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CFD Analysis On Convective Heat Transfer And Pressure Drop In An Annular Bend Tube With Different Nano Fluids

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ABSTRACT

Heat transfer by convection is unbelievably necessary for many industrial heating and cooling presentations. The heat convection could submissively be enlarged by boundary conditions, flow geometry, or by growing thermo physical properties of fluid. Nano-sized particles mixing in a base fluid, remarked as Nano fluids, hugelyincrease the heat transfer properties of the initial fluid, and are ideally suited to practical applications attributable to their extraordinary characteristics.

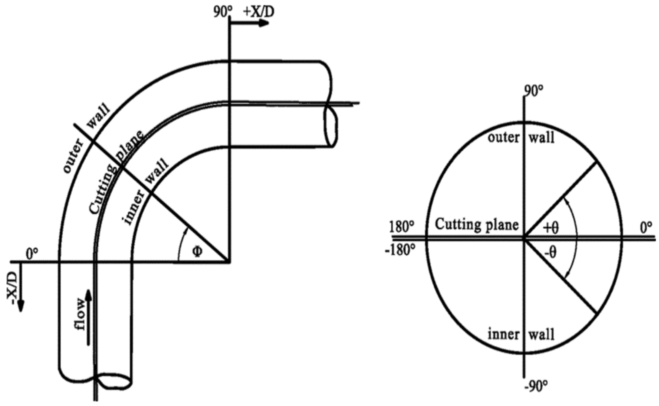
A numerical inspection based on computational fluid dynamics (CFD) method, witha single phase approach, has been carried out to study and compare the convective heat transfer and pressure drop of Nano fluid flowing through a straight tube and a helical coil. The Nano fluids thought-about during this thesis are Nanofluids made of base fluid water added to volume fraction 0.4 of Nanofluids, Aluminum oxide, Copper oxide Nano fluid, Silicon carbide Nano fluid and Titanium oxide Nano fluid as a base fluid. Thermal and CFD analysis are performed to evaluate the thermal behavior utilizingFEA software Ansys. 3D modeling of the annular bend tubes without contact and with contact is done inCatia

INTRODUCTION

In the humblest of terms, the punishment of heat transfer is worried with only two things: temperature, and the flow of heat. Temperature signifies the amount of thermal energy obtainable, whereas heat flow signifies the drive of thermal energy from place to place. On a tiny scale, thermal energy is connected to the kinetic energy of particles. The better a material's temperature, greater the thermal agitation of its basic molecules (established both in linear motion and Vibrational modes). It is normal for regions covering better molecular kinetic energy to pass this energy to areas with less kinetic energy.

Numerous material possessions serve to moderate the heat transferred between two regions at differing temperatures. Examples include thermal conductivities, specific heats, material thicknesses, fluid velocities, fluid viscosities, surface emissivity, and more. Taken composed, these properties serve to make the answer of many heat transfer difficulties ancomplicated process.

Heat transfer done a fluid is by convection in the attendance of bulk fluid motion and by transmission in the nonappearance of it. Therefore, transmission in a fluid can be watched as the limiting case of convection, consistent to the case of calm consistent to the case of calm fluid.



LITERATURE REVIEW

The paper is written by Willem I. Louw, Josua P. Meyer[1] Helically wound tube-in-tube heat exchangers are manufactured by coiling 2 tubes, one placed within the other. This methodology typically ends up in the tubes not sharing an equivalent center line, and thus annular contact happens in some cases. An experimental comparison was fabricated from such tubes during a device with annular contact, as against an aligned (concentric) device without annular contact, so as to quantify the impact of annual contact in terms of heat transfer coefficients and pressure drop. By comparing the heat transfer characteristics, it had been concluded that the heat transfer coefficient within the annulus was found to extend considerably. The result was an improved performance by the heat exchanger wherever annular contact happens, compared to the heat exchanger with the tubing during a concentric position.

