. Expansion inside the intensity move cost with out an exchange length and weight made the gadget more conservative. It is tracked down that with utilizing the helical perplex, thermohydraulic generally execution is more prominent in the laminar area and the warm presentation cost expansion inside the tempestuous locale is considerably less than the laminar area. Likewise, warm in general execution and strain drop are straightforwardly corresponding to each the puzzle separating and Reynolds range.

Shirvan et al [5] (2017) Numerically explored permeable filled twofold line warmness exchanger through applying Darcy-Brinkman-Forchheimer variant on the Two Dimensional model. Likewise did responsiveness assessment with assistance of Response Surface Methodology. With developing Reynolds assortment and Darcy assortment the propose Nusselt assortment got advanced. The Nusselt amount upgrade is 77.48% for permeable substrate thickness is $\frac{2}{3}$ and 203% for permeable substrate thickness is 1 and Reynolds range charge goes from 50 to 250. The most and insignificant worth of mean Nusselt amount was found for permeable substrate thickness of one and several/3 individually. Reynolds amount affects heat exchanger strong awareness and that of adverse consequence on the Darcy range. Results affirmed temperature contrast on each warm and bloodless side liquids affects Nusselt number while warmth exchanger adequacy enhance with Reynolds reach and temperature qualification anyway diminishes with developing Darcy assortment. Mathematical assessment showed that greatest warm presentation got for permeable layer thickness of $\frac{1}{3}$ or 1, with high Darcy range in twofold line warmness exchanger with permeable layer.

MohamadOmid et.al [6] (2017) analyzed the improvement procedure of twofold line heat exchanger and intensity switch upgrade strategies have likewise been generally examined. Additionally, various exploration with respect to the use of nanofluids in twofold line heat exchanger have been referenced in component. In this assess, the relationships of Nusselt assortment and strain drop coefficient are likewise provided.

2.1 Objective

The intention of this assignment is to make a 3-D model of the twofold line warmness exchanger and take a look at the CFD conduct of the twofold line warmness exchanger with the aid of playing out the restrained detail analysis. 3-D demonstrating programming (CATIA) become utilized for planning and exam programming (ANSYS) come to be applied for CFD research.

The machine endured in the task is as in line with the following:

- Make a three-D model of the twofold line heat exchanger amassing making use of parametric programming CATIA.
- Convert the surface version into Para robust file and import the model into ANSYS to do exam.
- Perform CFD examination on the Plain cylinder version and loop embed field of the twofold line warmness exchanger at severa mass flow expenses and liquids delta to figure out the temperature, warmth go with the flow rate, pressure drop and depth pass coefficient.

3. MODELING AND ANALYSIS

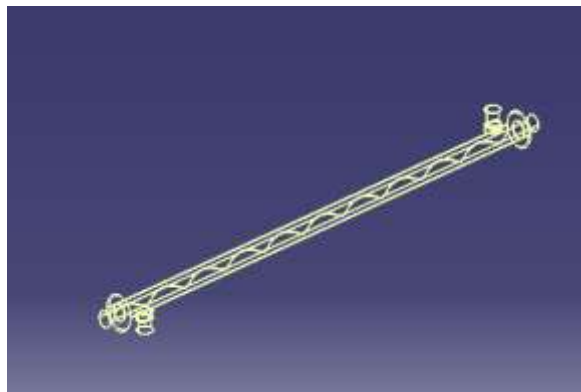
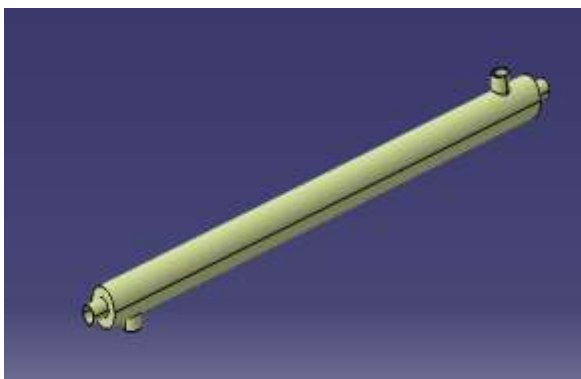


