Design and Analysis of Hair Pin Heat Exchanger with Different Nano Fluids

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Abstract: Heat exchanger device used to transfer heat between one or more fluids. Here the fluids are separated walls of solid to prevent mixup (or) may be in direct interact. These exchangers are single tube, double tube or multi tubes with in the hair pin shell. They are base tubes, fixed tubes, and u tubes. In this project nano fluids like Titanium nitride, magnesium oxide and silver nano particles are mixed with bare fluid. i.e is water and are calculated for combination properties at different volume fractions such as 0.15%,0.25%,0.35% and 0.45% The theoretical calculations are done in determine the nano fluid properties and the properties are taken as input for analysis 3D model of the hair pin heat exchanger is done in CATIA parametric software. CFD analysis is done on the hair pin heat exchanger at different nano fluid volume fractions and thermal analysis is done hair pin heat exchanger with different materials.

KEYWORDS: convective hear transfer, hairpin heat exchanger, nano fluids, CFD analysis

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INTRODUCTION:

Heat exchangers are one of the mostly used equipment in the process industries for cooling purposes. Heat Exchangers are used to transfer heat between two processes streams.one can realize their usage that any process which involve cooling, heating, condensation, boiling or evaporation will require a heat exchanger for this purpose. By increasing cooling efficient with different types of nano fluids increases heat transfer coefficient. Performance and efficiency of heat exchnagers are measured through the amount of heat transfer using least area of haet transfer and pressure drop.

Pressure drops and area required for certain amount of heat transfer provides capital cost and power requirement

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, about the introduction of the paper is provided along with process, important terms. In Section 2 we discuss related work. In Section 3 we have given the CFD Analysis of 3D Hair pin heat exchanger.Section4 we have given the Thermal analysis on the various sections discussed in the abstract. Section 5 we have given the Result analysis in table. Section 6 it includes Conclusion, Future scope and References.

OBJECTIVES

If we are using pure nano fluids such as Titanium nitride, magnesium oxide and silver nano particles it will results corrosion will cause on the pipes of heat exchanger. Due to this there is a reduction in heat transfer rate. To avoid the corrosion of heat exchanger pipes water combination properties at different volume fractions such as 0.15%,0.25%, 0.35% and 0.45%are used. Then we have analysed the system and finding the heat transfer by using ANSYS.

RELATED WORK

There are numerous works that have been done related to image processing machine learning algorithms.

Design And Analysis of Double Pipe Heat Exchanger Using Computational Method [1]Heat transfer equipment is defined by the function it fulfills in a process. On the similar path, Heat exchangers are the equipment used in industrial processes to recover heat between two process fluids. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, and natural gas processing. The operating efficiency of these exchangers plays a very key role in the overall running cost of a plant. So the designers are on a trend of developing heat exchangers which are highly efficient compact, and cost effective. A common problem in industries is to extract maximum heat from a utility stream coming out of a particular process, and to heat a process stream. Therefore, the objective of present work involves study of refinery process and applies phenomena of heat transfer to a double pipe heat exchanger.

Thermal Analysis of Double Pipe Heat Exchanger by Changing the Materials Using CFD [2]Heat Exchanger is a device used to exchange the heat energy between the two fluids by which increases the operating efficiency? These Efficiencies plays a major role for cost effective Operations in the process industries. While the both Fluids flow through the heat exchanger, the temperature of both fluids will exchange. The main objective of this paper is deals with the performance rate of double pipe heat exchanger by changing the materials which uses the heat input from the waste recovery of steam in refinery process. Double pipe heat exchangers are designed in CATIA and GAMBIT.

CFD analysis is done by using ANSYS. Final Results are obtained with three different types of materials steel, aluminum and copper.