The paper is written by A.D. Badgujar, M.D. Atrey [2], The U-type Pulse Tube Cryocooler (PTC) involves gas flow direction change as it flows from the regenerator to the pulse tube. Due to undesirable mixing at the cold end of the pulse tube and formation of eddies, the sharp U-bend will have unfavorable effect on cooling action of pulse tube. This work is dealt with experimental investigation and CFD analysis related to U-type PTCs. Two types of 'U' bends are studied; gradual 'U' bends and sharp 'U' bends. Experimentation is done utilizing screens of Copper material with 100-mesh size as flow straighteners. In the case of gradual U bend the optimum performance in terms of low temperature is achieved with a stack of 18 flow-straightener screens. The no-load temperature for gradual 'U' bend, with and without flow straighteners, was 57.7 K and 88.8 K, respectively, for a charging pressure of 16 bar. The no load temperature improved from 88.8K to 137K when the shap U bend is replaced by gradual 180 degree bend at the cold end was replaced by a sharp U bend, without flow straighteners.The paper is written by *Vemula Madhuri, D. Prasuna Lilly Florence [3]Heat transfer by convection is incredibly necessary for several industrial heating and cooling applications. The heat convection will passively be increased by ever-changing flow pure geometry, by incrementing fluid thermos physical properties or boundary conditions. A colloidal mixing of Nano-sized particles in a base fluid, referred to as Nano fluids, enormously increases the characteristics of heat transfer of the original fluid, and is ideally suited to practical applications as a result of its marvelous characteristics. Totally different materials of an annular bend tube are analyzed for their thermal behavior with turbulence flow. The materials thought of during this thesis are ethylene glycol, copper and aluminum. CFD and Thermal analysis is performed to work out the thermal behavior utilizing FEA software Ansys. 3D modeling is completed in PRO-E. CFD analysis is additionally done on the tube in tube heater for water for the above obtained best material materials.* The paper is written by Triloki Nath Mishra [4] In this thesis we model eda tube in tube helical coil heat exchanger in CATIAV5r18 and done CFD analysis utilizing ANSYS. The thesis shows the change of Nusseltnumber for various curvature ratio(D/d ratio) and Reynolds number.CFD analysis has been performed by changing inlet condition keeping the outer wall heat flux at constant. The counter heat exchanger with turbulent flow model is considered for analysis purpose. The material the base metal for both inner and outer pipe is Copper and analysis has been done utilizing ANSYS 13.0.The ANSYS 13.0 was utilized plot the temperature contour, velocity contour, pressure contour taking cold fluid at constant velocity within the outer tube and hot fluid with varying velocity within the inner one. We tend to conjointly conclude the wall shear stress on each inner and outer tube. The paper is written by B. Sairamprasad P P, N. GopalP P, P. Srinivasulu P [5] In this thesis, thermal behavior of various Nano fluids are simulated that are passing with turbulent flow through an annular bend tube. The Nano fluids thought-about during this thesis are Tri-Chloro ethylene glycol, Al Nano fluid, Cu Nano fluid and SiC Nano fluid made up of base fluid water except Tri-Chloro ethylene glycol.

CFD ANALYSIS OF ORIGINAL ANNULAR BEND TUBE USING ALUMINIUM NANO FLUID

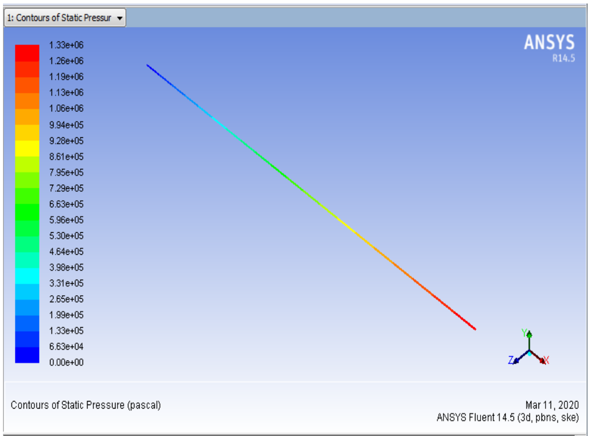


Fig: Static Pressure

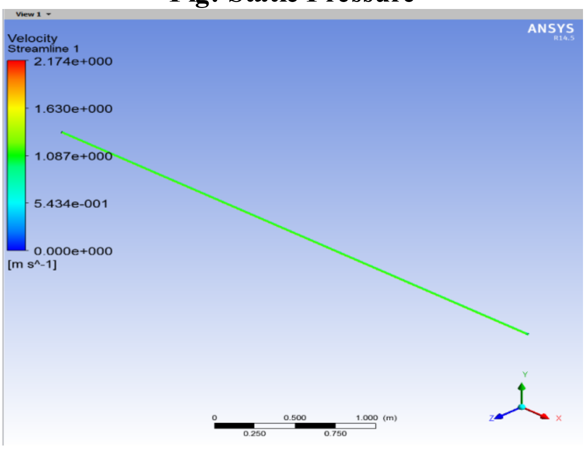


Fig:Velocity

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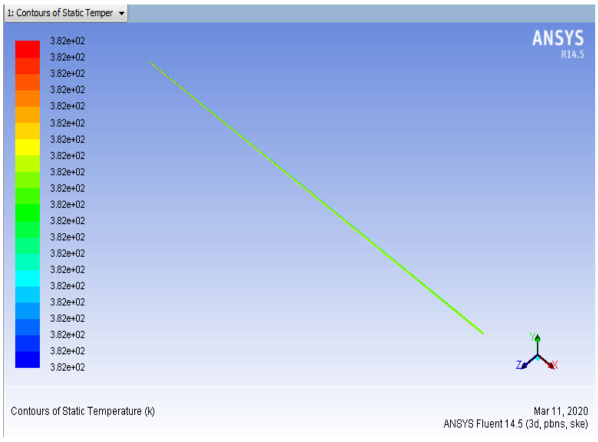

