

# Fluid Flow Analysis of Concentric Heat Exchanger with Different Nano Fluids and Mass Flow Rates

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**ABSTRACT-** In this article, the overall performance of water and other nano fluids mixed with base fluid water in a twin pipe warmth exchanger is investigated. At quantity fractions of 0.35 percentage, the nano fluids are Silicon Oxide and silver nano fluid. The traits of nano fluids are decided the usage of theoretical calculations, which can be then utilised as inputs for analysis. CATIA parametric software program is used to create a 3D model of the dual pipe heat exchanger (plain and coil insert tube). CFD research of a dual pipe warmth exchanger with water, silicon oxide, and silver nano particle at diverse mass float fees of zero.32, zero. Fifty two, 0.72, zero. Ninety two, and 1.12 kg/sec is performed. Theoretical calculations on the twin pipe warmth exchanger had been additionally finished.

**KEYWORDS-** CFD, NANO FLUID, CATIA,

## I. INTRODUCTION

Temperature may be characterised 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 remote 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.

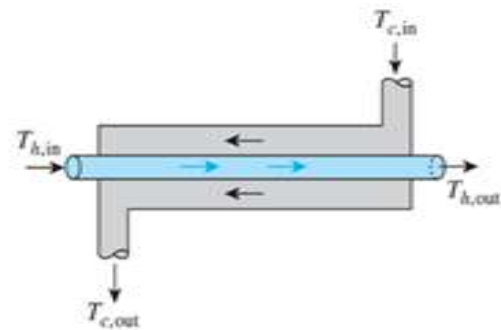


Figure 1: Double pipe exchanger diagram

## II. LITERATURE SURVEY

Han Xiaoxing et. Al [1] (2018) 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 warmth 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 m<sup>3</sup>/h, the cooling water temperature transformed into 30 ° C, the original warmth exchanger presented a higher intensity switch execution with most extreme warmth switch amount that is roughly 1600 W, and the normal warm opposition is zero.042 °C/W. N. Pro-am et. Al [2] (2018) researched the warm in general execution and liquid attributes of counter drift warmth 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] (2018) investigated the intensity exchanger powerfully. The overseeing way is presented through power dependability model yielding the framework and incomplete differential conditions. Multi variable, multi dimensional, 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 thermo hydraulic 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 thermo hydraulic 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-For chimer 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 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 1/3 or 1, with high Darcy range in twofold line warmness exchanger with permeable layer. Mohamad Omid et. Al [6] (2017) analyzed the improvement procedure of twofold line heat exchanger [7-20] and intensity switch upgrade strategies have likewise been generally examined. Additionally, various exploration with respect to the use of nano fluids 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.

### III. OBJECTIVE OF THE STUDY

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.

