CFD ANALYSIS ON INCREASING THE PERFORMANCE OF HEAT EXCHANGER USING NANOPARTICLES

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Abstract – *This paper deals with the CFD analysis of Heat Exchanger pipe using nanoparticles to increase the performance of heat exchanger. Thermal systems like refrigerators and air conditioners consume large amount of electric power. So in direction of creating air conditioning and refrigeration system energy efficient with nature friendly refrigerants need to be investigated. The increasing advances in nanotechnology have given way to developing of upcoming generation heat transfer fluids called nanofluids. In this paper we are going to Model a heat exchanger pipe in catia and then we are going to perform analysis on the pipe both using cold and hot water with parallel and counter flow and then we are going to compare the result of analysis.*

Key Words: **CFD, Heat Exchanger, Nanofluids, Analysis, Catia.**

1. INTRODUCTION

As the fossil fuels use is increasing its results in decreasing and nuclear power energy is not out of harm's way. In the upcoming energy resource crisis there is requirement for creating thermal systems that are energy efficient. Thermal systems like refrigerators and air conditioners consume large amount of electric power. So in direction of creating air conditioning and refrigeration system energy efficient with nature friendly refrigerants need to be investigated. The increasing advances in nanotechnology have given way to developing of upcoming generation heat transfer fluids called nano fluids. Nanofluids are created by draping nanoparticles in conventional fluids of size (1-100nm). Nanofluids having following advanced characteristics when differentiated with normal solid liquid suspensions.

(i) Heat transfer is high between the Fluid and particles because of particle high surface area.

(ii) Better diffusion strength with most important Brownian motion

(iii) Reduces particle obstruction

(iv) Decreased pumping work as differentiated to base fluid to obtain correspondent a heat transfer.

2. DESIGN AND MODELLING OF HEAT EXCHANGER

Design data of heat exchanger pipe

Length of the pipe =1610 mm.

Inner tube:

Material – SS of inner diameter = 9.5 mm and outer diameter = 12.7 mm.

Outer tube

Material – GI of inner diameter = 28 mm and outer diameter = 33.8 mm.

Following figure shows Cad Model is prepared in catia.