Fig: Static Temperature

CFD ANALYSIS OF ORIGINAL ANNULAR BEND TUBE USING COOPER NANO FLUID

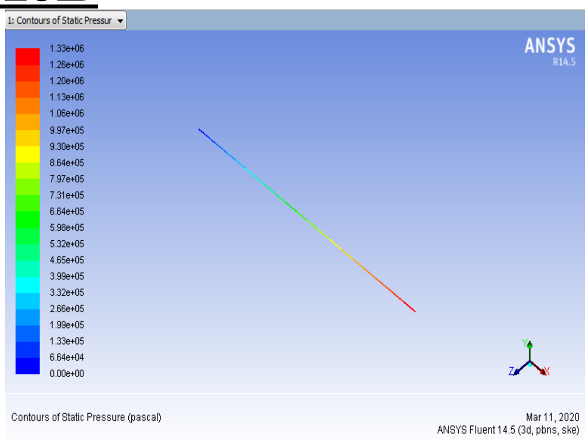

Fig: Static Pressure

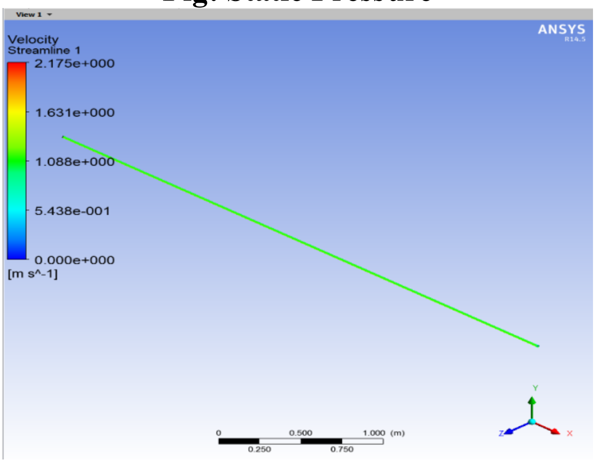

Fig: Velocity

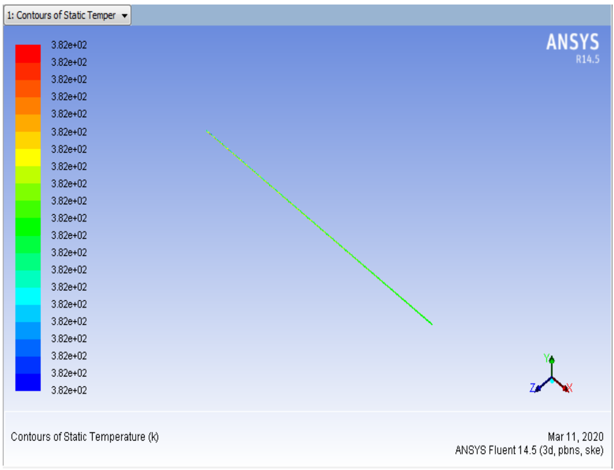

Fig: Static Temperature

THERMAL ANALYSIS OF ORIGINAL ANNULAR BEND TUBE USING ALUMINIUM NANO FLUID

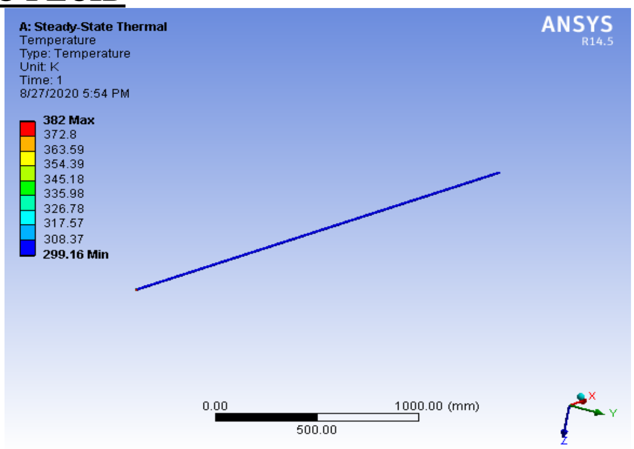

Fig: Temperature

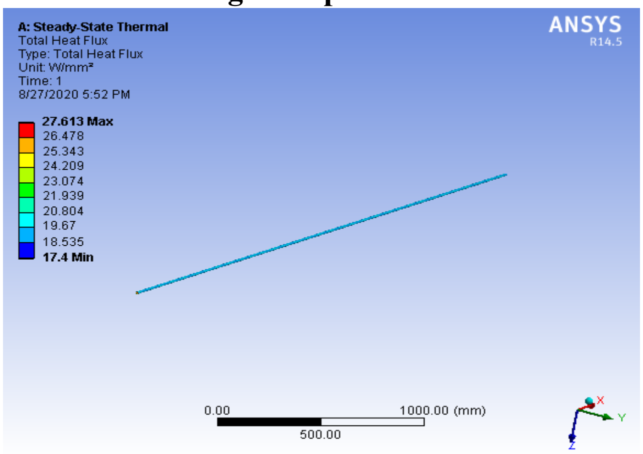

Fig: Heat flux

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THERMAL ANALYSIS OF ORIGINAL ANNULAR BEND TUBE USING COOPER NANO FLUID

