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## PERFORMANCE OF DOUBLE PIPE HEAT EXCHANGER WITH DIFFERENT NANO FLUIDS

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ABSTRACT A warmth exchanger is a gadget that is utilized to move nuclear power (enthalpy) between at least two fluids, between a strong surface and a fluid, or between strong particulates and a fluid, at various temperatures and in warm contact. Warmth exchangers are significant designing gadgets in many cycle businesses since the proficiency and economy of the interaction to a great extent rely upon the exhibition of the warmth exchangers.

The current work is coordinated towards the displaying of twofold line heat exchanger in strong works .CFD investigation is completed for twofold line heat exchanger utilizing water, TiO2 Nano and Al2o3fluids .The LMTD and warmth move coefficient is determined for the warmth exchangers. The stream directions to imagine the subsequent stream field .By noticing the outcomes the warmth move coefficient has been expanded 2.5 occasions by use Tio2 nano liquid in twofold line heat exchanger. By noticing the outcomes the warmth move coefficient has been expanded multiple times by use Al2o3 nano liquid in twofold line heat exchanger. From this we infer that the exhibition of the warmth exchanger will be better when Al2O3 nano liquid as the functioning liquid contrasted and the other two liquids. Keywords - CFD analysis double pipe heat exchange water with Ti02 and al03, Nano fluids, comparison.

## 1. INTRODUCTION TO HEAT EXCHANGERS

A warmth exchanger is a gadget that is utilized to move nuclear power (enthalpy) between at least two fluids, between a strong surface and a fluid, or between strong particulates and a fluid, at various temperatures and in warm contact. In heat exchangers, there are normally no outer warmth and work communications. Run of the mill applications include warming or cooling of a fluid stream of concern and vanishing or buildup of single-or multi part fluid streams. In different applications, the goal might be to recuperate or dismiss heat, or disinfect, sanitize, fractionate, distil, concentrate, take shape, or con-trol an interaction fluid. In a couple of warmth exchangers, the fluids trading heat are in direct contact. In most warmth exchangers, heat move between fluids happens through an

isolating divider or into and out of a divider in a transient way. In many warmth exchangers, the fluids are isolated by a warmth move surface, and in a perfect world they don't blend or break. Such exchangers are alluded to as immediate exchange type, or essentially recover. Normal instances of warmth exchangers are shell-and-cylinder exchangers, auto radiators, condensers, evaporators, air preheaters, and cooling towers. In the event that no stage change happens in any of the fluids in the exchanger, it is in some cases alluded to as a reasonable warmth exchanger. There could be inner nuclear power sources in the exchangers, for example, in electric radiators and atomic fuel components.



Fig.1.1: Simplified diagram showing the operation of double pipe exchangers

## 2. LITERATURE SURVEY

Traditional fluid are regularly coolants broadly utilized in heat exchangers to forestall overheating and to disseminate more warmth from heat move supplies like electronic gadgets, car radiators and so forth Anyway a convectional heat move liquid, for example, water or ethylene glycol by and large has helpless warm properties. Numerous test examines have been directed by specialists on fluids containing miniature metallic particles with high warm conductivity fully intent on working on the warm properties of the convectional heat move liquids. The utilization of micron estimated course particles in fluids produce sedimentation arrangement and disintegration of cylinder material and thus shed and subbed by substitute nanoparticles. Choi (1995) and his group created nanosized particles and got higher warm conductivity by



designing the molecule scattering in fluids. In this way the specialists like Masuda et al. (1993), Lee et al. (1999), Wang et al. (1999), Eastman et al. (1999, 2001), Das et al. (2003) for the most part focused on the assurance of compelling warm conductivity of Nano liquids. [1]

Past examinations on the convective warmth move improvement of Nano liquids have been accounted for as follows: Xuan and Li (2003) have first time introduced the experimental relationship for the assessment of Nusselt number in laminar and violent stream condition utilizing Cu Nano fluids[2]. Wen and Ding (2004) saw that Al2O3 nanoparticles when scattered in water can essentially improve the convective warmth move in the laminar stream system and the upgrade increments with Reynolds number, just as molecule focus contrasted with base liquid. Tests with Al2O3/water Nano liquid in the laminar stream scope of Reynolds number in the