Figure: 2 simple tube concentric

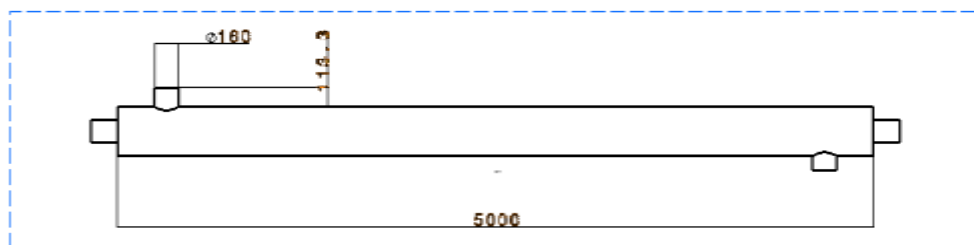


Figure: 3 Coil insert tube concentric

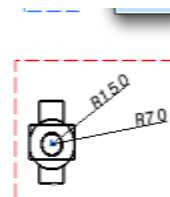


Figure 4: 2d drawing of concentric

- Density of Nano Fluid

$$\rho_{nf} = \phi \times \rho_s + [(1-\phi) \times \rho_w]$$

- Specific Heat Of nano Fluid

$$C_{p\,nf} = \frac{\phi \times \rho_s \times C_{ps} + (1-\phi)(\rho_w \times C_{pw})}{\phi \times \rho_s + (1-\phi) \times \rho_w}$$

- Viscosity Of Nano Fluid

$$\mu_{nf} = \mu_w (1 + 2.5\phi)$$

- Thermal Conductivity of Nano Fluid

$$K_{nf} = \frac{K_s + 2K_w + 2(K_s - K_w)(1 + \beta) \times \phi}{K_s + 2K_w - 2(K_s - K_w)(1 + \beta) \times \phi} \times K_w$$

Table :1 Nano Fluid Properties

FLUID	Volume fraction	Thermal conductivity (w/m-k)	Specific heat (J/kg-k)	Density (kg/m ³)	Viscosity (kg/m-s)
Silicon oxide	0.35	0.870	2121.459	1576.33	0.0018806
Silver		2.156	831.28	4323.83	0.0018806

calculations for outlet temperature, heat transfer and heat transfer coefficient

$$Q_c = M_c C_p (T_{co} - T_{ci})$$

$$T_{ho} = T_{hi} - \frac{Q_c}{M_c C_p}$$

For LMTD

$$\Delta T_1 = T_{hi} - T_{co}$$

$$\Delta T_2 = T_{ho} - T_{ci}$$

$$\Delta T_{lm} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}}$$

$$\text{Velocity} = U_c = \frac{M_c}{A_1}$$

$$\text{Reynolds number} = R_s = \frac{U_c D}{\mu_c}$$

$$\text{Friction factor} = f = (1.82 \ln R_s - 1.64)^{-2}$$

$$\text{Colburn factor} = j = \frac{f}{2}$$

$$\text{Prandtl number} = P_r = \frac{\mu_c C_p}{K_c}$$

$$\text{Heat transfer coefficient} = h_o = j * R_s * P_r^{2/3} * \frac{K_c}{D_s}$$

Pressure drop

$$\Delta p = f \frac{L}{D_e} \frac{\rho u_m^2}{2}$$

Nusselts number

$$Nu_b = \frac{((f/2))(Re_b) Pr_b}{1.07 + 12.7(f/2)^{1/2} (Pr_b^{2/3} - 1)}$$

Case: 1 Plain tube results

Fluid	Mass flow rate(kg/sec)	Pressure (Pa)	Temperature (k)	Heat transfer coefficient	Nusselts number	Heat transfer rate(w)
Water	0.32	3100	620	12800	3.20	6987.312
	0.52	3279	626	13050	0.8951	14528.15
	0.72	3425	628	14197	0.8233	38523.52
	0.92	3470	629	14350	0.231	49250.71
	1.12	3550	631	14520	0.0902	50105.240
Silicon oxide	0.32	2760	623	9582	0.695	1885.72
	0.52	2823	629	9856	0.705	40321.512
	0.72	3062	630	9952	0.697	28524.159
	0.92	3120	634	9980	0.0109	42367.00
	1.12	3260	635	10230	0.0084	44051.124
Silver nano fluid	0.32	784	627	10834	0.1784	8073.128
	0.52	833	630	11285	0.0324	10525.37
	0.72	852	632	12956	0.03	4937.317
	0.92	856	633	13147	0.0425	12453.102
	1.12	887	634	13420	0.0135	13237.130