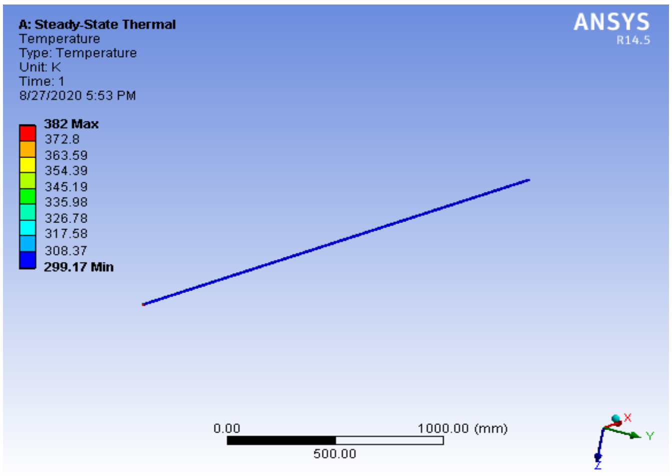

Fig: Temperature

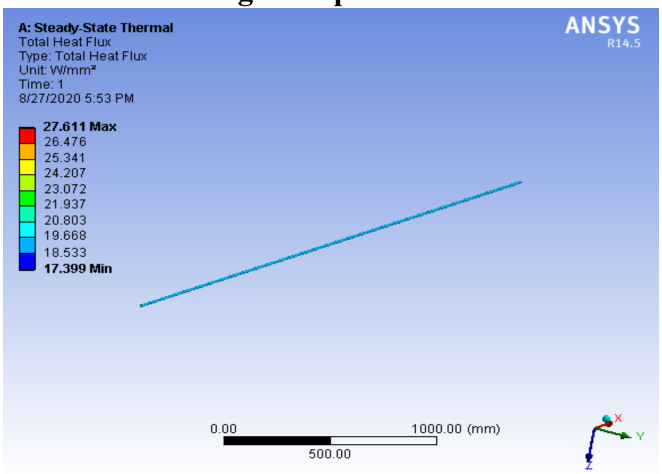

Fig: Heat flux

CFD ANALYSIS OF ANNULAR BEND TUBE MODIFIED MODEL WITH HELICAL SHAPE USING ALUMINIUM NANO FLUID

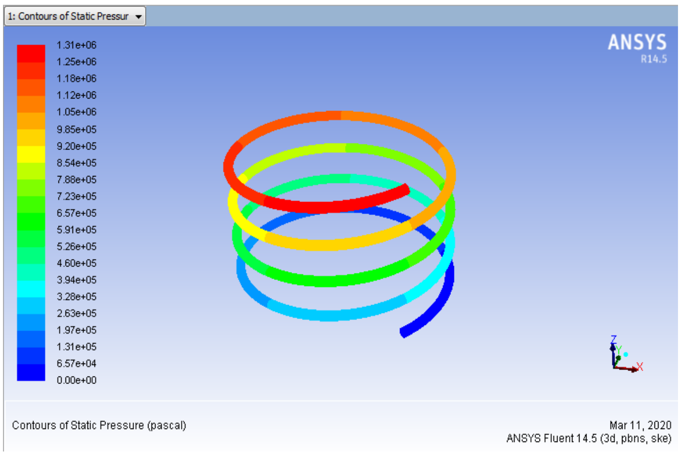

Fig: Static Pressure

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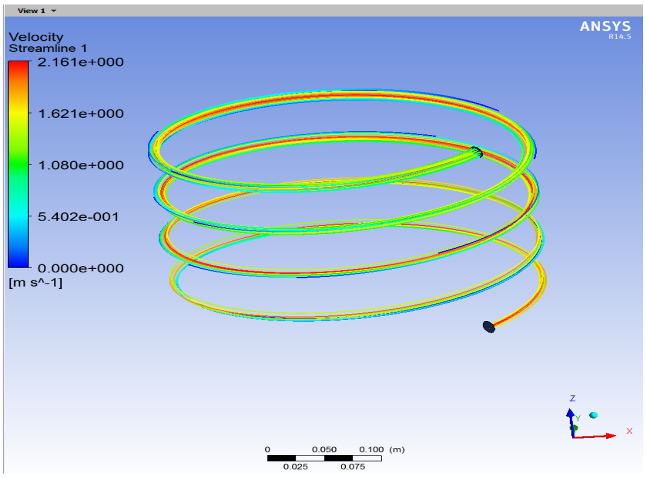