#### 3. CAD MODELING IN SOLIDWORKS

#### **MODELLING OF DOUBLE PIPE EXCHANGER**

Modeling of double pipe heat exchanger is as follows:



Fig:3.2 Iso view of pipe1 of length 1200mm

















Fig:3.6 Iso view





Fig:3.7 Different views of pipe 2

## ASSEMBLY OF DOUBLE PIPE HEAT EXCHANGER









Fig: 3. Different views of Double pipe heat exchanger assembly

4. CFD ANALYSIS OF DOUBLE PIPE HEAT EXCHANGER USING WATER AS FLUID

4.1 CFD analysis is carried out for double pipe heat Exchanger using water as fluid.

Analysis type	Consider closed cavities	Navigator
<ol> <li>Internal</li> </ol>	Exclude cavities without flow conditions	Analysis tupe
🔘 External	Exclude internal space	
Physical Features	Value	- Fluids
Heat conduction in	solids	Solids
Radiation		
Time-dependent		Wall conditions
Gravity		
Rotation		Initial conditions
teference axis: X	Dependency	

## Fig:4.1 Internal analysis

By selecting Flow simulation module in solidworks and creating new project for Internal analysis as shown above.

	Path	<b>^</b>	New	Navigator
Methanol	Pre-Defined			
Nitrogen	Pre-Defined			Analysis type
Oxygen	Pre-Defined			Co. Eluido
Propane	Pre-Defined	-		Piulos
R123	Pre-Defined			Colida
R134a	Pre-Defined	=		Solids
R22	Pre-Defined			TTT ALCOLUMN
RC318	Pre-Defined			wair conditions
User Defined				Initial conditions
Tio2 NANO FLUID	User Defined	-	Add	Thida Condidons
Project Fluids	Default Fluid		Remove	
Water (Liquids)	~			
			nepiace	
	Value			
Flow Characteristic				
Flow Characteristic	Laminar and Turbulent	-		
Flow Characteristic Flow type Cavitation	Laminar and Turbulent	-		
Flow Characteristic Flow type Cavitation	Laminar and Turbulent	-		

Fig: 4.2 water as fluid

By selecting water as project fluid for analysis

Parameter	Value	Navigator
Default wall thermal condition	Adiabatic wall	Analysis type
Roughness	0 micrometer	
		Fluids
		Wall conditions
		Initial and ambient conditions
	Dependency	
OK Apply	Cancel Help	7



By selecting default wall and thermal conditions as shown above.

Seneral Settings	PPG-	8 ×
Parameter	Value	Navigator
Parameter Definition	User Defined	An alusia tuno
Thermodynamic Parameters		Analysis Ope
Pressure	101325 Pa	Co. Elvido
Temperature	293.2 K	- Huids
Velocity Parameters		Solida
Velocity in X direction	0 m/s	
Velocity in Y direction	0 m/s	TTT
Velocity in Z direction	0 m/s	wai conditions
Turbulence Parameters		Initial conditions
Solid Parameters		
	Dependency	

Fig: 4.4 default conditions

By selecting default thermodynamic parameters as pressure 101325 Pa & temperature 293.2K

#### SYSTEM INFO

Product	Flow Simulation 2016 SP2.0. Build: 3350
Computer name	SANDEEP-PC
User name	Mech wind
Processors	AMD Phenom(tm) II X2 560 Processor
Memory	4093 MB / 8388607 MB
Operating system	Windows 7 Service Pack 1 (Build 7601)
CAD version	SOLIDWORKS 2016 SP2.0
CPU speed	3300 (792) MHz

