ISSN: 2454-9940

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

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INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

ISSN2454-9940www.ijsem.in

Vol 10, Issuse.2 April 2022

CFDANALYSISOFHAIRPINHEATEXCHANGERWITHDIFFE RENTNANOFLUID

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Abstract:
The term "heat exchanger" refers to a device that is used to move heat from one fluid to another. Alternatively, the fluids may be separated by a solid wall to prevent mixing.The combined qualities of glycerin (40 percent) and water (60 percent) are studied in this study. There are 0.1 percent titanium carbide, 0.3 percent magnesium oxide, 0.5 percent silver nano particle and 0.8 percent silver nano particles in the nano fluid. The properties of nano fluids are determined using theoretical calculations, and those qualities are employed as inputs in the study of the fluids. A single tube (Double Pipe) or several tubes within a hairpin shell (Multitude) are available, as are bare tubes, finned tubes, U-tubes, straight tubes (with rod-thru capability), fixed tube sheets, and removable bundle. CATIA parametric software was used to create a 3D model of the hair pin heat exchanger. It is determined that varied weight percentages of TiC, MgO, and silver nanoparticles, each at a percentage of 0, 1, 3, and 8, are effective in the hair pin heat exchanger under study.

Keywords: Analysis of the hair pin heat exchanger, CFD of the heat exchanger, and thermal analysis.

I. INTRODUCTION

One of the most common pieces of equipment in the manufacturing sector is the heat exchanger. Process streams can beheated by using heat exchangers. A heat exchanger is necessary for any process that requires cooling, heating, condensation, boiling, or evaporation. Prior to the process, the fluids are either heated or cooled, or experience a phase shift. The use of a heat exchanger determines its name. For example, heat exchangers being used to condense is known as condensers, similarly heat exchanger for boiling purposes are called boilers. The quantity of heat transferred while using the least amount of surface area and the pressure drop are the two metrics used to evaluate the efficiency and performance of heat exchangers. Calculating the overall heat transfer coefficient improves the clarity of its efficiency.It is possible to estimate a heat exchanger's startup and operating costs by measuring the pressure drop and surface area required to transfer a specific amount of heat

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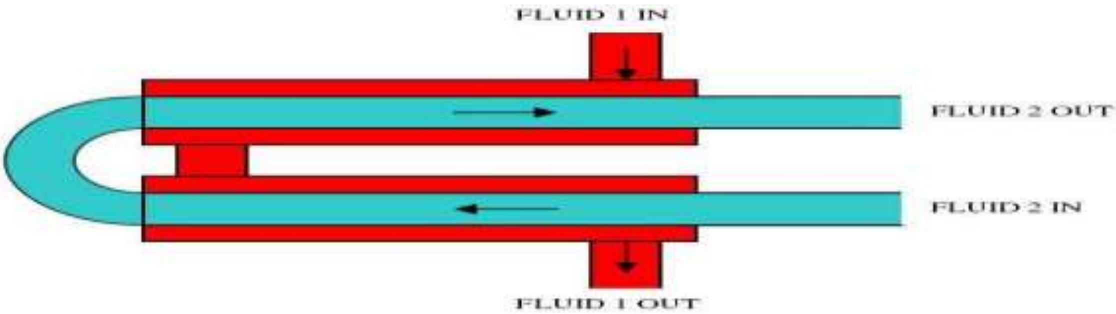


(Running cost). In most cases, a heat exchanger can be designed using a variety of existing ideas and literature.

II. LITERATUREREVIEW

Theodore Kumar (2015) A double-tube hair-pin heat exchanger was used to study how various concentrations of ethylene glycol mixed with water improved heat transfer in both laminar and turbulent flow. Ethylene glycol and water heat transfer coefficients rise with Re number and ethylene glycol concentration, according to results. [1]

Water was used as the working fluid in both pipes in an experiment conducted by KaderiDeepika (2015) on a double pipe heat exchanger. The tubes were made of galvanized pipe and copper pipe. This overall heat transfer coefficient is used to compute and compare the heat transfer in parallel and counterflows, respectively. In the end, it was determined that heat transfer in the counter flow direction was superior to that in the parallel flow direction. [2]

W H Azmi et al (2011) demonstrated that the values obtained from the non linear regression equations used to predict the density, specific heat, thermal conductivity, and viscosity are the same regardless of the particle sizes of Al_2O_3, TiO_2, and ZnO.