Fig:Velocity

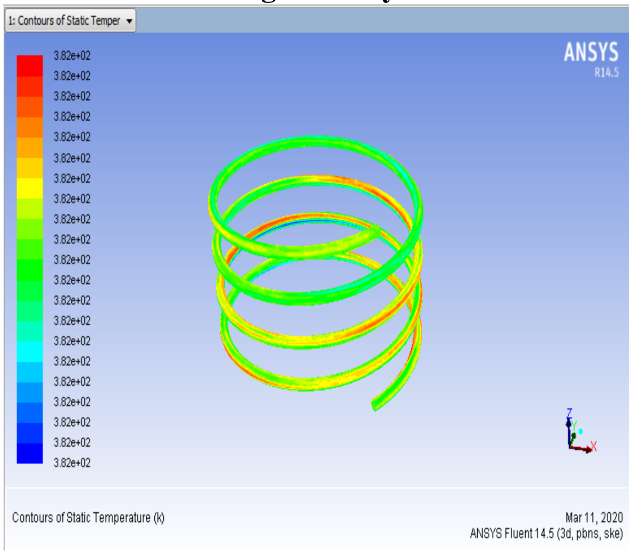


Fig: Static Temperature

CFD ANALYSIS OF ANNULAR BEND TUBE MODIFIED MODEL WITH HELICAL SHAPE USING COOPER NANO FLUID

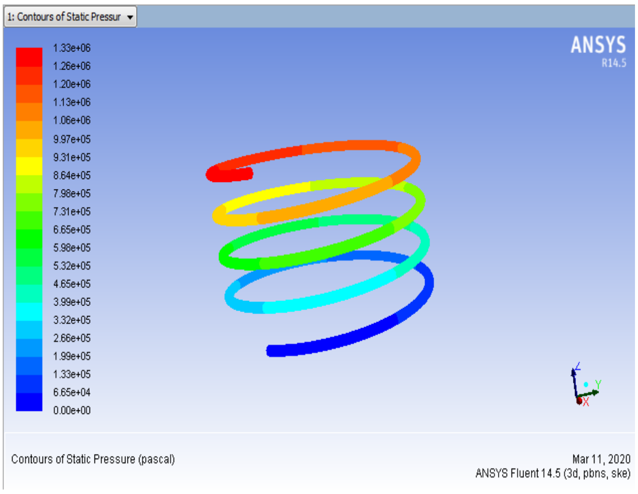


Fig: Static Pressure

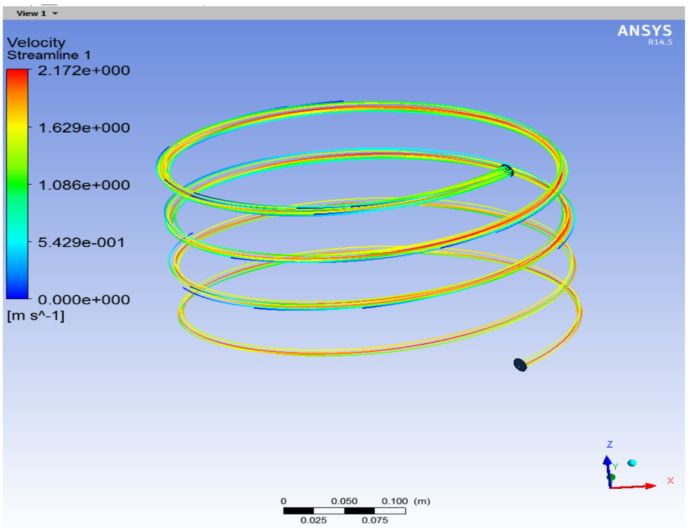


Fig: Velocity

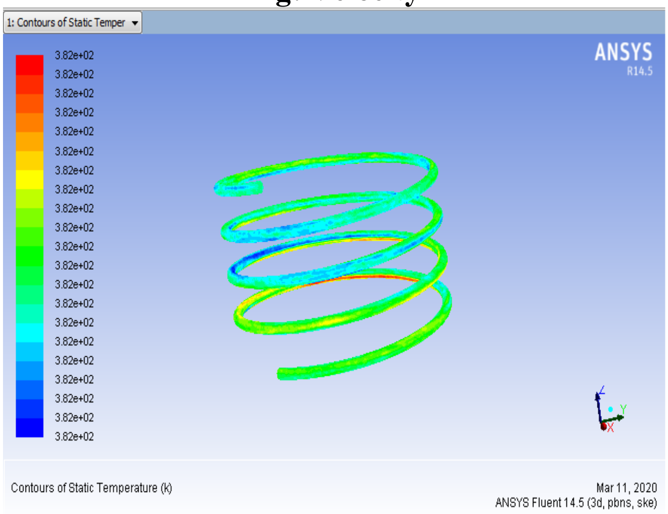


Fig: Static Temperature

THERMAL ANALYSIS OF ANNULAR BEND TUBE MODIFIED MODEL WITH HELICAL SHAPE USING ALUMINIUM NANO FLUID

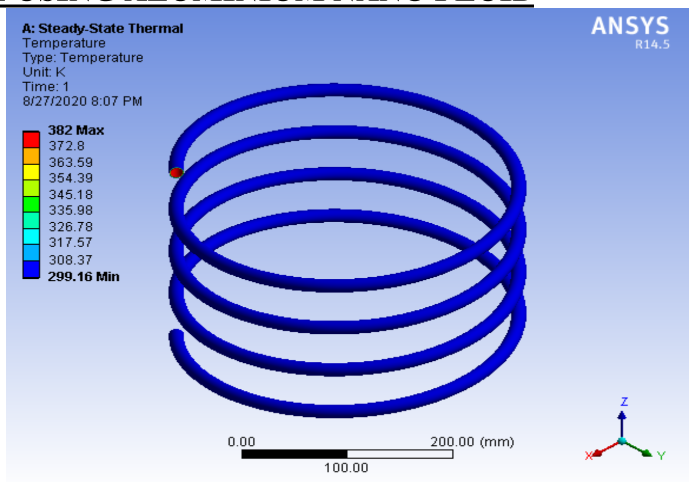


Fig: Temperature

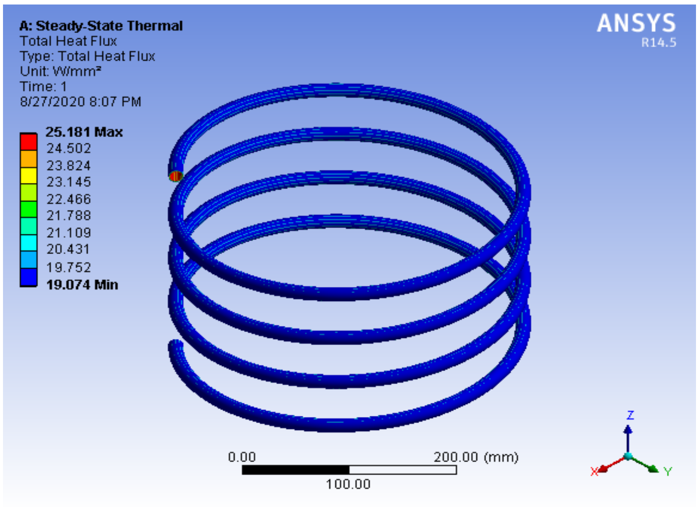


Fig: Heat flux

THERMAL ANALYSIS OF ANNULAR BEND TUBE MODIFIED MODEL WITH HELICAL SHAPE USING COOPER NANO FLUID

