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CFD Simulation of Tapered Coil by Using Silicon Dioxide and Zinc Oxide Nanofluid with Water and Ethylene Glycol as Its Base Fluid

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Abstract: Helical coils are very essential for various heat exchangers, nuclear reactors and in chemical engineering because of large quantity of heat transfer in a small space with high heat transfer rates and slight residence time dispersals even it suffers through a disadvantage of larger pressure drop. The curvature creates secondary flow arrangement which is perpendicular to main axial stream path. The secondary flow has insignificant capability to improve heat transfer owed to mingling of the fluid.

The objective of this work is to compare and increase the pressure drop inside tapered helical coil heat exchanger in copper tube to succeed a better and more quantitative insight into heat transfer process by increasing secondary flow inside the coil and this can allow proper intermixing of the fluid and to maintain desired flow rate inside the helical coil.

I work on CFD to analyze the helical coil by using ANSYS 15. Generation of 3D CAD model of aluminium and copper tapered helical tube of diameter (d) 10 mm keeping PCD 50 mm, pitch 20 mm , tapered angle 2^0 and length of 500 mm by using SOLIDWORKS and exporting to the IGES format and then import in ANSYS fluent 15.

Keywords: Helical Coil, Tapered, Nano-fluid, Heat Exchanger, CFD, Pressure Drop, Temperature Distribution.

I. INTRODUCTION

In the era of growing population of world, per capita income along with demand for fresh and processed food and drinks is increasing enormously resulting in critical need in effective process technologies to produce them. Right nowadays, half of the world‘s inhabitant‘s lives in a town or city and this can be expected to be 9 billion people on the planet by 2050. Processed nutrients and liquid refreshment from name-brand manufacturers, packed to suit the needs of customers, are in just as high request as fresh products – particularly among urban buyers. Heat exchange is a key element that points on these products‘ journey to the person who lastly consumes. Cooling is vital but not sufficient alone; in addition, loss of liquid and vitamins must be efficiently prevented. Heat exchangers form us set criteria with awe to energy efficiency, mid-air throw and effectiveness. These are crucial features for accessibilities, food distribution centres, storerooms, invention halls and hypermarkets require tremendous cooling duty.

The heat exchangers can be upgraded to execute heat-transfer duty by transferring of heat and upsurge techniques as active and passive techniques. The active technique involves exterior forces, e.g. electric field and surface vibrations etc. The passive technique requires fluid flow behaviour and distinct apparent geometries. Curved tubes are used for transferring of heat improvement procedures, relatively a lot of heat transfer applications.

Helical coils are distinguished coiled tubes which have been used in multiplicity of solicitations e.g. heat recovery, air-conditioning and refrigeration schemes, chemical reactors and dairy practices. Helical coil heat exchanger is the modern improvement of heat exchangers, to fulfill the industrial demand.

A helical coil are necessary for various heat exchangers, nuclear reactors and in chemical engineering, because of large quantity of heat is transferring in a small space with high heat transmission rates and slight residence time dispersals even it suffers through a disadvantage of larger pressure drop. Pressure drop features are essential for calculating fluid effect to overwhelmed pressure drops and for arrangement of necessary mass flow rates.

The pressure drops are also a function of the pipe curvature. The curvature creates secondary flow arrangement which is perpendicular to main axial stream path. This secondary flow has insignificant capability to increase heat transfer allocated to mixing of the fluid. The strength of secondary flow established in the tube. It is the value of tube diameter and coil diameter. The force which arises due to curvature of the tube and results in secondary flow advancement with increased rate of heat transfer is centrifugal force.

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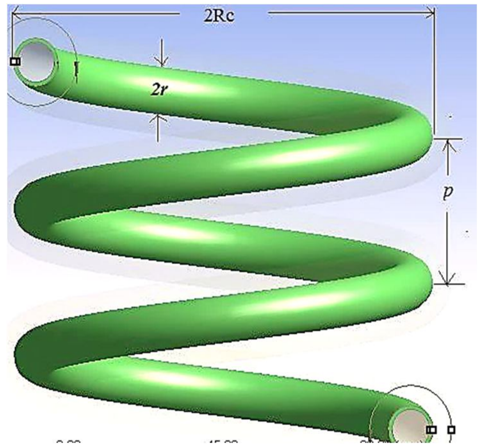