Model

pipe

Project name	CFD
Project path	C:\Users\sandeep\Desk top\
Units system	SI (m-kg-s)
Analysis type	Internal
Exclude cavities without flow conditions	On
Coordinate system	Global coordinate

	system
Reference axis	Z

#### **Information DATA**

Worldwide Mesh Settings

Programmed starting lattice: On

Result goal level: 3

Progressed thin channel refinement: Off

Refinement in strong district: Off

Math Resolution

Assessment of least hole size: Automatic

Assessment of least divider thickness: Automatic

**Computational Domain** 

## **Starting Conditions**

Thermodynamic parameters	StaticPressure: 101325.00 Pa
	Temperature: 293.20 K
Velocity parameters	Velocity vector
	Velocity in X direction: 0 m/s
	Velocity in Y direction: 0 m/s
	Velocity in Z direction: 0 m/s
Solid parameters	Default material: Copper
	Initial solid temperature: 293.20 K

## **BOUNDARY CONDITIONS** 4.4.1 COLD FLUID

Туре	Inlet Mass Flow
Faces	Face<1>@LID27-1
Coordinate system	Face Coordinate System



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Reference axis	Х
Flow parameters	Flow vectors direction: Normal to face
	Mass flow rate: 0.1500 kg/s
	Fully developed flow: No
	Inlet profile: 0
Thermodynamic parameters	Temperature: 278.00 K
Turbulence parameters	Boundary layer parameters

## **HOT WATER**

Туре	Inlet Mass Flow
Faces	Face<2>@LID34-1
Coordinate system	Face Coordinate System
Reference axis	Х
Flow parameters	Flow vectors direction: Normal to face
	Mass flow rate: 0.2000 kg/s
	Fully developed flow: No
	Inlet profile: 0
Thermodynamic parameters	Temperature: 323.15 K
Turbulence parameters	Boundary layer parameters

## **STATIC PRESSURE 2**

Туре	Static Pressure
Faces	Face<3>@LID33- 1Face<4>@LID21-1
Coordinate system	Global coordinate system
Reference axis	Х

Thermodynamic parameters	Static pressure: 303975.00 Pa
	Temperature: 293.20 K
Turbulence	Boundary layer
parameters	parameters

## **COLD FLUID INLET**





By selecting the lid of outer pipe for cold fluid inlet with inlet mass flow of 0.15kg/s

## HOT WATER INLET



Fig: 4.6 Hot water inlet THI

By selecting the lid of inner pipe for hot fluid inlet with inlet mass flow of 0.2kg/s

## **ENVIRONMENT PRESSURE AT OUTLETS**





By selecting the environment pressure for the outlet lids.

#### **RESULTS:**

#### **TRAJECTORIES OF COLD AND HOT**



Fig:4.8 Flow Trajectories of cold and hot fluid

Flow trajectories of cold and hot fluid are shown as above. The heat lost by hot fluid is to be 318k from 323k . The heat gain by cold fluid is 288.15k from 278.15k.

#### **TRAJECTORIES OF COLD FLUID**



Fig: 4.9 Flow Trajectories of cold fluid

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The heat gain by cold fluid is 288.15k from 278.15k.

#### **TRAJECTORIES OF HOT FLUID**

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Fig:4.10 Flow Trajectories of hot fluid

The heat lost by hot fluid is to be 318k from 323k.

## CFD ANALYSIS OF DOUBLE PIPE HEAT EXCHANGER USING Tio2 NANO FLUID

	tems tem Properties Tables and Curves		
Cities	Property	Value	
Contact Electrical Resistan	Name	Tip2 NANO FLUID	
Contact Thermal Resistanc	Comments		
Custom - Visualization Para	Densky	1203 kg/m*3	
ans an Chita	Dynamic viscosity	0.000807154875 Pa*a	1
Sinks	Specific heat (Cp)	41040 J/(kg*K)	
	Thermal conductivity	0.638 W/(m*K)	
essible Liquids	Cavitation effect		
inted Circuit Boards adiation Spectra adiative Surfaces hermoelectric Coolers recers wo-Resistor Components			

Fig: 4.11 Tio2 nano fluid properties

By applying same boundary conditions as above just changing project fluid as Tio2 nano fluid the results are as follows:

## **Tio2 NANO TRAJECTORIES OF HOT AND COLD FLUID**



Fig:4.12 Flow Trajectories of hot and cold fluid

Flow trajectories of cold and hot fluid are shown as above. The heat lost by hot fluid is to be 309.15k from 323k. The heat gain by cold fluid is 295.15k from 278.15k.