CFD Analysis Of Double Pipe Heat Exchanger[3] Heat exchangers are used in industrial processes tore cover heat between two process fluids. All the heat exchangers are designed based on the function it fulfills in a process. Although the necessary equations for heat transfer and the pressure drop in a double pipe heat exchanger are available, using these equations the validation of the design is laborious. In this paper the analytical design of the exchanger has been validated based on the results obtained from the CFD analysis. In this paper the CFD analysis is based on the standard k-ε modeling. The solution of the problem yields the optimum values of inner pipe diameter, outer pipe

diameter and utility flow rate to be used for a double pipe heat exchanger of a given effective length, when a specified flow rate of process stream is to be treated for a given inlet to outlet temperature.

CFD ANALYSIS OF HAIR PIN HEAT EXCHANGER

The properties that we considered or taken as inlet are

MATERIAL PROPERTIES

MAGNESIUM OXIDE

Density = 3580 kg/m^3

Thermal conductivity =60W/m-k

Specific heat = 1030J/kg-k

TITANIUM NITRIDE

Density = 5400 kg/m^3

Thermal conductivity =28.84 W/m-k

Specific heat = 330 J/kg-k

Silver

Density = 10500 kg/m^3

Thermal conductivity =406.0 W/m-k

Specific heat = 233 J/kg-k

WATER

Density = 998.2 kg/m^3

Thermal conductivity = 0.6 W/m-k

Specific heat = 4182 J/kg-k

Viscosity = 0.001003kg/m-s

Fluid-Magnesium Oxide

At volume fraction - 0.15%

FLUID- MAGNESIUM OXIDE

At volume fraction - 0.15%

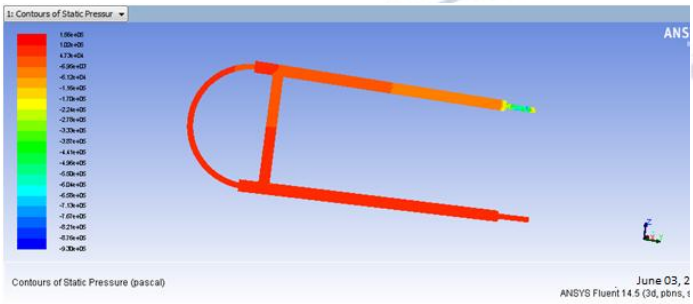

Fig 1 Contonour Pressure

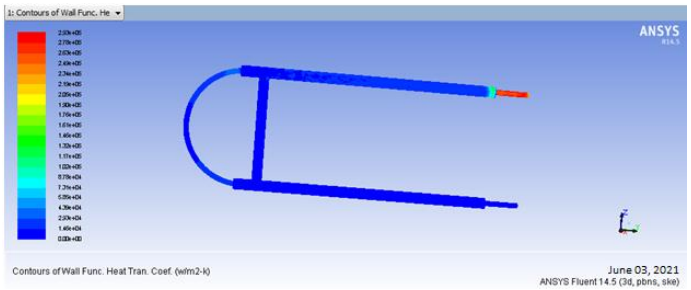

Fig 2 Contonour Pressure