### IV. MODELING AND ANALYSIS

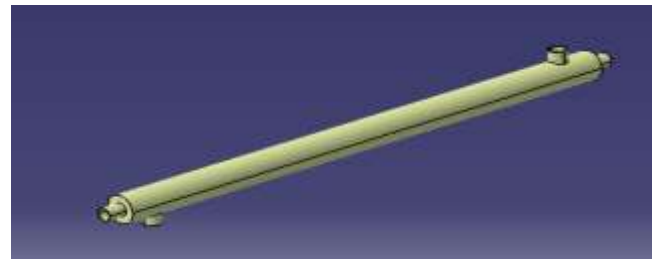


Figure 2: Simple tube concentric

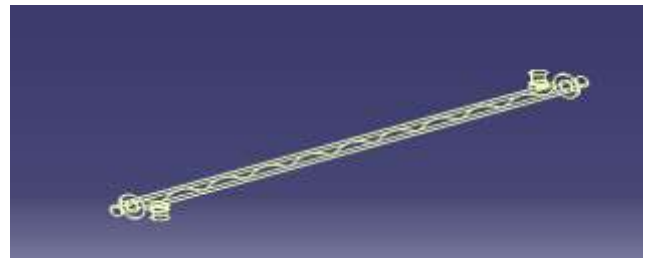


Figure 3: Coil insert tube concentric

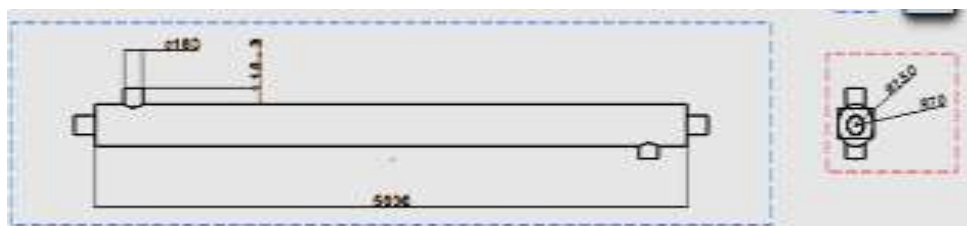


Figure 4: 2d drawing of concentric

• 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

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

Table 1: Nano Fluid Properties

FLUID	Volume fraction	Thermal conductivity (w/m-k)	Specific heat (J/kg-k)	Density (kg/m <sup>3</sup> )	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

A. 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

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

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

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

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

$$\text{Reynolds number} = Re_s = \frac{U_s D}{\mu_c}$$

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

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

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

$$\text{Heat transfer coefficient} = h_o = j * Re_s * Pr^{2/3} * \frac{K_c}{D_e}$$

Pressure Drop:

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

Nusselts Number:

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

Table 2: 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

Table 3: Coil insert tube results

Fluid	Mass flow rate(kg/sec)	Pressure (Pa)	Temperature (k)	Heat transfer coefficient	Nusselts number	Heat transfer rate(w)
Water	0.32	3198	621	13823	2.01	33246.64
	0.52	3370	626	13954	0.00897	45943.24
	0.72	3495	628	14200	0.0827	30374.65
	0.92	3570	630	14320	0.0739	18235.137
	1.12	3869	631	14560	0.0600	12647.207
Silicon oxide	0.32	2190	627	9733	0.176	28354.52
	0.52	2205	631	9820	0.0630	25736.10
	0.72	2300	632.2	9960	0.0706	19149.25
	0.92	2740	632.5	9990	0.062	15327.112
	1.12	2870	632.9	10230	0.0619	10214.071
Silver nano fluid	0.32	783	628.1	10023	0.0817	197073.04
	0.52	819	632	10943	0.0410	17324.25
	0.72	843	637	11085	0.00375	14239.83
	0.92	897	633	12373	0.00271	12736.001
	1.12	914	634	13124	0.00197	10365.501