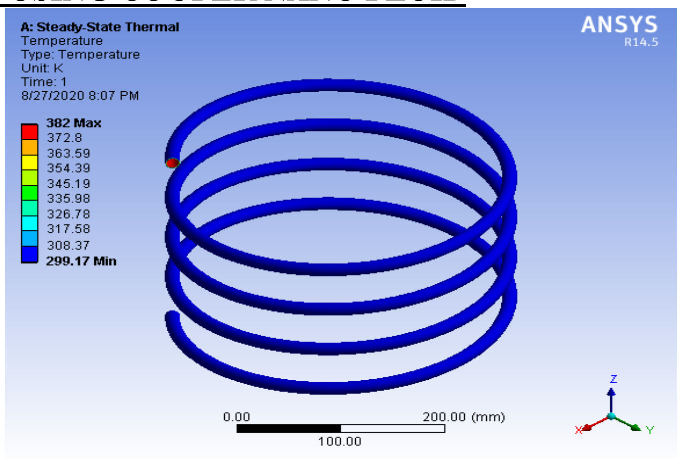


Fig: Temperature

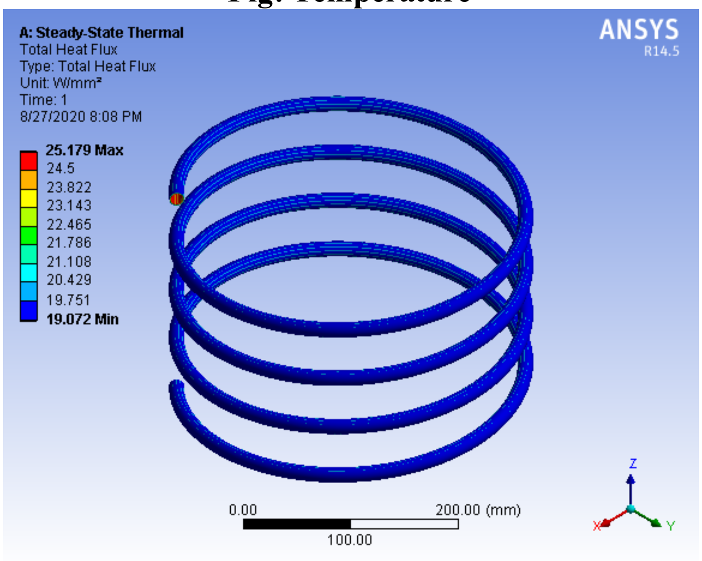


Fig: Heat flux

CFD ANALYSIS RESULTS

ORIGINAL ANNULAR BEND TUBE

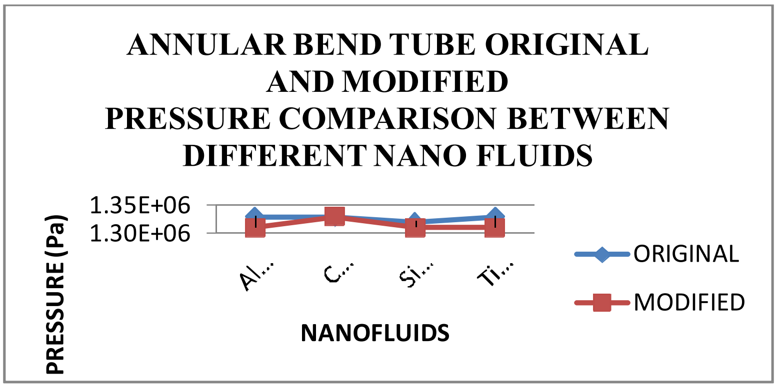
Nano fluid	Pressure(Pa)	Temperature (K)	Velocity (m/s)	Heat transfer coefficient(W/m^2k)	Mass flow rate(kg/s)	Heat transfer Rate(W)
Aluminum Oxide	1.33E +06	3.82E+ 02	2.174E +000	1.43E+0 3	-4.7684E- 07	9.859375
Copper Oxide	1.33E +06	3.82E+ 02	2.175E +000	9.42E+0 2	-2.384E- 07	-3.84375
Silicon carbide	1.32E +06	3.82E+ 02	2.173E +000	1.31E+0 3	1.7881393 E-07	2.515625
Titanium oxide	1.33E +06	3.82E+ 02	2.174E +000	8.63E+0 2	- 1.7881393 E-07	-5.59375