## **Tio2 NANO TRAJECTORIES OF COLD FLUID**



Fig:4.13 Flow Trajectories of cold fluid

The heat gain by cold fluid is 295.15k from 278.15k.

Tio2 NANO Trajectories of Hot Fluid



Fig:4.15 Flow Trajectories of hot fluid

The heat lost by hot fluid is to be 309.15k from 323k.

# CFD ANALYSIS OF DOUBLE PIPE HEAT EXCHANGER USING A1203 NANO FLUID

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stabase tree:	tems tem Properties Tables and Curves					
E Cities	Property	Value				
Contact Electrical Resistant	Name	AL203 NANO FLUD				
Contact Thermal Resistanc	Comments		(			
Q Custom - Visualization Para	Density	1203 kplm*3	(			
😪 Fans	Dynamic viscosity	0.000807154875 Pa*s	(			
🚰 Heat Sinks	Specific heat (Cp)	41040 J/(kg*K)				
Materials	Thermal conductivity	0.638 W/(m*K)				
- O Compressible Liquids	Cavitation effect	[7]				
🛞 🛶 Gases	Radiation properties	F1				
A Steam     Perovated Plates     Porous Media     Printed Circuit Boards     Radiative Surfaces     Thermoelectric Coolers     Thermoelectric Coolers						
Two-Resistor Components						

Fig:4.16 Al2o3 nano fluid properties

By applying same boundary conditions as above just changing project fluid as Al2o3 nano fluid the results are as follows:

## Al2O3 NANO TRAJECTORIES OF HOT AND COLD FLUID



Fig: 4.17 Flow Trajectories of hot and cold fluid

Flow trajectories of cold and hot fluid are shown as above. The heat lost by hot fluid is to be 306.15k from 323k. The heat gain by cold fluid is 298.15k from 278.15k.

## Al2O3 NANO TRAJECTORIES OF COLD FLUID

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Fig: 4.18 Flow Trajectories of cold fluid

The heat gain by cold fluid is 298.15k from 278.15k.

## AI2O3 NANO TRAJECTORIES OF HOT FLUID



Fig: 4.19 Flow Trajectories of hot fluid

<b>RESULTS AND</b>	DISCUSSION	FOR	DOUBLE	PIPE	HEAT
EXCHANGER					

S. N O	TH I	TH O	TCI	TC O	LMT D(K)	QAV( KW)	H(W/ M2K)	FL UI D
	323	318	278	288				Wa
1	.15	.15	.15	.15	37.4	5.23	59.85	ter
								Tio
								2
	323	309	278	295	29.4		151.7	na
2	.15	.15	.15	.15	7	11.18	4	no
								Al2
								о3
	323	306	278	298			234.6	Na
3	.15	.15	.15	.15	26.4	15.49	9	no

By observing the above results the heat transfer coefficient has been increased 2.5 times by TiO2 nano fluid and almost 4 times by use Al2o3 nano fluid in double pipe heat exchanger.

# SAMPLE CALCULATION FOR DOUBLE PIPE HEAT EXCHNAGER:

Thi= 323.15k

Tho= 318.15k

Qh= mxcx(Thi-Tho)= 0.2x4.187x5=4.187kw

A=SURFACE AREA=DxL=0.0025X1=0.0025m2

Tci=278.15k

Tco=288.15k

Qc= mxcx(Tco-Tci)= 0.2x4.187x10=6.28kw

Qavg=(Qh+Qc)/2=5.23kw

ΔT1=Tho-Tci=318.15-278.15=40k

ΔT2=Thi-Tco=323.15-288.15=35k

LMTD=( $\Delta$ T1- $\Delta$ T2)/ln( $\Delta$ T1/ $\Delta$ T2)=37.4k

Heat tramsfer coefficient,h= Qav/(AxLMTD)= 59.8 w/m2k

#### Graph: 1



#### Graph: 2



## **5. CONCLUSIONS**

Warmth move liquids like water, mineral oils and ethylene glycol assume a significant part in numerous mechanical areas including power age, substance creation, cooling, transportation and microelectronics. The presentation of these ordinary warmth move liquids is frequently restricted by their low warm conductivities. Driven by mechanical necessities of cycle heightening and gadget scaling down, advancement of elite warmth move liquids has been a subject of various examinations lately.