At volume fraction - 0.25%

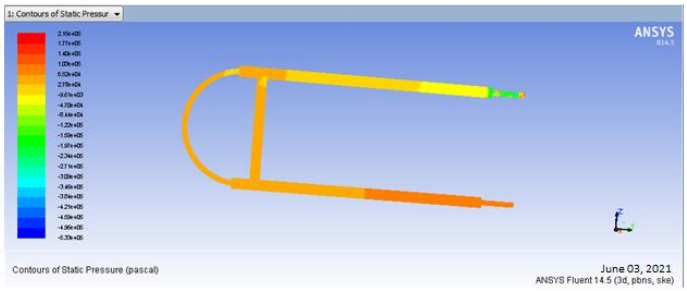

Fig 3 Pressure

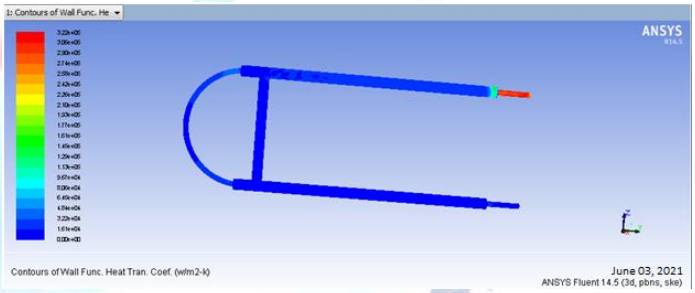

Fig 4 Heat Transfer Coefficent

At volume fraction - 0.35%

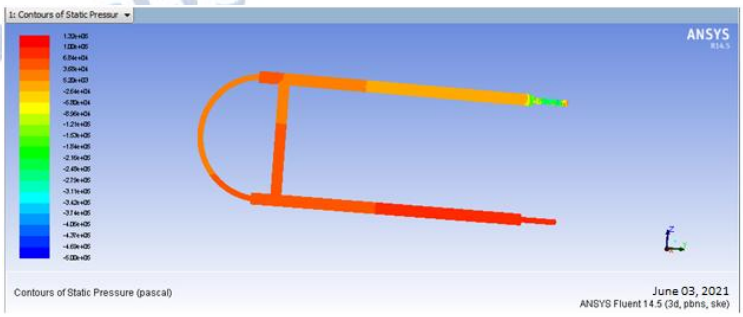

Fig 5 Pressure

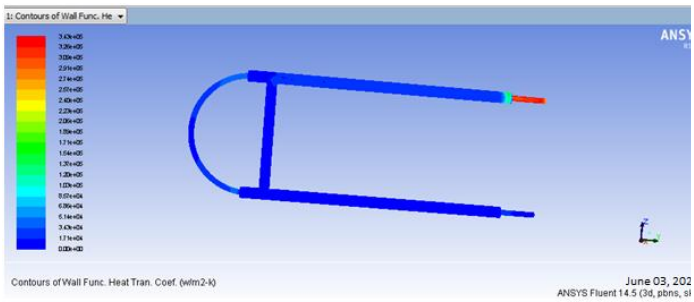

Fig 6 Heat Transfer Coefficent

At volume fraction - 0.45%

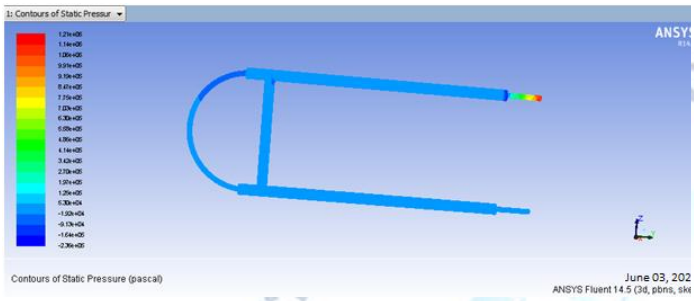

Fig 7 Contour pressure

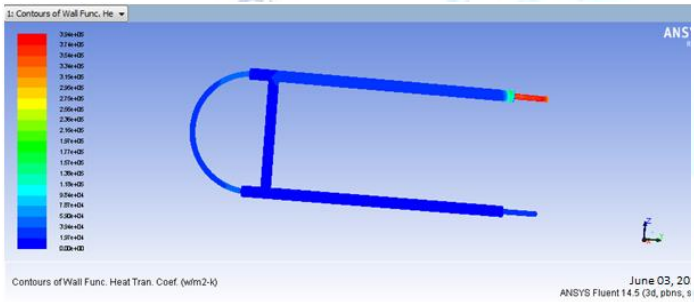

Fig 8 Heat Transfer Coefficent

***FLUID*- TITANIUM NITRIDE**

At volume fraction - 0.15%

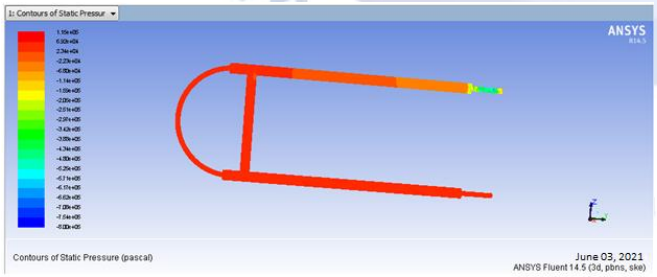

Fig 9Contonour Pressure

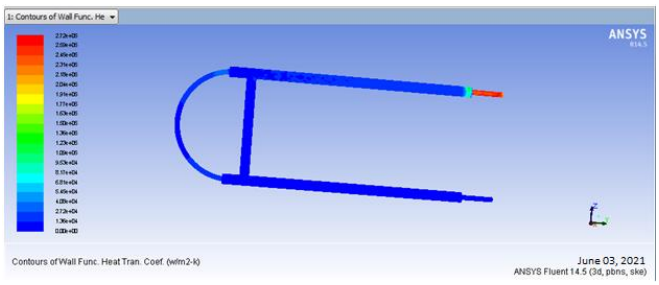

Fig 10 Heat Transfer Coefficent

At volume fraction -0.25%

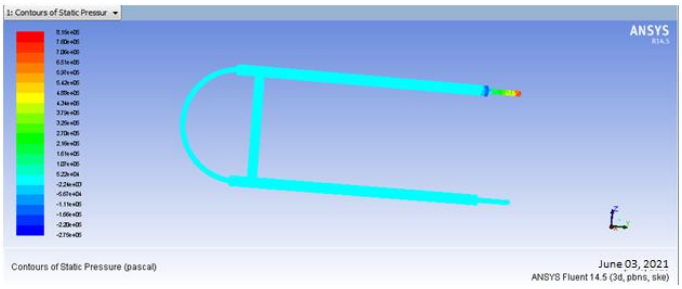

Fig 11Contonour Pressure

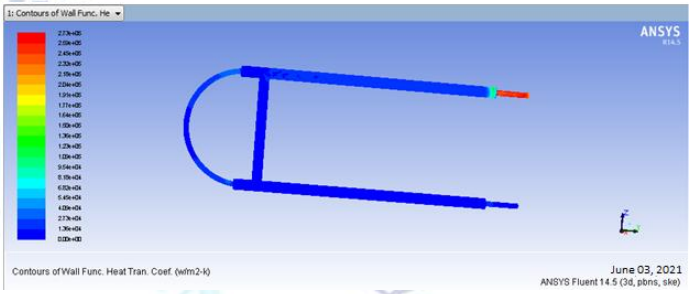

Fig 12 Heat Transfer Coefficent