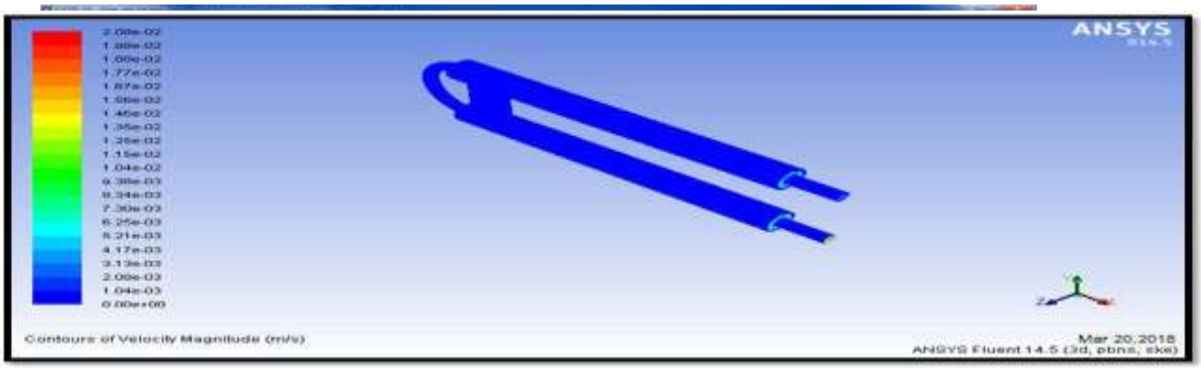
DESIGNANDANAYSISOFHAIRPINHEATEXCHANGERUSINGCOMPUTATIONALMETHOD

The role it plays in a process is what gives a piece of heat transfer equipment its name. Another piece of equipment utilized in industrial processes is the heat exchanger, which is employed in the transition between two process fluids in order to recover heat. Heating, cooling, refrigeration, and air conditioning are some of the most common applications for these devices. They are also utilized in power plants, chemical plants, petroleum refineries, and natural gas processing facilities. The entire cost of running a facility is heavily influenced by the efficiency of heat exchangers like these. As a result, heat exchangers are being developed that are compact, efficient, and cost-effective. Heat extraction and heating are two of the most common issues faced by industries, and this is a common concern. Because of this, the purpose of this research is to examine refinery processes and apply heat transfer phenomena to a two-pipe heat exchanger.

Dimensions ofdesigned double tubeHair-pin heat
exchanger:OuterpipespecificationInnertubespecification
U-shaped copper tube
Diameter of shell: 19.05 millimeters
Its diameter is 8.4 mm. U-shaped copper tubing
The shell's I.D. is 19.05 mm.
Tube OD is 8.4 millimeters.
The diameter of the shell is 22 mm. The diameter of the tube is 9.5 mm. Distance from center to center is measured.
(0.55 mm) wall thickness
1.5 to 1.8 times the diameter of the shell's outer diameter. Heat loss through the wall at the temperature of 385 w/m2K Each G.I. pipe is 22.86 centimeters long.
45cm is the maximum practical length of a copper tube for heat transmission. A copper tube's total length, including the straight portion, is equal to its total length.

In this case, the total length is 60cm (51cm x 9cm).

3Dmodelofhairpinheatexchanger



INTRODUCTIONTOCFD

Computationalfluiddynamics,usuallyabbreviatedasCFD,isabranchoffluidmechanicsthatusesnumericalmethodsandalgorithmstosolveandanalyzeproblemsthatinvolvefluidflows.

CALCULATIONSTODETERMINEPROPERTIESOFNANOFLUIDBYCHANGINGVOLUMEFRACTIONS

NANOFLUID CALCULATIONSNOMENCLATURE

nf = Nanofluid Density (Kg/m3)

s = Mass per unit volume of solid material

Density of water in kilograms per cubic meter is the volume fraction.

A fluid material's specific heat (in joules/kg-k) is known as Cpw. Cps = Solid material specific heat (j/kg-k) w = Water's viscosity (in kilograms per square meter per second)

nf = Nano fluid viscosity (kg/m-s) Heat capacity of water (W/m-k) is given by the coefficient Kw. Solid material's thermal conductivity (W/m-k) is Ks.