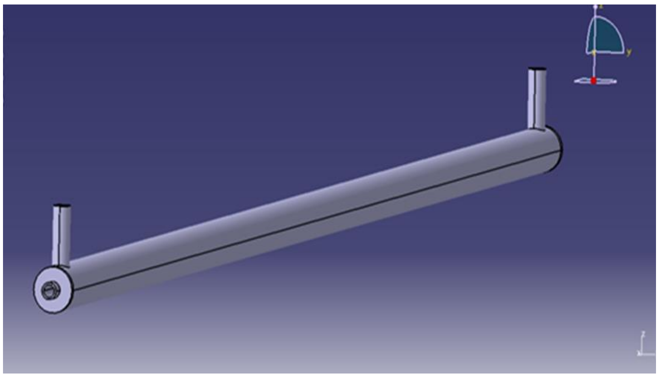

Figure -1: Isometric view of the cad model

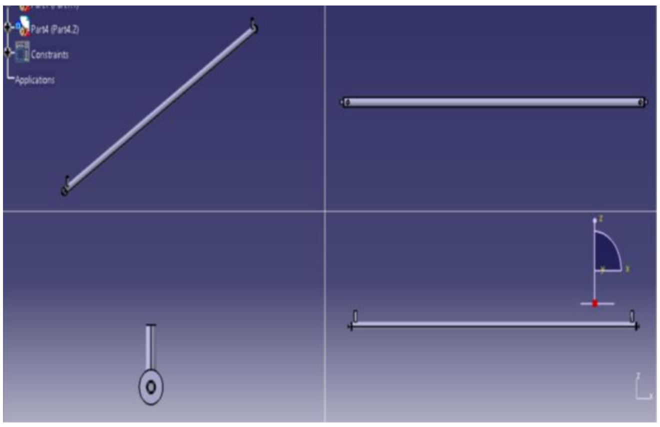

Figure -2: Different views of the same model

3. MESHING

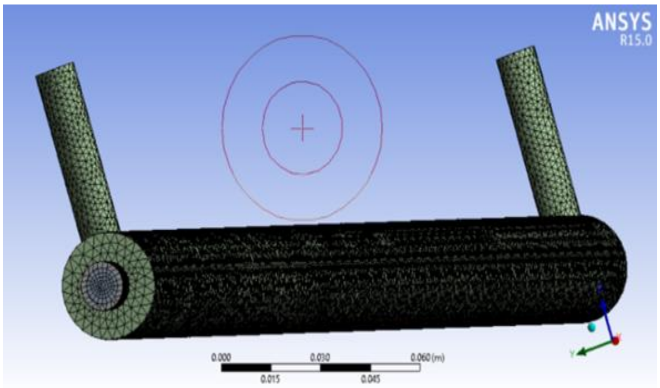

Figure -3: Isometric view of Pipe Meshing

Table No. 1 Meshing Report

Domain	Nodes	Elements
Cold-Fluid	84749	415496
Hot-Fluid	80012	70299
Tube	45800	25620
All Domains	210561	511415

3.1 BOUNDARY CONDITIONS

Table no. 2: Boundary Condition

Domain	Boundaries	
	Type	Condition
Cold Fluid	Cold Inlet	Mass Flow Inlet
	Cold Outlet	Outflow
	Interface -1 Target	Interface
	Wall Cold Fluid	Wall
Hot Fluid	Hot Inlet	Mass Flow Inlet
	Hot Outlet	Outflow
	Interface-2 src	Interface
Tube	Interface-1 src	Interface
	Interface-2 Target	Interface
	Wall Tube	Wall