At volume fraction -0.35%

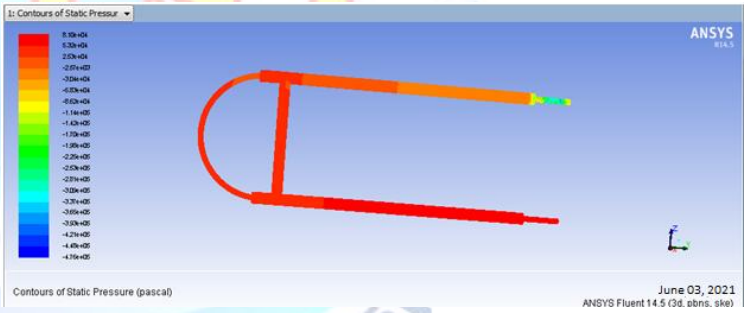

Fig 13Contonour Pressure

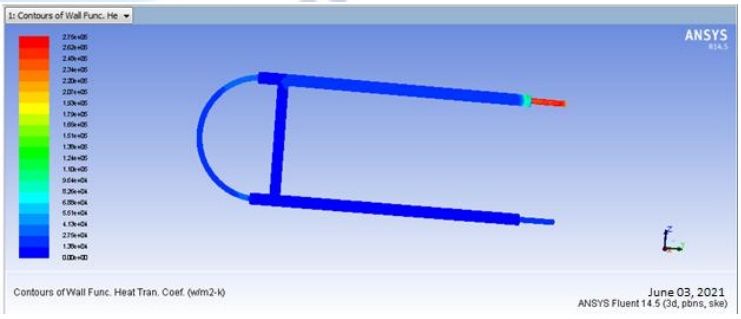

Fig 14 Heat Transfer Coefficent

At volume fraction -0.45%

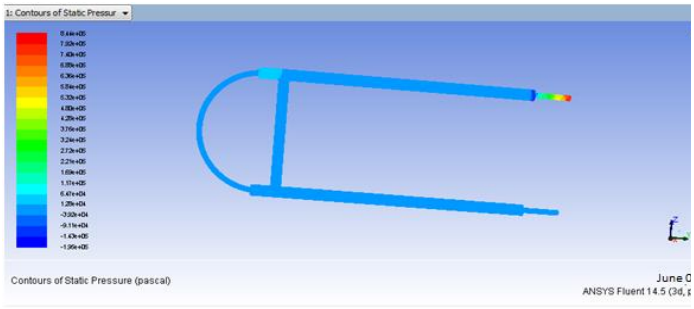

Fig 15Contonour Pressure

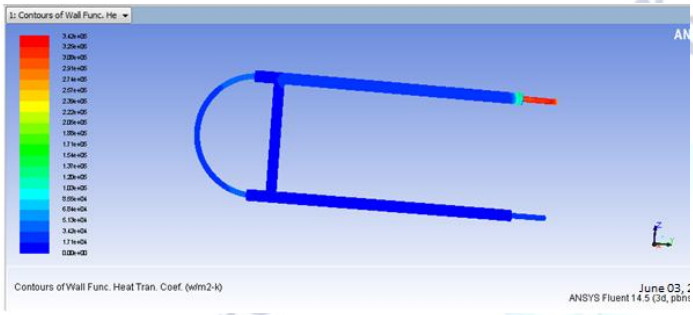

Fig 16 Heat Transfer Coefficent

At volume fraction -0.25%

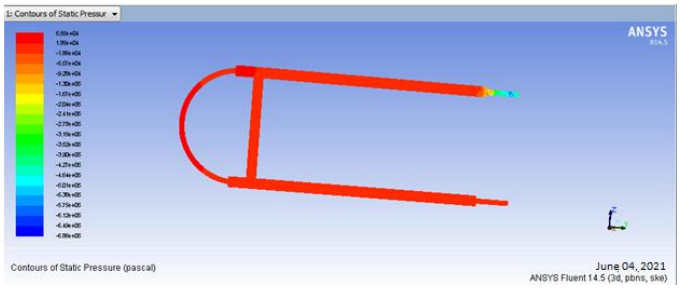

Fig 19Contonour Pressure

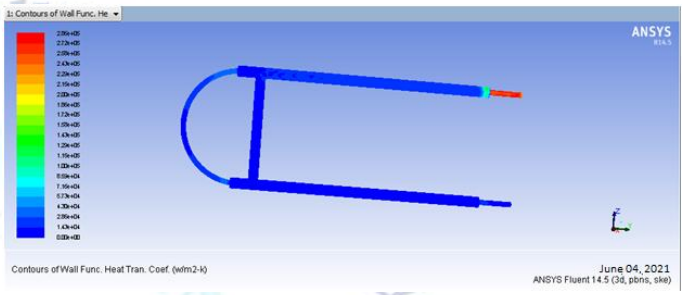

Fig 20 Heat Transfer Coefficent

***FLUID-* SILVER**

At volume fraction - 0.15%

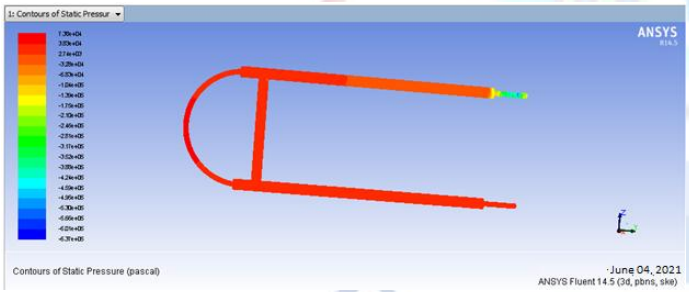

Fig 17Contonour Pressure

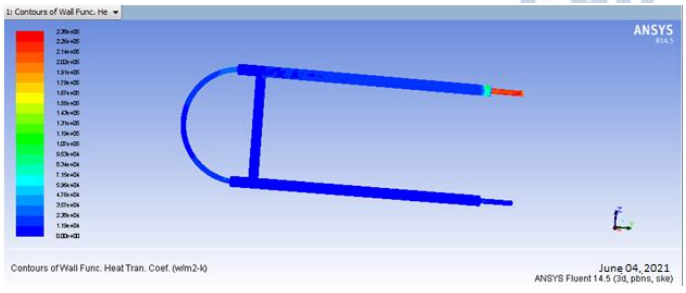

Fig 18 Heat Transfer Coefficent

At volume fraction - 0.35%

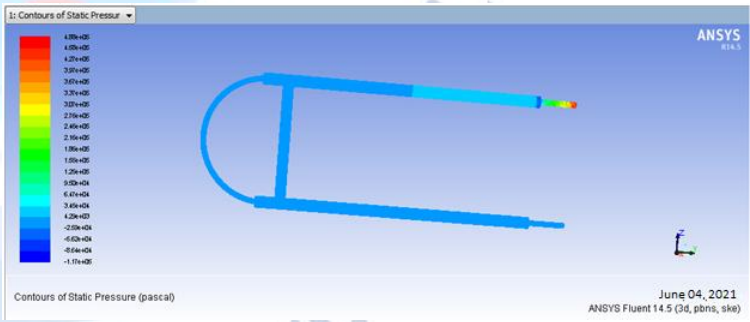

Fig 21Contonour Pressure

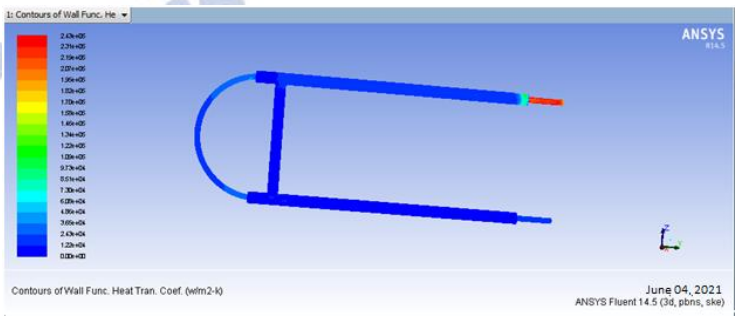