DENSITYOFNANOFLUID

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

SPECIFICHEATOFNANOFLUID

$$= \frac{\varphi \times \rho s \times Cps + (1-\varphi)(\rho w \times Cpw)}{\varphi \times \rho s + (1-\varphi) \times \rho}$$

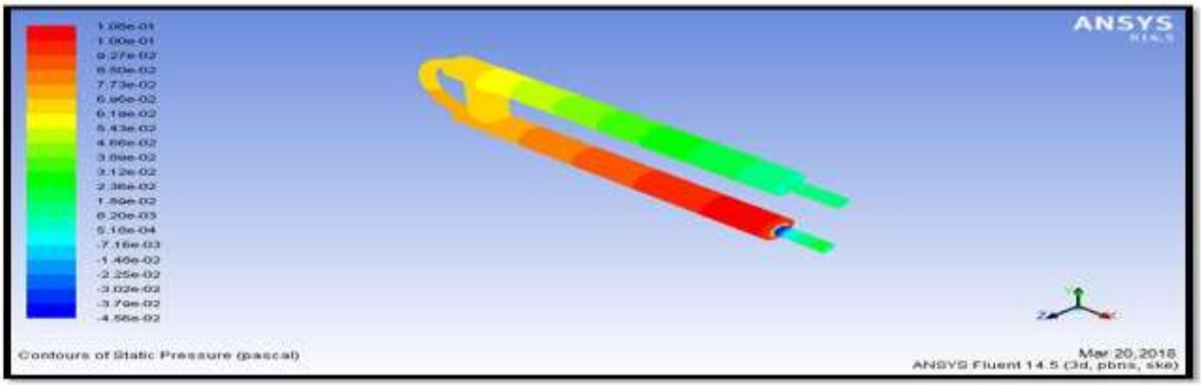
VISCOSITYOFNANOFLUID

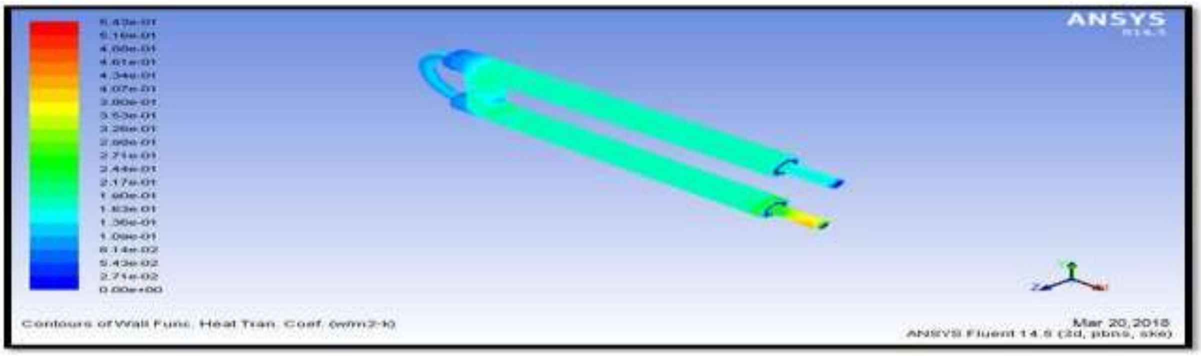
$\mu nf = \mu w(1+2.5\varphi)$

PRESSURE

VELOCITY

HEATTRANSFERCOEFFICENT





MASSFLOWRATE

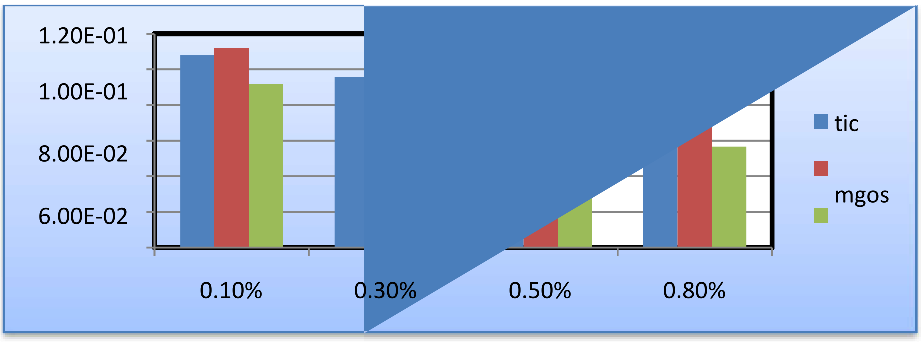
Mass Flow Rate	(kg/s)	
cold_inlet	0.049999997	
cold_outlet	-0.32807603	
contact_region-contact_region_3-contact_region_2-contact_region_3-src		-0.55263227
contact_region-contact_region_3-contact_region_2-contact_region_3-trg		0.55263036
contact_region_4-src	0.010181041	
contact_region_4-trg	-0.01018121	
hot_inlet	0.69999987	
hot_outlet	-0.44418025	
interior-16	-0.55263025	
interior-5	0.010180988	
interior-____msbr	-16.106001	
wall-14	0	
wall-15	0	
wall-17	0	
wall-18	0	
wall-____msbr	0	
Net	-0.022258495	