**B. Fluid Flow Analysis of Concentric Heat Exchanger with Coil Inset**

Fluid- Silver Nano fluid Particles At mass flow rate-1.12 kg/sec

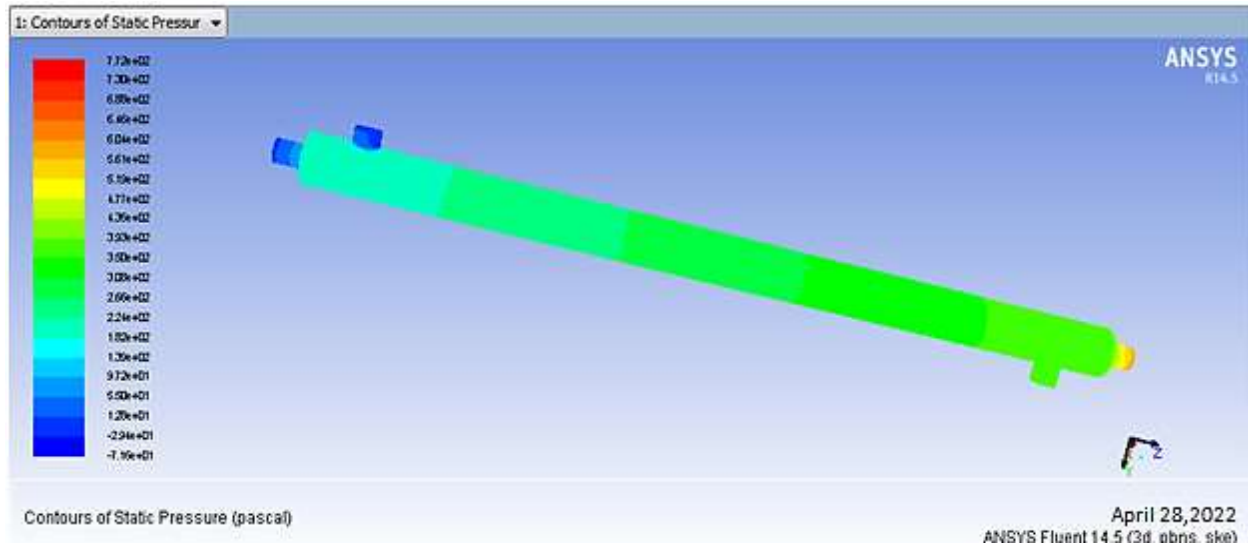


Figure 5: Pressure Plot

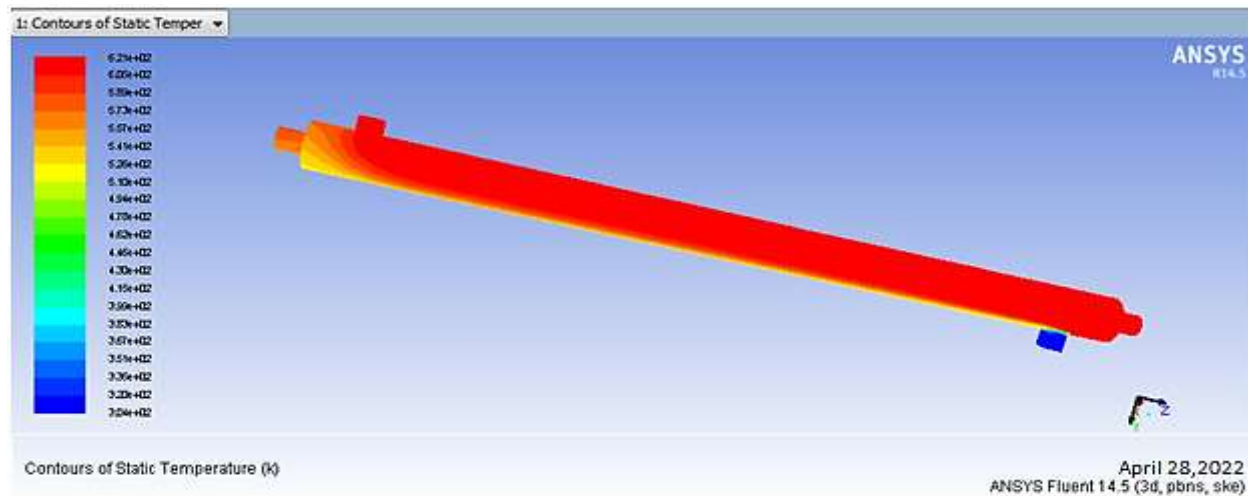
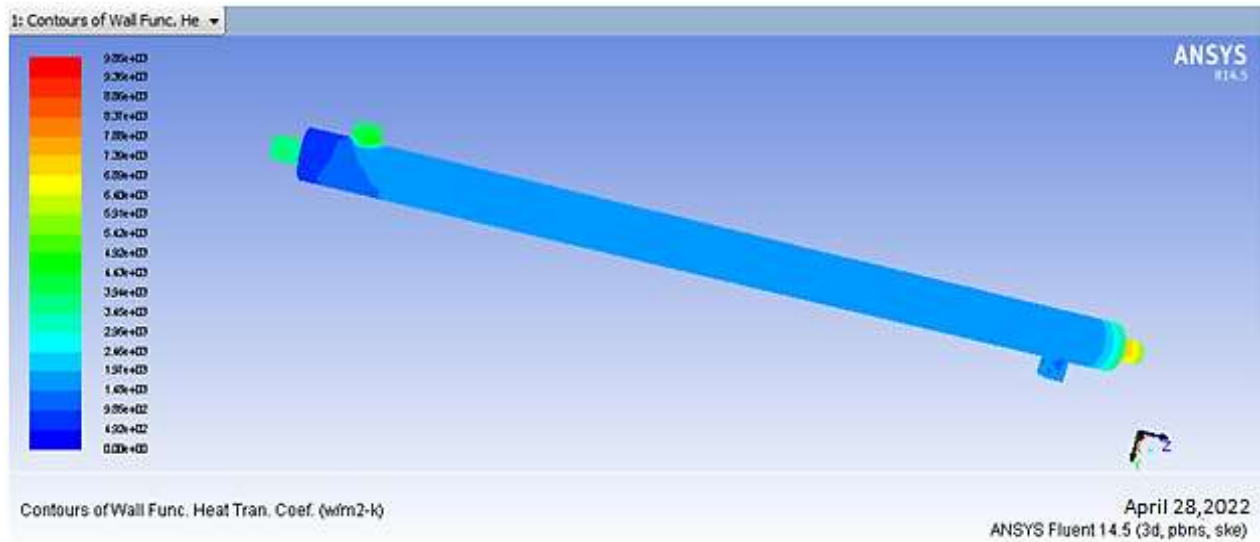


Figure 6: Temperaturesplot



C. Heat Transfer Rate

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

V. RESULTS AND DISCUSSIONS

As discussed in results the tube results in table 1, 2 and table 3 of different Fluid analysis like water, silicon oxide, silver nano fluid is in Table.4 and Table.5 discussed about coil interact about same fluids.