Figure 1 : Helical Coil Heat Exchanger

A. Applications Of Helical Coil

Applications of helical coil heat exchangers in various heat transfer applications are:

1) Helical coils are used for transmitting heat in chemical industries because of high heat transfer coefficient as compared to other configurations.
2) Due to compact shape they can be recycled in heat transfer applications with space limitations, for e.g. marine cooling systems, cooling of lubricating oil, steam generation in marine system and industrial applications.
3) Helically coiled tubes are broadly used in cryogenic industry for the liquefaction of gases.
4) The helical coil heat exchangers are used in food beverage industries like in food treating and pre-heating, for storing them at desired temperatures and pasteurization of liquid food objects.
5) Helical coil heat exchangers are also used as condensers in HVACs.
6) Helical coils are used in hydrocarbon processing industries for recovery of CO_2 & for cooling of liquid hydrocarbons.
7) Also employed in polymer industries for cooling purposes.

B. Nano Fluid

Now a day, it is seen that the liquid coolants which are used today, they have very poor thermal conductivity (with the omission of liquid metal, which cannot be used at most of the relevant useful temperature ranges). For example, water is evenly poor in heat conduction than copper, in the case with engine coolants, the oils, and organic coolants. The liquid having thermal conductivity and it will be limited by the natural restriction on creating turbulence or increasing area. To overcome this problem the suspension of solid in cooling liquid is a better option and a new fluid will be made which is used to increase the thermal conduction behaviour of cooling fluids.

Nanofluid are fluid particles which are a lesser amount even a μ (nearly 10-9 times smaller) in diameter and very reactive and effective material which can be used to rise factor like rate of reaction, thermal conductivity of some metal or material are that much reactive and offered four possible methods in nano fluids which may contribute to thermal conduction.

1) Brownian motion of nano particles.
2) Liquid layering at the liquid/particle edge.
3) Ballistic nature of heat transport in nano particles.
4) Nano particle clustering in nano fluids.

The Brownian motion of nano particles is too slow to transfer heat over a nano fluid. This mechanism works well only when the particle collecting has both the positive and negative effects of thermal conductivity which is gained indirectly through convection.

II. LITERATURE REVIEW

Vidula Vishnu Suryawanshi et.al. [1] done his look at in layout & evaluation of Heat Exchanger. In this paper CFD evaluation is been completed by way of numerous different diameter one of a kind fabric future works required to be completed for in addition development of helical heat exchanger are: CFD evaluation and optimization of the curvature ratio using Dean range and Colburn aspect for boundary situations of consistent wall temperature and consistent wall warmth flux for both laminar and turbulent go with the flow. To examine the outcomes and optimize the heat transfer charge with various the pitch of the helical coil.

N. Ghorbani et.al. [2] carried out experimental look at of thermal performance shell and coil heat exchanger in the cause of this text is to get entry to the have an impact on of tube diameter , coil pitch , shell side and tube side mass float price on the changed effectiveness and overall performance coefficient of vertical helical coiled tube heat exchanger. The calculation has been achieved for the constant kingdom and the experiment was conducted for both laminar and turbulent waft interior coil. It changed into observed that the mass drift charge of tube aspect to shell ratio was powerful on the axial temperature profiles of heat exchanger. He concluded that with growing mass drift charge ratio logarithmic imply temperature distinction become decreased and the changed effective's decreases with increasing mass go with the flow price.

GA Sheikhzadeh et.al. [3] has done work on Effect of Al2O3-water nanofluid on heat transfer and pressure drop in a three-dimensional micro-channel after analysis of his work he found that Addition of nanoparticles increased average Nusselt number, which indicated higher heat transfer into the fluids. Thus nano-fluids could be a promising replacement for pure water in micro-channel where there is need to more efficient heat transfer.

Ashkan Alimoradi et.al [4] has finished his investigation of exergy performance in shell and helically coiled tube warmth exchangers. He gives exergy evaluation for compelled convection heat switch in shell and helically coiled tube heat exchanger. The effect of operational and geometrical parameters on exergy efficiency became investigated. Water is chosen as the operating fluid of each facts, consequences display that, the efficiency decreases linearly with the increase of the fluids dimensionless inlet temperature distinction. primarily based on the consequences, a correlation was evolved to are expecting the performance for wide range of mass float prices ratio (0.1 < Rm < 4), fluids dimensionless inlet temperature distinction (zero < RT < zero.eight), made from Reynolds numbers (3.31E+eight < (Rec. Resh) < 1.32E+nine) and dimensionless geometrical parameters. consistent with this equation it turned into found that, the coil which has the maximum wide variety of turns and minimal diameter is extra green than other coils that have the same length and pitch.