FULID FLOW ANALYSIS OF CONCENTRIC HEAT EXCHANGER WITH COIL INSERT

Fluid- Silver Nano fluid Particles

At mass flow rate-1.12 kg/sec

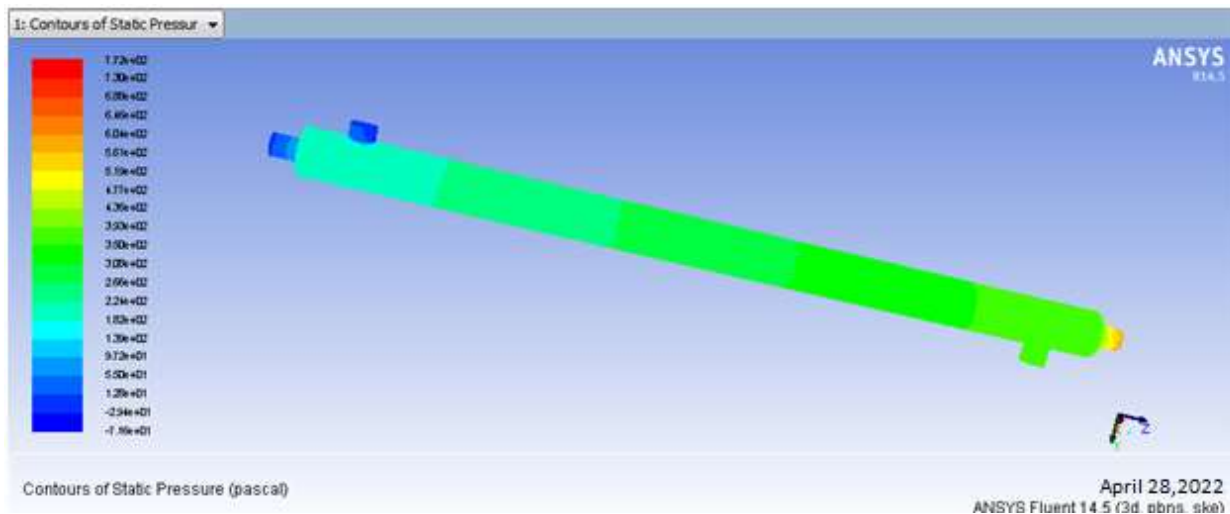


Figure: 5 pressureplot

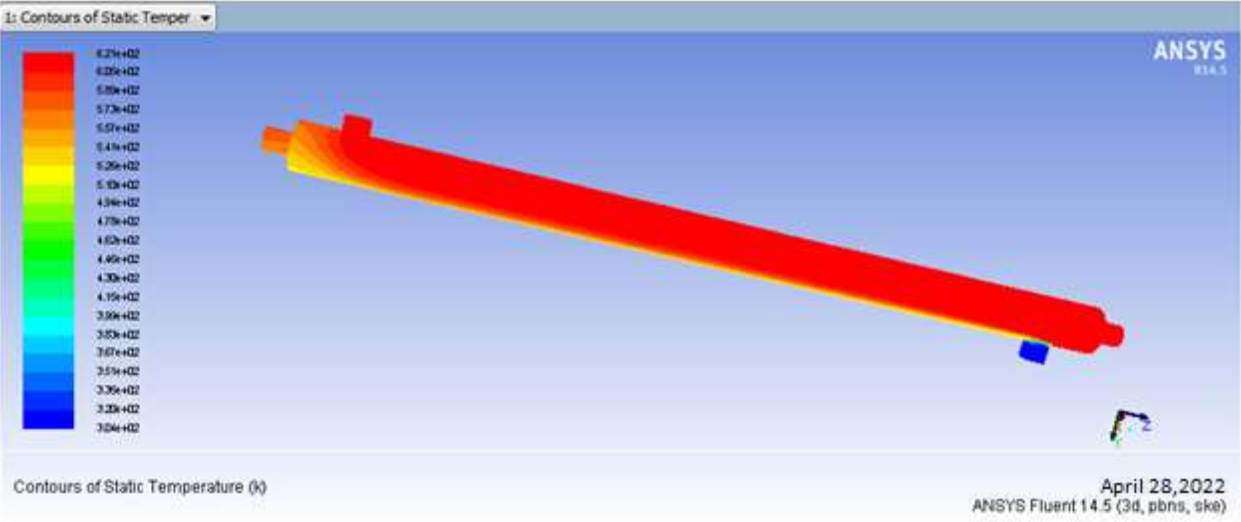


Figure: 6 Temperaturesplot

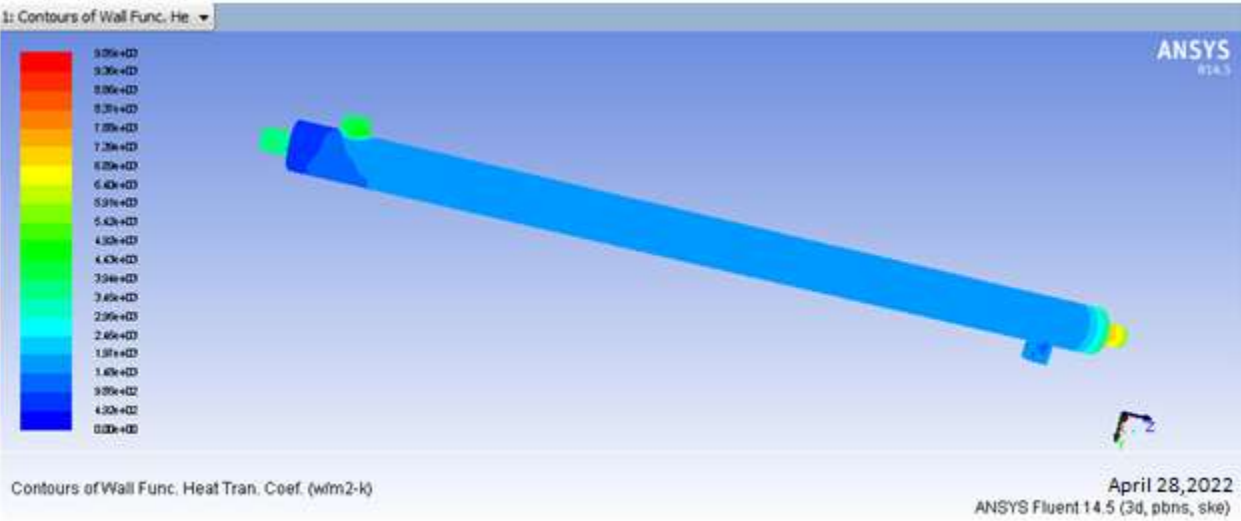