Table 4: Simple tube results

Fluid	Mass flow rate(kg/sec)	Pressure (Pa)	Temperature (k)	Heat transfer coefficient	Nusselts number	Heat transfer rate(w)
<b>Water</b>	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
<b>Silicon oxide</b>	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
<b>Silver nano fluid</b>	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

Table 5: Coil Insert tube results

Fluid	Mass flow rate(kg/sec)	Pressure (Pa)	Temperature (k)	Heat transfer coefficient	Nusselts number	Mass flow rate(kg/sec)	Heat transfer rate(w)
Water	0.32	3170	620	13000	1.88	0.01388	30131.955
	0.52	3270	622	13100	0.0763	0.01209	42844.258
	0.72	3370	625	13200	0.0732	0.00981	28641.531
	0.92	3430	629	13250	0.069	0.00671	11692.314
	1.12	3740	630	13300	0.061	0.00612	9867.12
Silicon oxide	0.32	2120	620.2	9330	0.0915	0.02098	27218.1072
	0.52	2210	623.1	9340	0.0568	0.02673	23148.104
	0.72	2250	625.3	9350	0.06068	0.012403	18991.374
	0.92	2390	627	9400	0.0494	0.01653	13457.23
	1.12	2410	629	9410	0.0471	0.01345	9256.125
Silver nano fluid	0.32	753	621	9870	0.07321	0.05791	18054.525
	0.52	802	623.2	9890	0.0268	0.01941	17097.976
	0.72	836	627	9930	0.0222	0.00541	13960.04
	0.92	883	627.3	9950	0.021	0.00215	10827.12
	1.12	892	628	9970	0.0192	0.00192	8343.12

The analysis effects of various fluids of pressure, temperature, and heat transfer with respect to cost is shown in figure.8, figure.9 and figure.10. Analytical results of various fluids and mass go with the flow expenses, flow expenses with respect to heat switch charge as shown in figure.10 and figure.11.

A. Plain Tube Heat Exchange Graphs

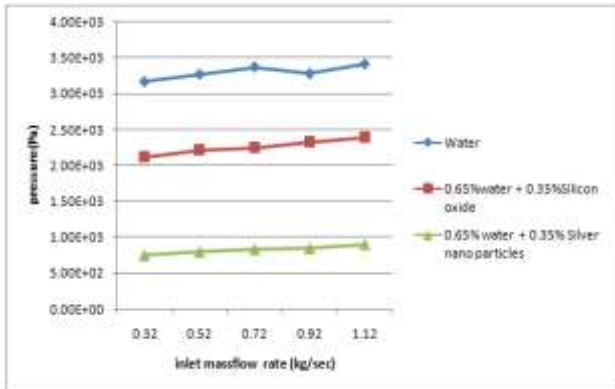


Figure 8: Analytical effects of various fluids and mass drift costs Vs Pressure

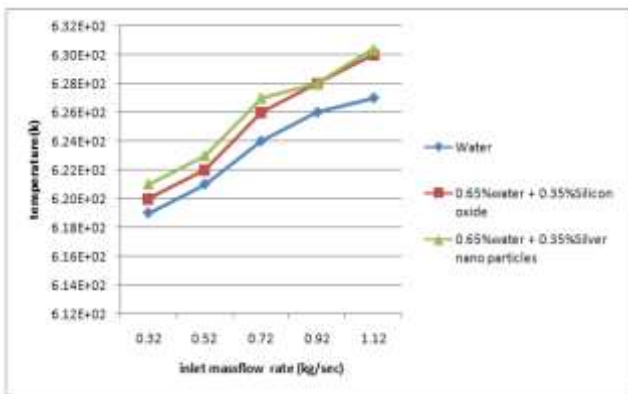


Figure 9: Analytical outcomes of different fluids and mass flow costs Vs Temperature