K. Abdul Hamid et. al. [5] has done paintings on pressure drop for Oil (EG) primarily based Nano fluid. The Nano fluid is prepared through dilution approach of TiO2 in based totally fluid of aggregate water and EG in volume ratio of 60:40, at 3 volume concentrations of 0.five %, 1.0 % and 1.5 %. The test turned into carried out below a float loop with a horizontal tube test section at diverse values of glide fee for the variety of reynolds range much less than 30,000. The experimental result of TiO2 Nano fluid pressure drop is in comparison with the Blasius equation for based totally fluid. It turned into located that stress drop growth with growing of Nano fluid quantity awareness and decreases with growing of Nano fluid temperature insignificantly. He determined that TiO2 isn't always extensively increased examine to EG fluid. The working temperature of Nano fluid will lessen the stress drop because of the reducing in Nano fluid viscosity.

K Palanisamy [6] investigates the warmth switch and the pressure drop of cone helically coiled tube warmth exchanger using (Multi wall carbon nano tube) MWCNT/water nanofluids. The MWCNT/water nanofluids at zero.1%, 0.3%, and 0.five% particle quantity concentrations have been prepared with the addition of surfactant with the aid of using the 2-step method. The tests have been conducted below the turbulent glide in the Dean number range of 2200 < De < 4200. The experiments were carried out with experimental Nusselt range is 28%, 52% and 68% higher than water for the nanofluids extent concentration of 0.1%, zero.three% and zero.5% respectively. it's miles observed that the strain drop of 0.1%, zero.three% and zero.five% nanofluids are discovered to be sixteen%, 30% and 42% respectively higher than water.

Hemasunder Banka et. al. [7] have done an analytical investigation on the shell and tube heat exchanger the use of force convective heat transfer to determine drift characteristics of nano fluids with the aid of various volume fractions and mixed with water, the nano fluids are titanium carbide (TiC), titanium nitride (TiN) and ZnO Nano fluid and different extent concentrations (0.02, 0.04, 0.07 & 0.15%) flowing under turbulent waft situations. CFD evaluation is completed on warmth exchanger by making use of the house of nano fluid with distinct volume fractions to attain temperature distribution heat transfer coefficient and heat transfer fee. He discovered that heat transfer coefficient and warmth transfer quotes are increasing by means of growing the quantity fractions.

M. Balchandaran et. al [8] have accomplished experimental look at and CFD simulation of helical coil warmth exchanger the usage of solid works go with the flow simulation the use of water as fluid. The fluid used for each coil and tube side is water. The go alongwith the float price of every fluids is maintained below as laminar and the go with the flow price of cold fluid is stored constant on the equal time as that of heat fluid is modified. The readings throughout experimental observe are taken as soon as normal united states of america has reached. The general overall performance parameters regarding heat exchanger including effectiveness, preferred warmth switch coefficient, velocity contours, temperature contours and lots of others were recommended, primarily based at the outcomes.

it is inferred that the warm temperature transfer rates and one of a kind thermal houses of the helical coil heat exchanger are comparatively better than that of a right away tube heat exchanger.

B. Sidda Reddy et al. [9] studied helical tube heat exchanger as compared to immediately tubular warmth exchanger in both counter shaft and parallel glide by using variable parameters like pitch, mass glide charge , temperature and pitch coil diameter. He use outdoor diameter of stainless-steel cylinder of sixty three.five mm and inside diameter of chrome steel cylinder 1.058D mm, thickness of tube range from 6 mm to 9 mm, flow fee of cold and hot water is taken 0.0625 kg/s and 0.166 kg/s. The initial temperature of bloodless and hot water is 300C and 1000C is taken. Result show that warmth transfer growth incounter glide configuration whilst hot fluid mass drift charge is increased. growth in pitch coil diameter decreases the price of heat switch at identical configuration and at the same mass drift charge additionally if the coil pitch increases there is lower in heat switch at equal mass float rate.