Figure: 7 Heat Transfer Coefficient

Heat TransferRate

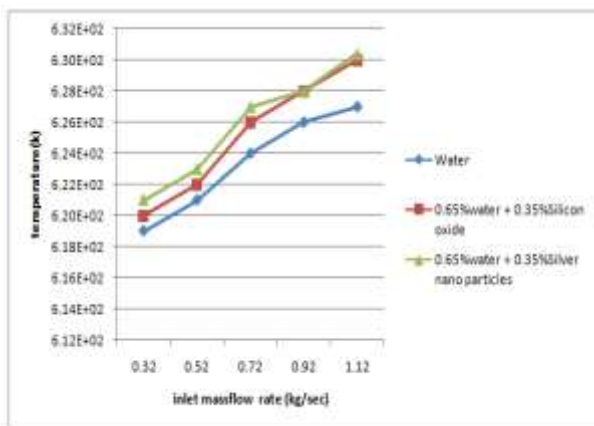
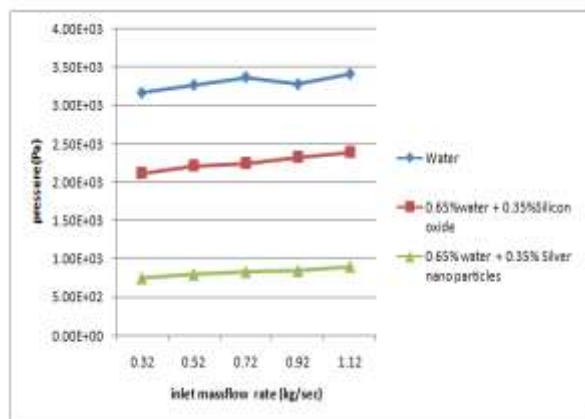
Total Heat Transfer Rate	(w)
cold_inlet	13825.847
cold_outlet	-891045.31
hot_inlet	1277008
hot_outlet	-391458.72
wall-____msbr	14.097899
Net	8343.9133