3. ANALYSIS OF HEAT EXACHAGER PIPE

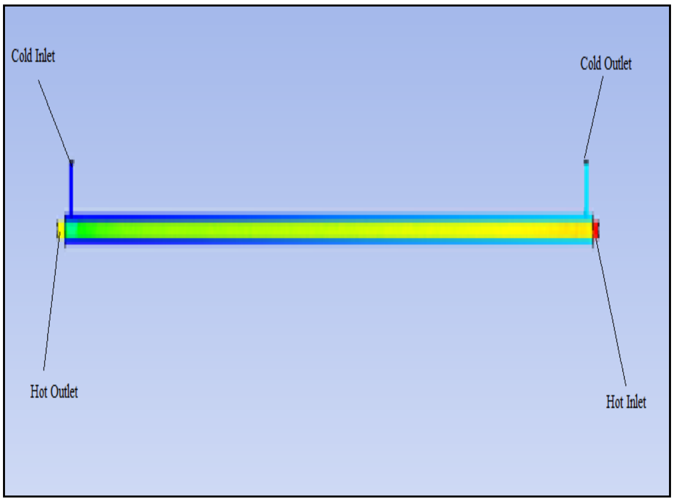

Figure 4: CFD Model Showing Inlet And Outlet

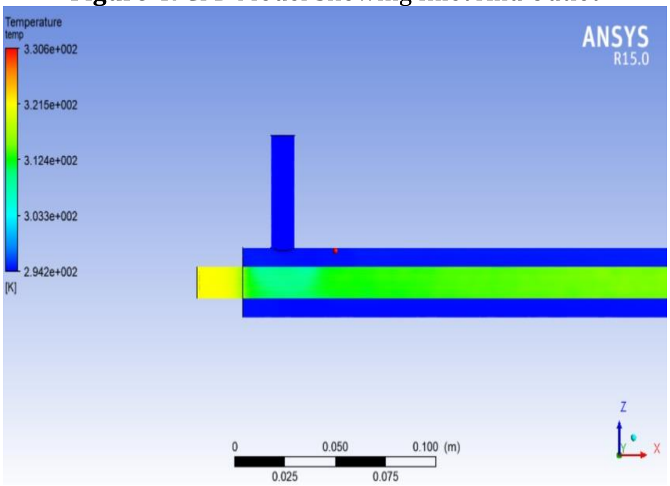

Figure 5: Cold water inlet hot water outlet

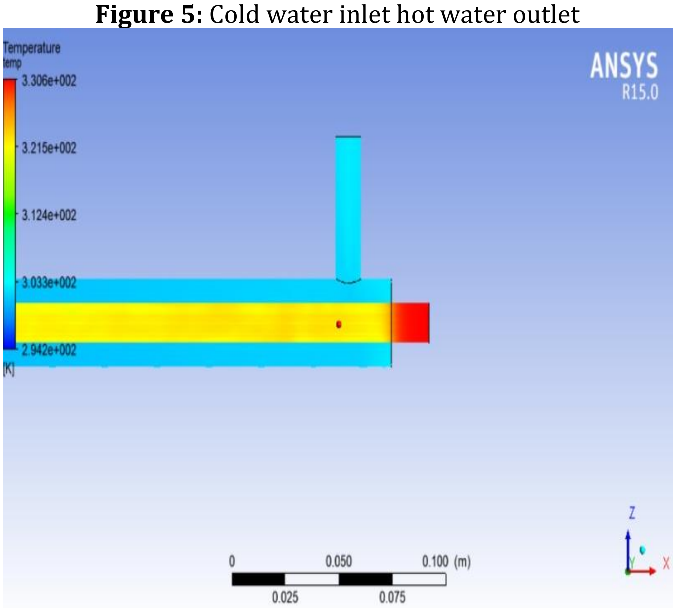

Figure 6: Hot water inlet cold water outlet

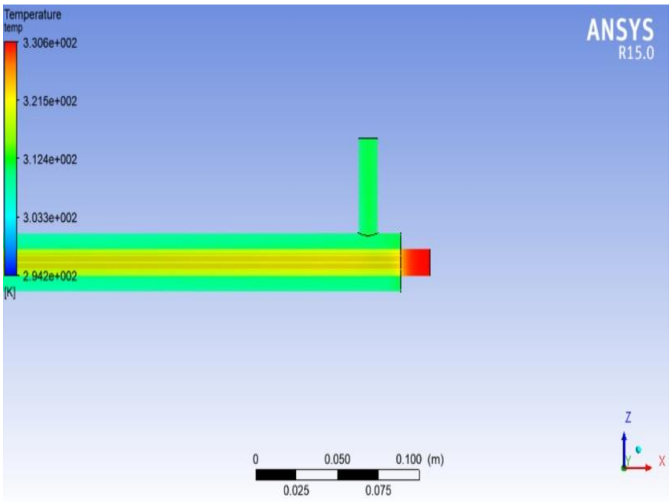

Figure 7: Hot water inlet nanofluid outlet (0.5)

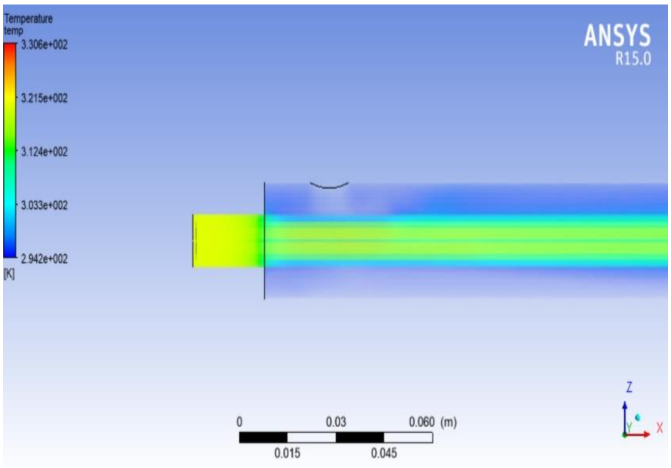

Figure 8: Nanofluid inlet hot water outlet (0.5)