Helical coils making sure large surface vicinity which allows the fluid to be interacting with the walls for greater time period. in order that there's enhancement in heat transfer as evaluate to of hetero pipe.

Shiva Kumar et al. 2013 [10] studied CFD simulation of copper made helical coil warmth exchanger, used water as a operating fluid underneath consistent wall temperature conditions for both immediately and helical tube heat exchangers. The geometrical parameters of helical coil are 10 mm interior tube diameter, pitch coil diameter of forty mm, pitch of 15 mm at waft price of 0.half kg/s, 0.02 kg/s and zero.05 kg/s at three one-of-a-kind Reynolds numbers (Re) of 1068, 4274 and 10685. overall performance parameters followed for contrast are go out temperature of water, heat switch charge heat transfer coefficient and strain drop. He perceived that, the pressure drop is 11% large in helical coil than that for immediately tube heat exchangers. boom in Nusselt wide variety (Nu) is 10% for helical coils; however stress drop in case of helical coils is higher when related to instantly tubes. Fluid streams within the outside layer exchanges greater right away than the fluid streams within the internal layer of the tube. difference within the fluid velocity will increases vortex formation and creating secondary drift within the coil, by means of which the warmth switch rate increases.

T. Srinivas et. al. [11] have accomplished experimental take a look at on heat switch Enhancement using Copper Oxide (CuO)/Water Nano fluid in a Shell and Helical coil heat exchanger. Experiments have been done in a shell and helical coil warmth exchanger at numerous concentrations of CuO nanoparticles in water (0.three, 0.6, 1, 1.five & 2%), velocity (500, 1000 and 1500rpm) and shell side fluid (heating medium) temperatures (forty, forty five & 500C). Water has been used as coil side fluid. He observed that the heat switch rate increases with growth in awareness of CuO/water Nano fluid this could be attributed to multiplied thermal conductivity of base fluid due to the addition of nano debris.

Vinita Sisodiya et. al. [12] take a look at on the use of Helical coil heat exchangers (HCHEs) with (Aluminium Oxide) Al2O3 - Water section exchange material to recognize if HCHEs can yield extra prices of warmth switch. An analytical take a look at changed into conducted the usage of a counter go with the flow HCHE along with 8 helical coils. two analysis changed into performed, one where water changed into used as warmth transfer fluid (HTF) on the coil and sell facets, respectively; at the same time as the second one made use of different extent fractions of Al2O3 and water at the coil and shell facets, respectively. The NTU effectiveness courting of the HCHE whilst Al2O3 fluid is used processes that of a warmth exchanger with a warmness capacity ratio of 0. the heat switch results have proven that when using an Al2O3, as boom in warmness transfer price may be acquired whilst as compare to heat switch outcomes received using directly warmness transfer sections. it's been concluded that the extended precise warmth of the Al2O3 as well as the fluid dynamics in helical coil pipes are the primary contributors to the increased heat switch.

III. COMPUTATIONAL FLUID DYNAMICS

Computational simulation is technique for examining fluid flow, heat transfer and related phenomena such as chemical réactions. This project uses CFD for analysis of flow and heat transfer. CFD analysis accepted out in the numerous industries is used in R&D and manufacturing of aircraft, internal combustion engines and in power plant combustion as well as in many industrial applications.

The advancement in the high speed computers and the computational fluid dynamics (CFD) has a great impression on the engineering strategy and survey of the heat exchangers. In the previous decades, explain compound geometry and complex drift problem to increasing capability of design and examination and for decreasing the cost and time. The CFD methodology has appear to become an effective approach for collecting information to improve engineering design and investigation of heat exchangers.

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IV. METHODOLOGY

A. Pre Processing

1) *CAD Modeling:* Creation of CAD Model by by means of CAD modeling tools for making the geometry of the part/assembly of which we want to accomplish FEA. CAD model may be 2D or 3D.

a) *Type of Solver:* Pick the solver for the problem from Pressure Based and density based solver.
b) *Physical model:* Choose the required physical model for the problem i.e. laminar, turbulent, energy, multiphase, etc.
c) *Material Property:* Choose the Material property of flowing fluid.
d) *Boundary Condition:* Define the desired boundary condition for the problem i.e. velocity, mass flow rate, temperature, heat flux etc.