4. RESULTS AND DISCUSSIONS

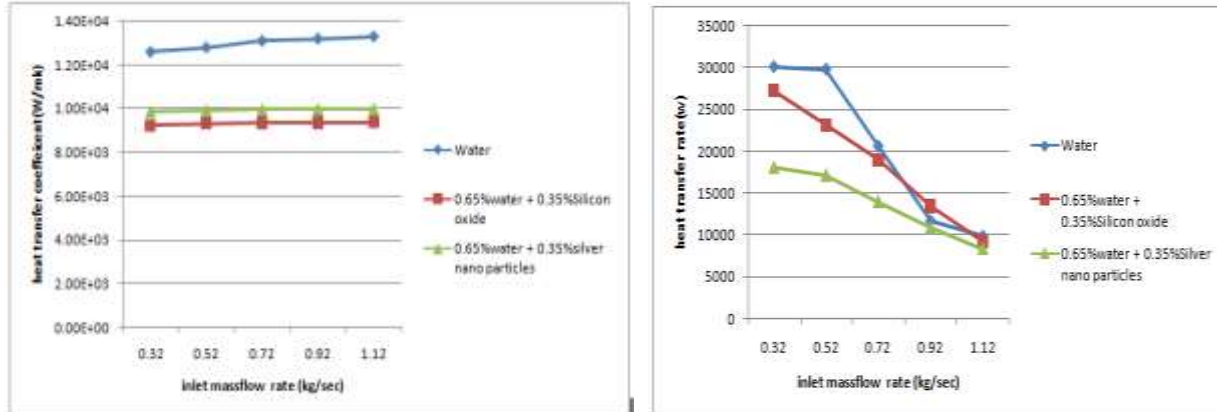
Case: 1 simple tube results

Fluid	Mass flow rate(kg/sec)	Pressure (Pa)	Temperature (k)	Heat transfer coefficient	Nusselts number	Heat transfer rate(w)
Water	0.32	3050	619	12600	3.14	6571.317
	0.52	3190	621	12800	0.8356	14323.19
	0.72	3220	624	13100	0.7971	34707.64
	0.92	3280	626	13200	0.06909	47533.67
	1.12	3410	627	13300	0.0067	49177.22
Silicon oxide	0.32	2160	620	9230	0.647	1628.619
	0.52	2260	622	9330	0.607	38304.764
	0.72	2330	626	9350	0.601	38921.784
	0.92	2390	628	9360	0.0049	41342.156
	1.12	2460	630	9370	0.0041	43653.122
Silver nano fluid	0.32	772	621	9850	0.1583	7372.043
	0.52	821	623	9910	0.0257	9180.522
	0.72	845	627	9940	0.0221	9339.838
	0.92	848	628	9960	0.0199	11341.132
	1.12	903	630.4	9970	0.0181	12145.112

Plain Tube Heat Exchanger Graphs



Graph1: : analytical effects of various fluids and mass drift costs Vs Pressure Graph 2: analytical outcomes of different fluids and mass flow costs Vs Temperature



Graph3: analytical consequences of diverse fluids and mass go with the flow costs Vs warmth transfer coefficient Graph 4: analytical results of various fluids and mass go with the flow expenses Vs heat switch charge

5. CONCLUSION

In this postulation, 3-d model of the twofold line warmth exchanger (undeniable and loop embed tube) is executed in CATIA parametric programming. CFD examination is completed right away pipe heat exchanger with water, silicon oxide and silver nano molecule at numerous mass move quotes like zero.32, 0.Fifty two, 0.Seventy two, 0.92 & 1.12 kg/sec. Except hypothetical estimations achieved pronto pipe warmth exchanger. Mathematical and insightful exercise has been accomplished for twofold line plain and curl tube heat exchanger utilising ANSYS FLUENT 15. The charts are plotted for temperature, strain warmth pass price and intensity flow coefficient for the water and nanofluids wherein move circumstance is taken as fierce. Following are the results of the above study; By noticing the CFD exam effects the temperature esteem more at loop embed tube water with silver nano molecule weight charge 0.35% when we contrasted with other calculation and liquids. So it tends to be completed up the silver nano molecule at weight fee 0.35% liquid is the better and math is twofold line loop embed tube heat exchanger.

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