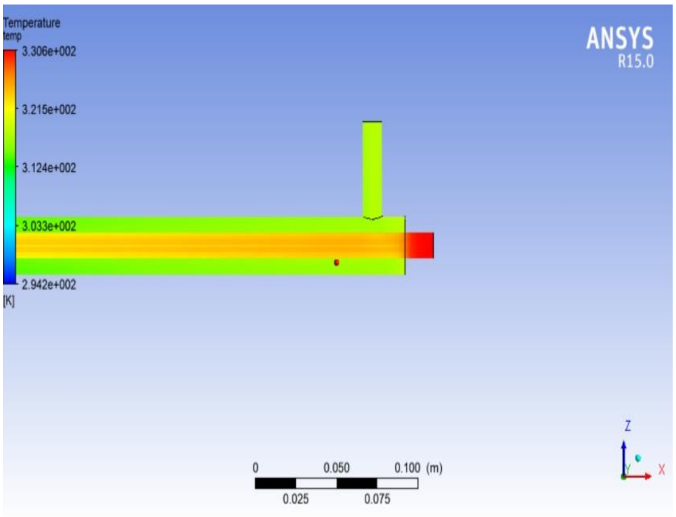

Figure 9: Hot water inlet nanofluid Outlet (0.7)

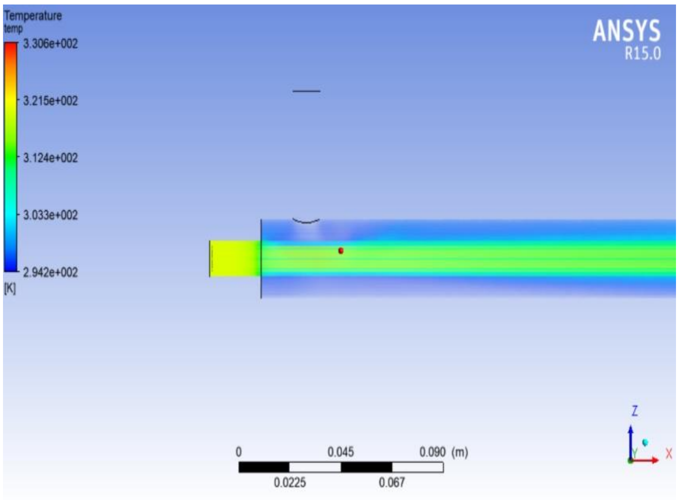

Figure 10: Nanofluid inlet hot water outlet (0.7)

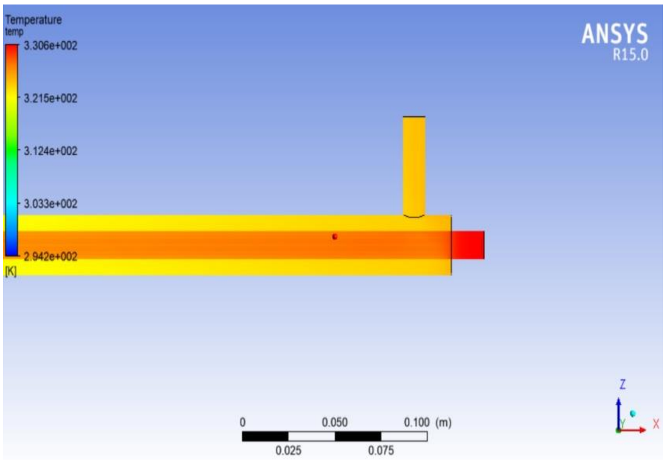

Figure 11: Hot water inlet nanofluid Outlet (0.9)

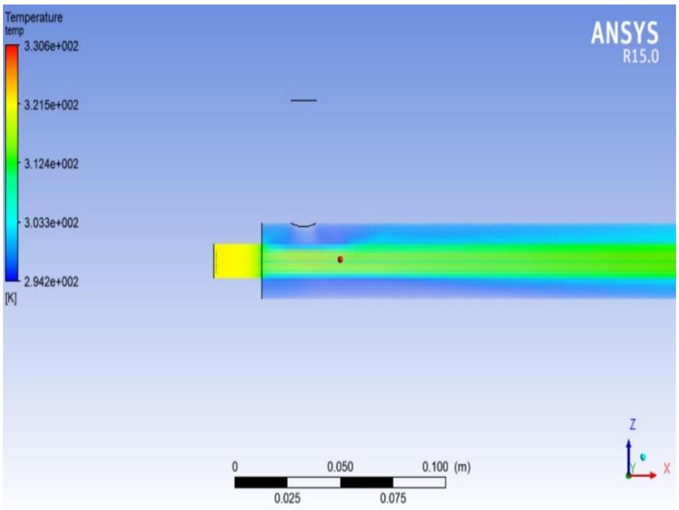

Figure 12: Nanofluid inlet hot water outlet (0.9)