B. Solution

1) *Solution Method:* Choose the Solution method to solve the problem i.e. First order, second order.
2) *Solution Initialization:* Initialized the solution to get the initial solution for the problem.
3) *Run Solution:* Run the solution by giving no of iteration for solution to converge.

C. Post Processing

For viewing and clarification of result, this can be viewed in various formats like graph, value, animation etc.

- STEP 1: CFD analysis of helical coil heat exchanger by using ANSYS 15

Pre-processing:

CAD Model: Generation of 3D model by using SOLIDWORKS and exporting to the IGES format and then import in ANSYS fluent 15.

CAD modelling / meshing has been done by following steps

a) Open Solid works then select part for modelling.
b) In part modelling select circle of 50 mm diameter.
c) After that select helix geometry of pitch 20 mm, tapered angle 2^0 and length 500 mm.
d) Now again come to circle command and at the end of helix pierce it.
e) Then select sweep command and in sweep command selecting tube then click to curve and geometry came.

Table 1 : Parameters of Geometry of Tapered Helical Coil

S.No.	Dimensional Parameters	Dimensions
1	Pitch Coil Diameter	50 mm
2	Tube Diameter	10 mm
3	Pitch	20 mm
4	Tube Length	500 mm
5	Tapered angle	2^0

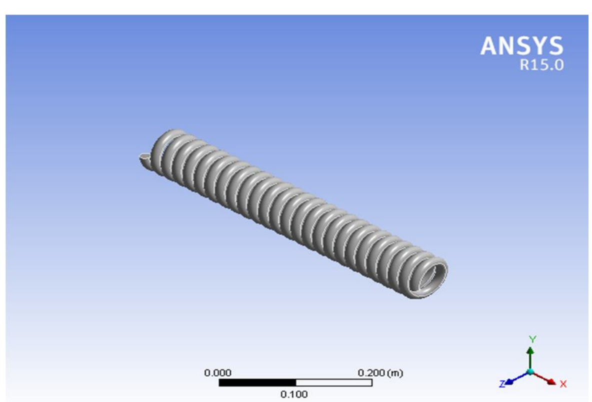

Figure 2 : 3D model of helical coil heat exchanger with PCD 50 mm and tube diameter 10 mm.

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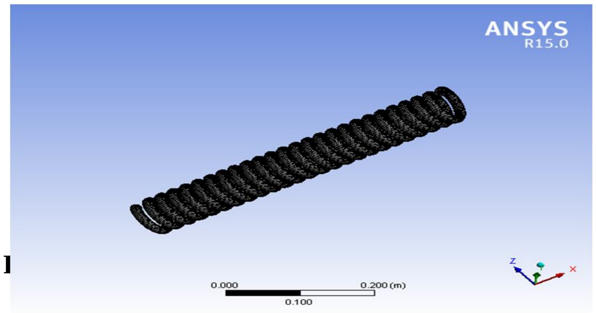

Figure 4: Meshing of Helical Coil Heat Exchanger

Table 3 : Helical Coil Meshing Statistics

Mesh type	Fine grid mesh
No. of nodes	160447
No. of elements	130754

- *Step 3*

Fluent Setup:

After mesh setup generation define the following steps in the **ANSYS** fluent 15.

- Problem Type -3D solid
- Type of Solver – pressure
- Physical Model – viscous k- two equation turbulence model
- Mixture- Volume of fraction

- *Step 4*

Fluid Property

Table 5: Properties of Zinc Oxide Nanofluid

Density (ρ)	1091.7 kg/m^3
Viscosity (μ)	0.0010531 kg/m-s
Specific heat (C_p)	3.7982 KJ/Kg-K
Thermal conductivity (k)	25.32 Watt/mK

Table 6: Properties of Silicon Dioxide Nanofluid

Density (ρ)	2196.7 kg/m^3
Viscosity (μ)	0.0012531 kg/m-s
Specific heat (C_p)	0.680 KJ/Kg-K
Thermal conductivity (k)	1.3 Watt/mK

Table 7: Properties of Water

Density (ρ)	998.2 kg/m^3
Viscosity (μ)	0.0010003 kg/m-s
Specific heat (C_p)	4.182 KJ/Kg-K
Thermal conductivity (k)	0.6 Watt/K

Table 8: Properties of Ethylene Glycol

Type of fluid	Ethylene Glycol
Density (ρ)	1111.4 kg/m3
Viscosity (μ)	0.0157 kg/m-s
Specific heat (Cp)	2.415 KJ/Kg-K
Thermal conductivity (k)	0.252 Watt/mK

D. ***Solution***

Solution Method

Pressure - Velocity - Coupling – Scheme - Simple

- Pressure – standard pressure
- Momentum- 2nd order
- Turbulence –kinetic energy 2nd order
- Turbulence dissipation rate 2nd order

Solution Initialisation

Initiate the solution to get the initial solution for the problem.