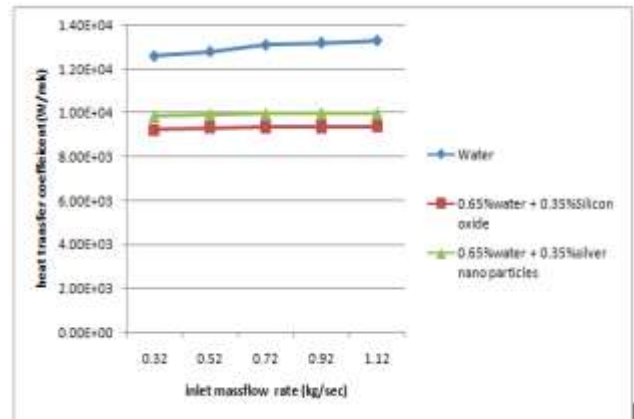


Figure 10: Analytical consequences of diverse fluids and mass go with the flow costs Vs heat transfer coefficient

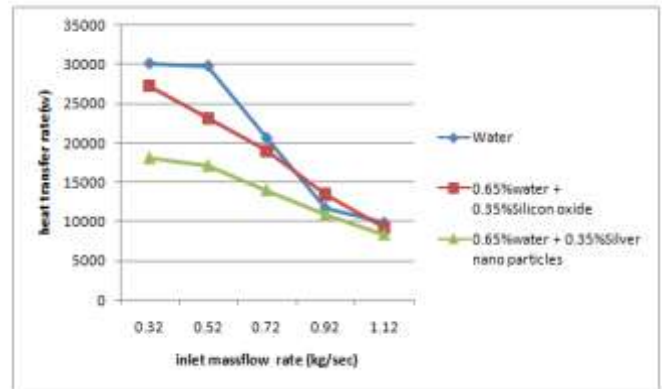


Figure 11: Analytical results of various fluids and mass go with the flow expenses Vs heat switch charge

Coil insert tube heat exchanger graphs of various fluids and mass of drift expenses Vs Pressure as shown in figure.12, prices Vs Temperature as shown in figure.13, charges Vs warmness switch coefficient as shown in figure.14, mass glide rates Vs heat transfer rate as shown in figure 15.

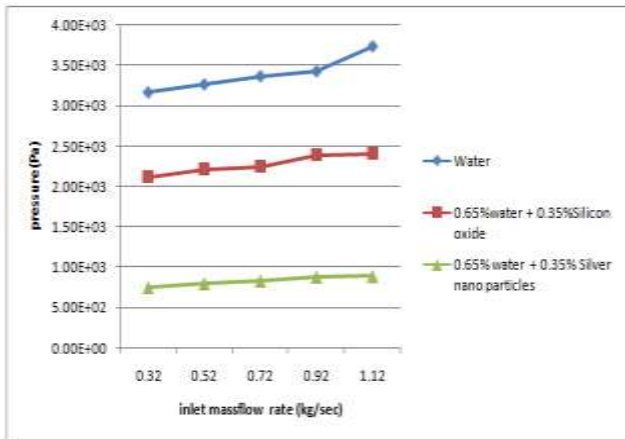


Figure 12: Analytical outcomes of various fluids and mass go with the drift expenses Vs Pressure

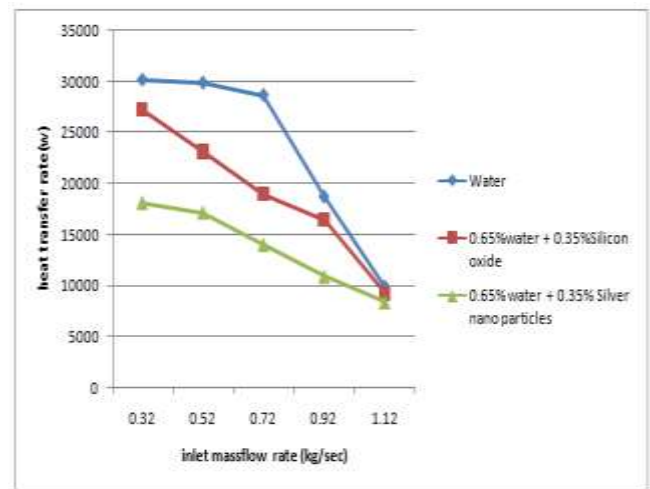


Figure 15: Analytical consequences of different fluids and mass glide rates Vs heat transfer rate