MODIFIED ANNULAR BEND TUBE

Nano fluid	Pressure(Pa)	Temperature (K)	Velocity (m/s)	Heat transfer coefficient(W/m^2k)	Mass flow rate (kg/s)	Heat transfer Rate(W)
Aluminum Oxide	1.31E+ 06	3.82E +02	2.161E +000	1.47E+ 03	- 2.622604 4E-06	- 1.078125
Copper Oxide	1.33E+ 06	3.82E +02	2.172E +000	1.03E+ 03	1.251697 5E-06	-0.0625
Silicon carbide	1.31E+ 06	3.82E +02	2.164E +000	1.34E+ 03	- 1.043081 3E-06	-0.6875
Titanium Oxide	1.31E+ 06	3.82E +02	2.161E +000	8.82E+ 02	4.470348 4E-07	0.234375

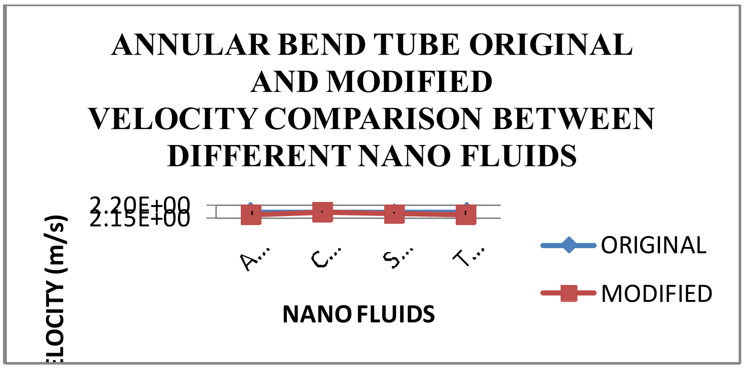
Table – CFD analysis results of Modified Annular Bend Tube at different Nano fluids.

GRAPHS



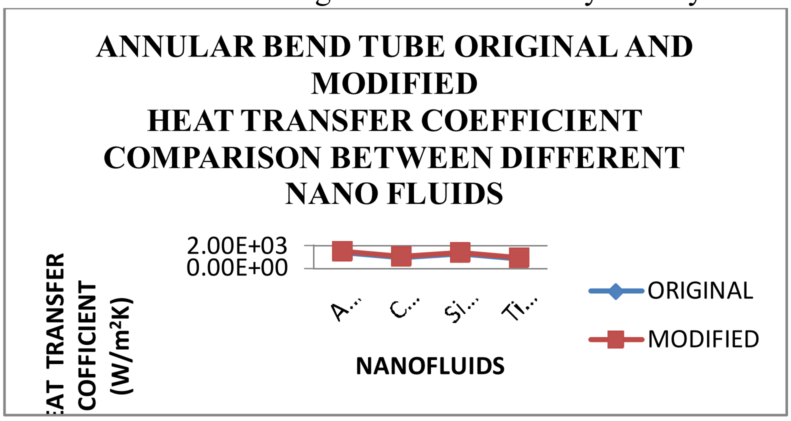
Graph – Annular Bend Tube Original and Modified Pressure Comparison between Different Nano Fluids

From the above graph it is observed that the Pressure is more for original and modified. Pressure is more when Copper oxide nano fluid is used, by about 80% when Aluminum oxide is used by about 78% when Silicon Carbide is used and by about 90% when Titanium oxide is used when compared.



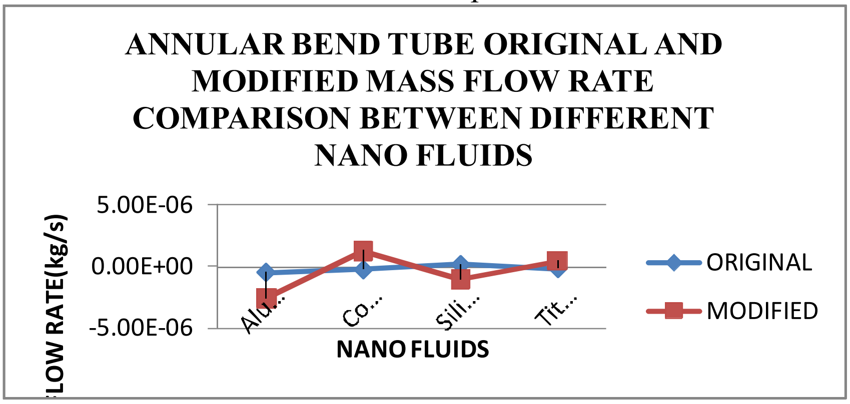
Graph – Annular Bend Tube Original and Modified Velocity Comparison between Different Nano Fluids