Run Solution

Run the solution by giving 500 number of iteration for solving the convers.

Post Processing

For viewing and interpret of result, the result can be viewed in various formats like graph, value, animations etc.

V. RESULTS & DISCUSSION

1) The pressure drop data were collected for the configuration of tapered for the ZnO and SiO_2 nanofluid as water and ethylene glycol as its base. The various effects were observed.
2) CFD computations were done for copper coiled tube.
3) Performance parameters adopted for comparison of pressure drop and temperature distribution in all the cases.
4) Effect of total Pressure drop in tapered helical coil using SiO2 nanofluid as ethylene glycol as a base fluid.

Table 9: Effect of pressure drop on the helical coil by using SiO_2 nanofluid as ethylene glycol as its base fluid.

Case	Tube diameter	Fluid	Pressure drop (Pa)
1	10 mm	SiO_2 Nano fluid	2268

5) Effect of Temperature on the tapered helical coil by using SiO_2 nanofluid with ethylene glycol as its base fluid on high pressure.

Table 10: Effect of Temperature on the helical coil by using SiO_2 nanofluid with ethylene glycol as its base fluid on high pressure

Case	Tube diameter	Fluid	Tempera ture (K)
1	10 mm	SiO2 Nano fluid	340

6) Effect of pressure drop on the tapered helical coil by using SiO_2 nanofluid as water as its base fluid.

Table 11 : . Effect of pressure drop on the helical coil by using SiO_2 nanofluid as water as its base fluid.

Case	Tube diameter	Fluid	Pressure drop (Pa)
1	10 mm	SiO_2 Nano fluid	553

7) Effect of Temperature on the tapered helical coil by using SiO_2 nanofluid as water as its base fluid on high pressure

Table 12: Effect of Temperature on the helical coil by using SiO_2 nanofluid as water as its base fluid on high pressure

Case	Tube diameter	Fluid	Temperatu re (K)
1	10 mm	SiO_2 Nano fluid	339.4

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8) Effect of pressure drop on the tapered helical coil by using ZnO nanofluid as ethylene glycol as its base fluid.

Table 13: Effect of pressure drop on the tapered helical coil by using ZnO nanofluid as ethylene glycol as its base fluid.

Case	Tube diameter	Fluid	Pressure drop (Pa)
1	10 mm	ZnO Nano fluid	439875

9) Effect of temperature on the tapered helical coil by using ZnO nanofluid as ethylene glycol as its base fluid on high pressure.

Table 14: Effect of temperature on the tapered helical coil by using ZnO nanofluid as ethylene glycol as its base fluid on high pressure.

Case	Tube diameter	Fluid	Temperature (K)
1	10 mm	ZnO Nano fluid	342

10) Effect of pressure drop on the tapered helical coil by using ZnO nanofluid as water as its base fluid.

Table 15: Effect of pressure drop on the helical coil by using ZnO nanofluid as water as its base fluid.

Case	Tube diameter	Fluid	Pressure drop (Pa)
1	10 mm	ZnO Nano fluid	726

11) Effect of temperature on the helical coil by using ZnO nanofluid as water as its base fluid on high pressure.

Table 16: Effect of temperature on the helical coil by using ZnO nanofluid as water as its base fluid on high pressure.