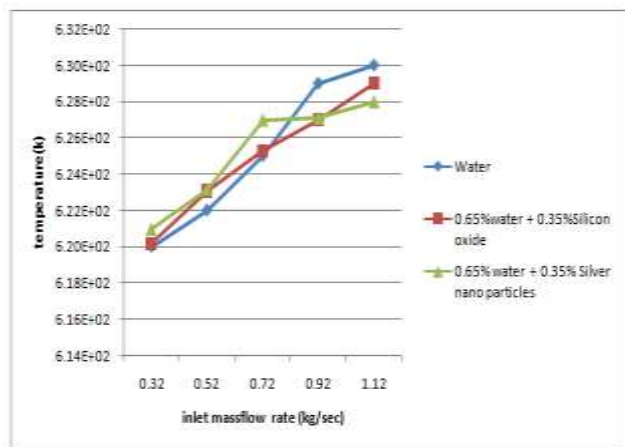


Figure 13: Analytical results of various fluids and mass glide prices Vs Temperature

The comparison graphs pressure values of theoretical and analytical and temperature values of theoretical and analytical is shown in figure.16 and figure 17.

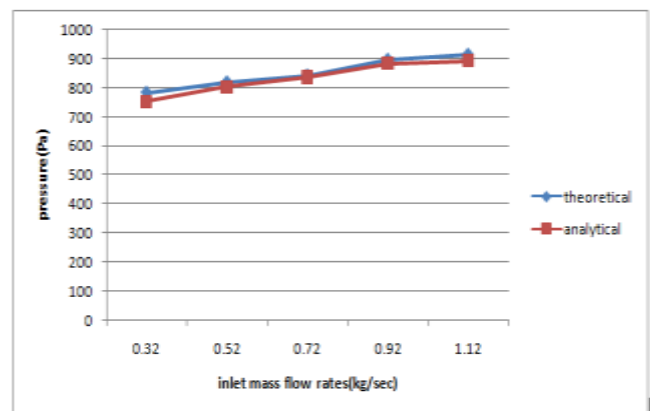


Figure: 16 Coil inserts tube at fluid is water zero.65% +silver 0.35% pressure values of theoretical and analytical

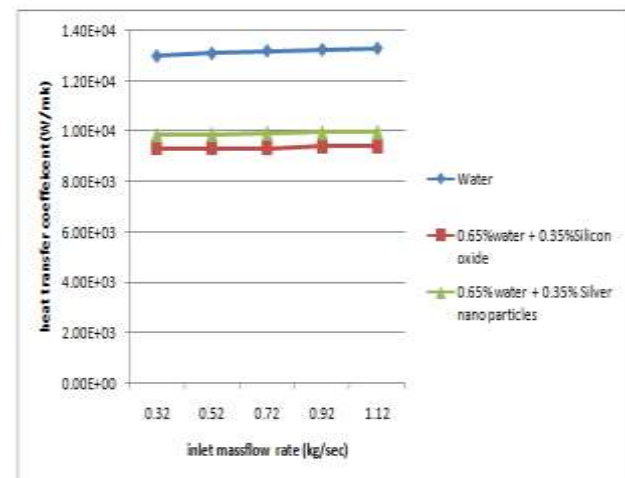


Figure 14: Analytical results of different fluids and mass waft charges Vs warmth switch coefficient

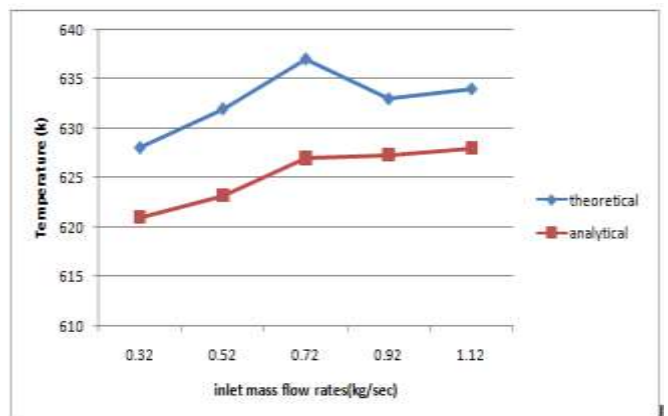


Figure 17: Coil inserts tube at fluid is water zero.Sixty five% +silver zero.35% temperature values of theoretical and analytical

## VI. 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 utilizing ANSYS FLUENT 15. The charts are plotted for temperature, strain warmth pass price and intensity flow coefficient for the water and nano fluids 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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