The current work is coordinated towards the displaying of twofold line heat exchanger in strong works .CFD examination is done for twofold line heat exchanger utilizing water, Ti02 Nano and Al2o3fluids .The LMTD and warmth move coefficient is determined for the warmth exchangers. The stream Trajectories to picture the subsequent stream field.

By noticing the outcomes the warmth move coefficient has been expanded 2.5 occasions by use Tio2 nano liquid in twofold line heat exchanger.

By noticing the outcomes the warmth move coefficient has been expanded multiple times by use Al2o3 nano liquid in twofold line heat exchanger.

From this we infer that the presentation of the warmth exchanger will be better when Al2O3 nano liquid as the functioning liquid contrasted and the other two liquids.

#### REFERENCES

- [1] Choi, S.U.S., 1995. Improving warm conductivity of liquid with nanoparticles. In: Siginer, D.A., Wang, H.P. (Eds.), Developments and Applications of Non-Newtonian Flows, FED-V.231/MD-V.66. ASME, New York, 99–105.
- [2] Das, S.K, Putra, N., Thiesen, P., Roetzel, W., 2003. Temperature reliance of warm conductivity improvement for nanofluids, Journal of Heat Transfer, 125, 567 – 574.
- [3] Eastman, J.A., Choi, S.U.S., Li, S., Soyez, G., Thompson, L.J., DiMelfi, R.J., 1999. Novel warm properties of nanostructured materials, Journal of Metastable Nanocrystal Materials, 2(6), 629 – 634.
- [4] Eastman, J.A., Choi, S.U.S., Li, S., Yu, W., Thompson, L.J., 2001. Atypically increment powerful warm conductivities of ethylene glycol-based nanofluids containing copper nanoparticles, Applied Physics Letter, 78(6), 718 – 720.
- [5] Einstein, 1956, "Examination on the hypothesis of Brownian development dover", New York.
- [6] Eiamsa-ard, S., Promvonge, P., 2007. Warmth move attributes in a cylinder fitted with helical screw-tape with/without center bar embeds, International Communications in Heat and Mass Transfer, 34, 176-185.
- [7] Gnielinski, V., 1976. New conditions for warmth and mass exchange in violent line and channel stream, International Chemical Engineering, Vol. 16, pp. 359-368.
- [8] Hamilton. R.L., and Crosser.O.K, 1962, Thermal conductivity of heterogeneous two-part frameworks, Ind. Eng. Chem. Fundam., Vol.1 pp. 187-191.
- [9] Heris, S.Z., Esfahany, M.N.Etemad, S.Gh, 2007. Exploratory examination of convective warmth move of Al2O3/water nanofluid in round tube, International Journal of Heat and Fluid Flow. 28, 203-210.
- [10] Lee. S., Choi, S.U.S., Li, S., Eastman, J.A., 1999. Estimating warm conductivity of liquids containing oxide nanoparticles, Journal of warmth move, 121, 208-289.
- [11] Maiga, S.E.B., Palm, S.J., Nguyen, C.T., Roy,
   G., Galamis, N., 2005. Warmth move improvement by utilizing nanofluids in constrained show



streams. Worldwide Journal of Heat and Fluid Flow, 26, 530 – 546. Masuda, H., Ebata, A., Teramae, K., Hishinuma, N., 1993, Altration of warm conductivity and thickness of fluid by scattering super fine particles (scattering of  $\gamma$ -Al2O3, SiO2 and TiO2 super fine particles). Netsu Bussei (in Japanese) 4(4), 227 – 233.