From the above graph it is observed that the Velocity is more for original. Velocity are more when cooper oxide Nano fluid is used, by about 99% when Aluminum oxide is used by about 80% when Titanium oxide is used and by about 98% when Silicon Carbide is used when compared. Here the modified and the original model have very near by results



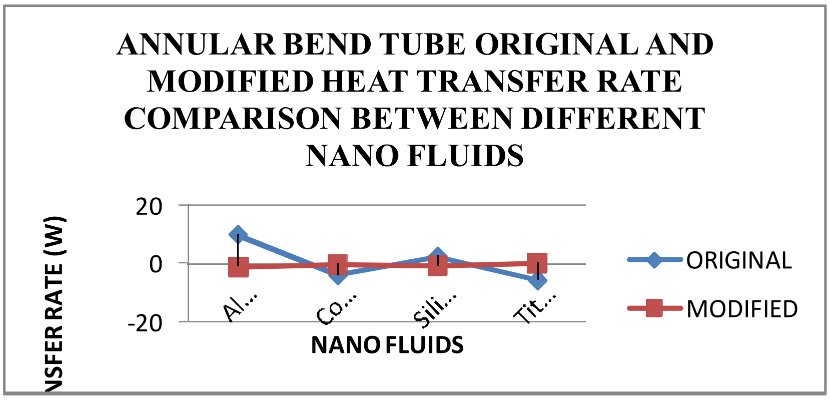
Graph – Annular Bend Tube Original and Modified Heat transfer coefficient Comparison between Different Nano Fluids

From the above graph it is observed that the heat transfer coefficients are more for modified model. Heat transfer coefficients are more when Aluminum oxide nano fluid is used, by about 80.4% when copper oxide is used by about 98% when silicon Carbide is used and by about 97% when titanium oxide is used when compared.



Graph – Annular Bend Tube Original and Modified Mass Flow rate Comparison between Different Nano Fluids

From the above graph it is observed that the mass flow rate is more for modified model. Mass flow rate are more when cooper oxide nano fluid is used, by about 80.4% when aluminum oxide is used by about 68% when silicon Carbide is used and by about 47% when titanium oxide is used when compared.



Graph – Annular Bend Tube Original and Modified Heat transfer rate Comparison between Different Nano Fluids

From the above graph it is observed that the heat transfer rate is increasing for annular bend tube for the original model by about 98% when aluminum oxide nano fluid is used, by about 80.4% when copper oxide nano fluid is used, by about 99% when silicon carbide nano fluid is used and by about 99% when titanium oxide nano fluid is used when compared.

THERMAL ANALYSIS RESULTS

ORIGINAL ANNULAR BEND TUBE

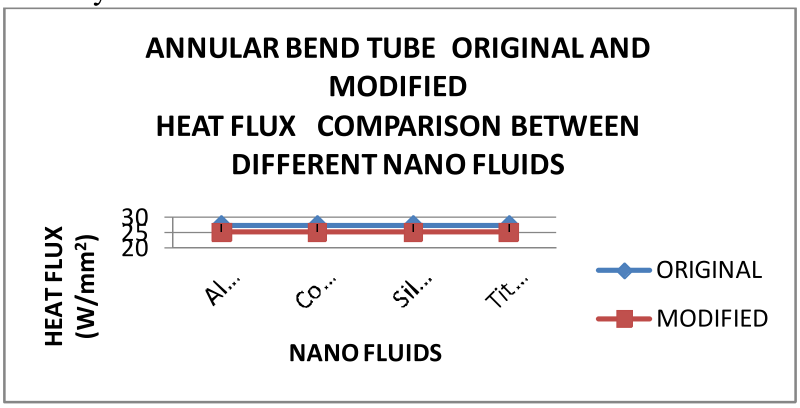
MATERIALS	CONVECTION VALUE	TEMPERATURE(K)	HEAT FLUX (W/mm^2)
Aluminum Oxide	1.43E+03	382	27.613
Copper Oxide	9.42E+02	382	27.611
Silicon carbide	1.31E+03	382	27.613
Titanium Oxide	8.63E+02	382	27.61

Table – Thermal analysis results of Original Annular Bend Tube at different Convections.

MODIFIED ANNULAR BEND TUBE

MATERIALS	CONVECTION VALUE	TEMPERATURE(K)	HEAT FLUX (W/mm^2)
Aluminum Oxide	1.47E+03	382	25.181
Copper Oxide	1.03E+03	382	25.179
Silicon carbide	1.34E+03	382	25.18
Titanium Oxide	8.82E+02	382	25.178

Table – Thermal analysis results of Modified Annular Bend Tube at different Convections.



Graph– Annular Bend Tube Original and Modified Heat Flux Comparison between Different Nano Fluids.

From the above graph it is observed that the heat flux (i.e.) heat transfer rate is more for original model and Aluminum nano fluid is used. The heat flux is increasing for annular bend tube without contact by about 2.12% when aluminum oxide nano fluid is used, by about 1.4% when copper oxide nano fluid is used, by about 1.18% when silicon carbide nano fluid is used and by about 1.1% when titanium oxide nano fluid is used when compared. So here we can use any one of the both either original or modified.

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