3.2 RESULT

Table No. 3 Showing variation of heat transfer coefficient with mass flow rate for water and alumina at same volume fraction (0.5)

Mass flow rate (lpm)	Overall heat transfer coefficient of water (W/m²k)	Overall heat transfer coefficient of water- Alumina (W/m²k)
2	753.211	777.24
3	1010.35	1098.40
4	1092.21	1228.02
5	1145.25	1327.11

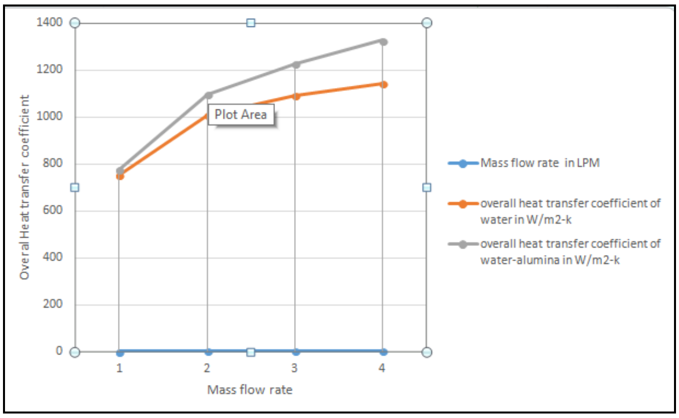

Figure 13: Showing variation of heat transfer coefficient with mass flow rate for water and alumina at same volume fraction (0.5)

Table 6.1.2 Showing variation of overall heat transfer coefficient vs Volume fraction for water and water-alumina as cold fluid at 2 lpm

Volume Fraction (Ø)	Heat flow rate (Q) in W	Overall heat transfer coefficient (U) in W/m2-k
0.1	1318.9	1083.48
0.2	1284.72	1116.6
0.3	1209.26	1105.53
0.4	1079.27	1027.65
0.5	833.08	777.24
0.6	781.31	830.89
0.7	620.58	706.56
0.8	460.95	583.88
0.9	310.51	458.07

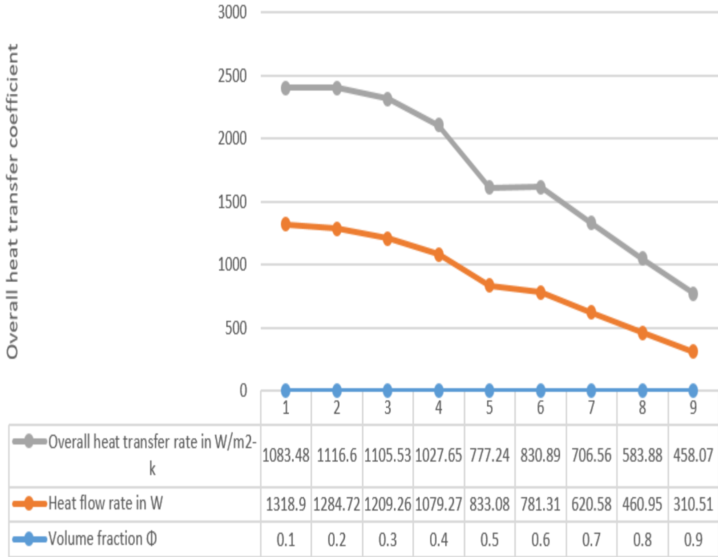

Figure 14: Showing variation of overall heat transfer coefficient vs Volume fraction for water and water-alumina as cold fluid at 2 lpm

4. CONCLUSION

From the above analysis we conclude that when we vary the volume fraction of the nano particles with the constant flow rate then the overall heat transfer coefficient increases up to certain point then it goes on decreasing, and incase if volume fraction of the nano particles is kept constant by varying the flow rate the overall heat transfer coefficient increases.

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