Fig 22 Heat Transfer Coefficent

At volume fraction -0.45%

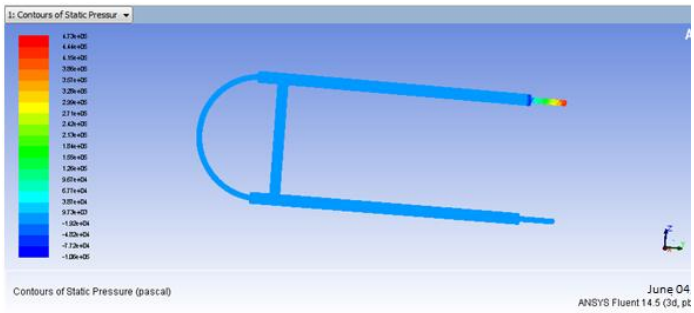

Fig 23Contonour Pressure

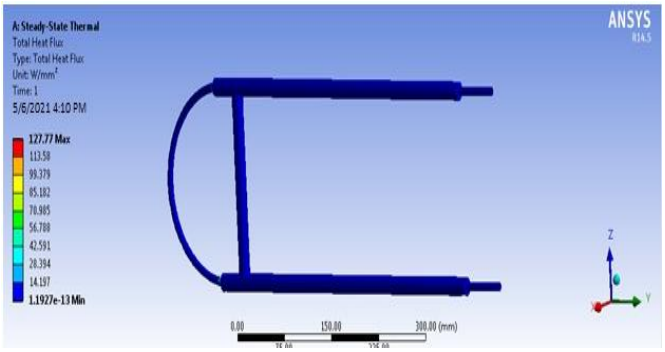

Fig3 Heat Flux

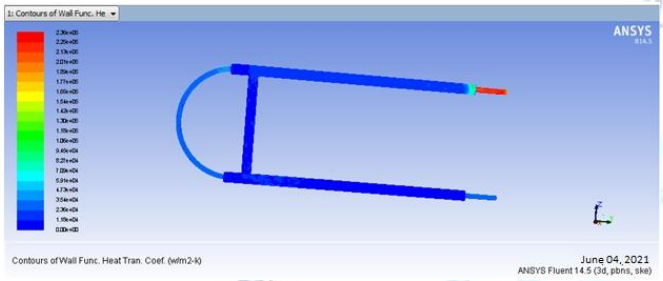

Fig 24 Heat Transfer Coefficent

THERMAL ANALYSIS OF HAIR PIN HEAT EXCHANGER

MATERIAL: ALUMINUM ALLOY

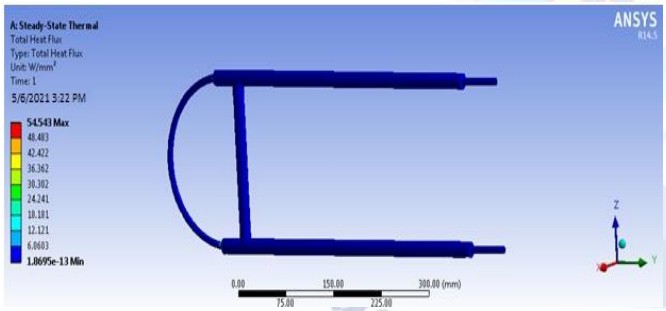

Fig1 Heat Flux

MATERIAL: COPPER

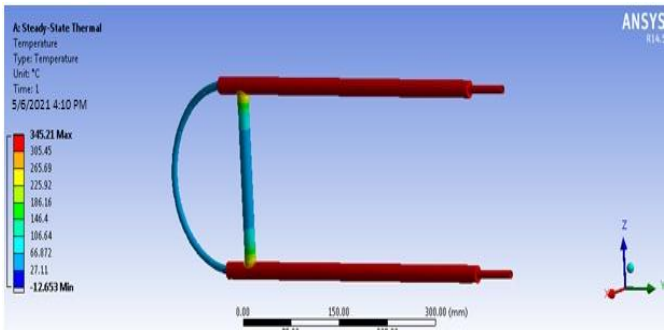

Fig2 Heat Flux

RESULT

5.1 CFD ANALYSIS RESULTS:

Nano fluid	Volume fraction	Pressure (Pa)	Heat transfer coefficient	Heat transfer rate(w)
MAGNESIUM OXIDE	**0.15**	1.56e+05	2.93e+05	1088867.7
	0.25	2.15e+05	3.22e+05	997964.47
	0.35	1.32e+05	3.43e+05	805075.5
	0.45	1.21e+06	3.94e+05	741280
TITANIUM NITRIDE	**0.15**	1.15e+05	2.72e+05	931338.48
	0.25	8.15e+05	2.73e+05	689732.03
	0.35	8.10e+04	2.75e+05	522748.29
	0.45	8.44e+05	3.42e+05	591064.22
SILVER	**0.15**	7.38e+04	2.38e+05	653880.13
	0.25	5.55e+04	2.86e+05	637533.66
	0.35	4.88e+05	2.43e+05	336461.2
	0.45	4.73e+05	2.36e+05	276048.74

5.2 THERMAL ANALYSIS RESULTS:

material	Temperature (°C)		Heat flux
	Min	Max	
Aluminum alloy 7475	27.003	345.44	54.543
Copper	27.11	345.21	127.77

CONCLUSION

By observing the CFD analysis results the heat transfer rate and heat transfer coefficient values more at magnesium oxide nano particle volume fraction 0.45%.

By observing the thermal analysis results the heat flux value more at copper when we compared to aluminum alloy 7475 material.

So, it can be concluded the magnesium oxide nano fluid at volume fraction 0.45% fluid is the better fluid for hair pin heat exchanger.

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