HEATTRANSFERRATE

```
             Total Heat Transfer Rate                  (w)
-------------------------------- --------------------
                      cold_inlet            2905.0381
                     cold_outlet           -70405.109
contact_region-contact_region_3-contact_region_2-contact_region_3-src                    0
contact_region-contact_region_3-contact_region_2-contact_region_3-trg                    0
            contact_region_4-src                    0
            contact_region_4-trg                    0
                       hot_inlet            150220.63
                      hot_outlet           -86969.914
                         wall-14                    0
                         wall-15                    0
                         wall-17                    0
                         wall-18                    0
                     wall-___msbr                   0
                ---------------- --------------------
                             Net           -4249.3604
```

V.RESULTTABLES

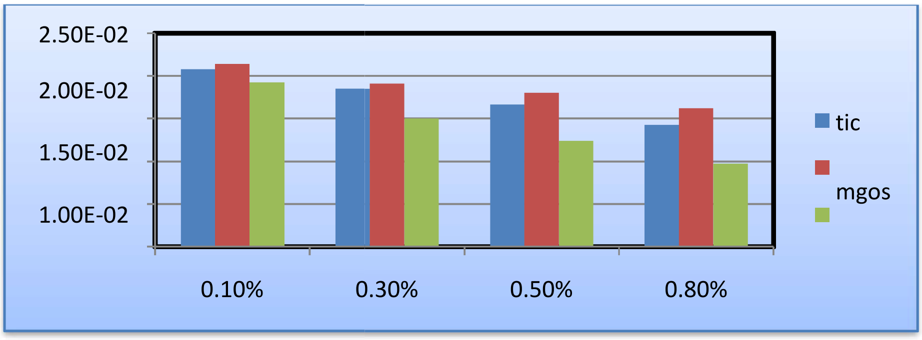
CFDANALYSIS GRAPHSPRESSUREPLOT



VELOCITYPLOT

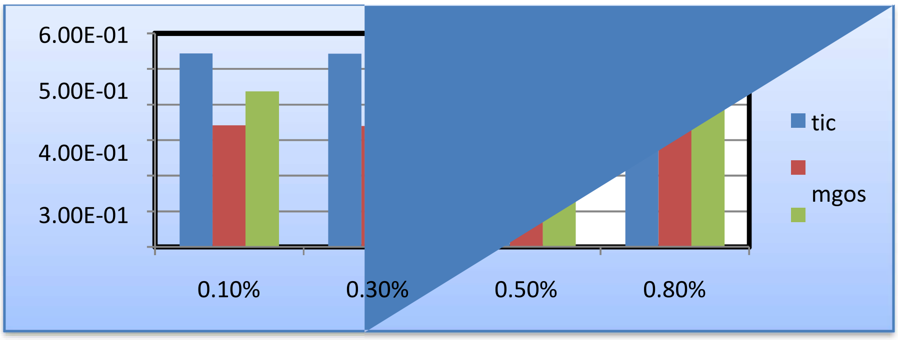
CFD RESULT TABLES

Fluid	Pressure (Pa)	Velocity (m/s)	Heat transfer coefficient (w/m2-k)	Mass flow rate(kg/s)	Heat transfer rate(W)
Tic (0.1%)	1.08e-01	2.08e-02	5.43e-01	0.0222584	4249.3604
Tic (0.3%)	9.57e-02	1.85e-02	5.42e-01	0.0074508	1501.1453
Tic (0.5 %)	7.66e-02	1.67e-02	5.02e-01	0.004508815	866.03149
Tic (0.8%)	7.76e-02	1.43e-02	4.78e-01	0.015195	2116.966
MgO (0.1%)	1.12e-01	2.14e-02	3.41e-01	0.00857707	1870.842
MgO (0.3%)	1.05e-01	1.91e-02	3.39e-01	0.028222	5086.1448
MgO (0.5 %)	9.86e-02	1.80e-02	3.59e-01	0.024875	5267.2834
MgO (0.8%)	8.82e-02	1.62e-02	3.66e-01	0.0100406	2363.6135
Silver (0.1%)	9.20e-02	1.92e-02	4.37e-01	0.0070454	1194.8652
Silver (0.3%)	8.21e-02	1.50e-02	4.24e-01	0.015154109	2254.1187
Silver (0.5 %)	7.11e-02	1.24e-02	4.58e-01	0.033654	5029.21
Silver (0.8%)	5.69e-02	9.72e-03	5.11e-01	0.0550869	11198.48

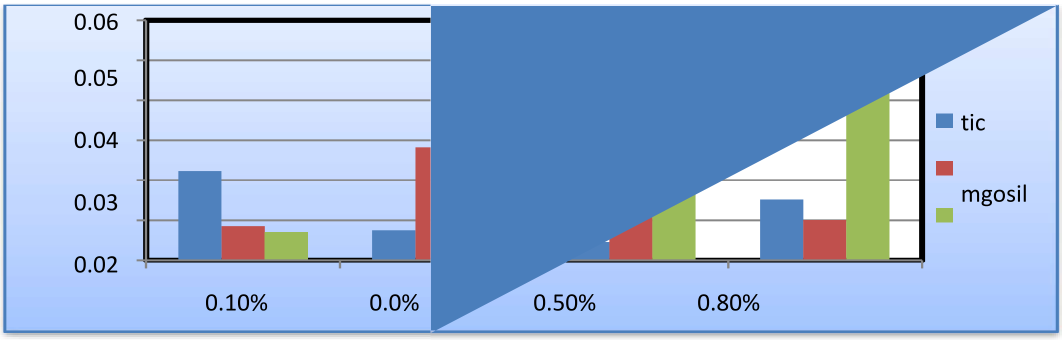


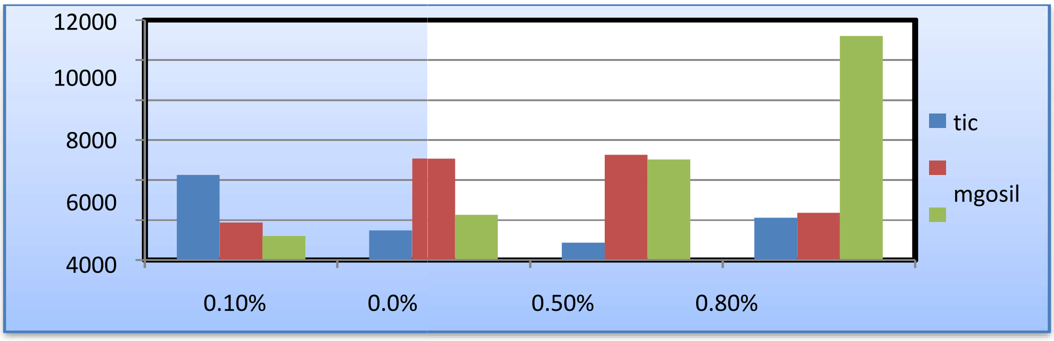
HEATTRANSFERCOEFFICIENTPLOT

MASSFLOWRATEPLOT



HEATTRANSFERRATEPLOT





CONCLUSION

The combination qualities of glycerin (40 percent) and water (60 percent) are studied in this thesis. titanium carbide, magnesium oxide, and silver nanoparticles make up the nanofluid, which has a weight percentage of 0.1% 0.3% 0.5% 0.5% 0.8%. The properties of nano fluids are determined using theoretical calculations, and those qualities are employed as inputs in the study of the fluids. A single tube (Double Pipe) or several tubes within a hairpin shell (Multitude) are available, as are bare tubes, finned tubes, U-tubes, straight tubes (with rod-thru capability), fixed tube sheets, and removable bundle.

According to the CFD research, the heat transfer rate is higher at a silver nano particle weight percentage of 0.8%.

For hair pin heat exchangers, it can be concluded that the silver nano particle nano fluid with a weight percentage of 0.1 percent is the best fluid to use.

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