Case	Tube diameter	Fluid	Temperature (K)
1	10 mm	ZnO Nano fluid	340

12) *Case-1:* Tube Diameter is 10 mm, SiO_2 nanofluid is used as ethylene glycol as its base fluid in tapered helical coil, Pressure drop is 2268 Pa

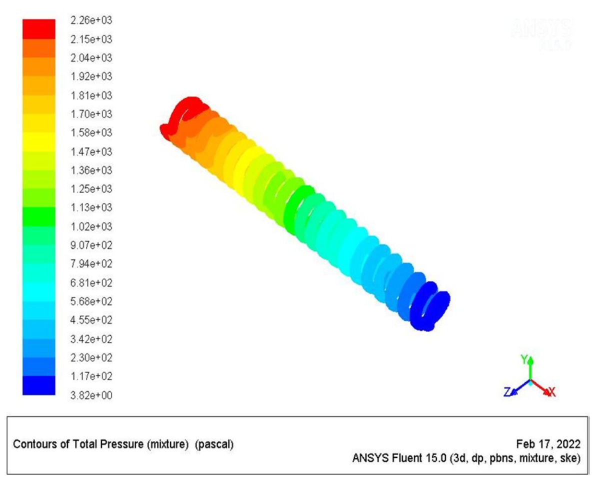

Figure 6 : Total Pressure in copper helical coil using SiO_2 nanofluid as ethylene glycol as a base fluid

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13) *Case-2:* Tube Diameter is 10 mm, SiO_2 nanofluid is used as water as its base fluid in tapered helical coil, pressure drop is 553 Pa

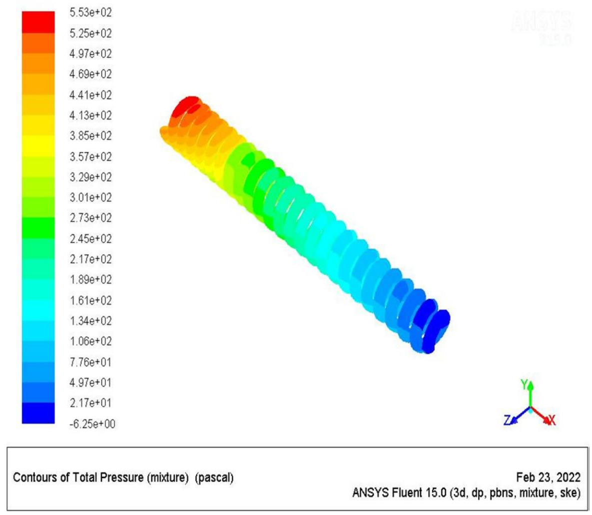

Figure 7 :Total Pressure in copper helical coil using SiO_2 as a nano fluid and water as a base fluid

14) *Case-3:* Tube Diameter is 10 mm, ZnO nanofluid is used as ethylene glycol as its base fluid in tapered helical coil, pressure drop is 439875 Pa.

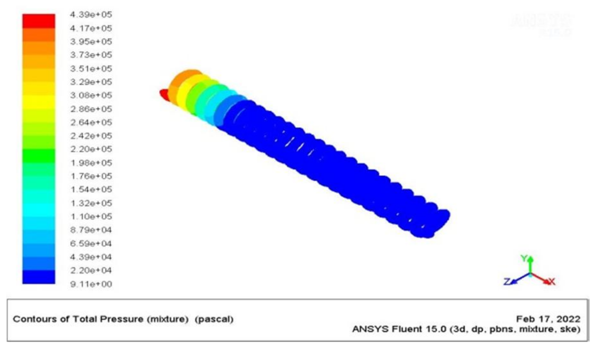

Figure 8 :Total Pressure in copper helical coil using ZnO as a nano fluid and ethylene glycol as a base fluid.

15) *Case-4*: Tube Diameter is 10 mm, ZnO nanofluid is used as water as its base fluid in tapered helical coil, pressure drop is 726 Pa.

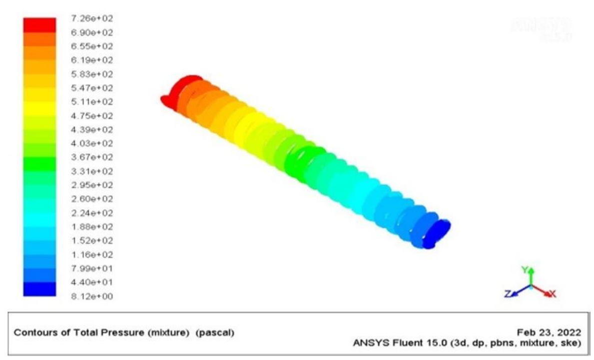

Figure 9 :Total Pressure in copper helical coil using ZnO as a nano fluid and water as a base fluid

16) *Case-5:* Tube Diameter is 10 mm, SiO_2 nanofluid is used as ethylene glycol as its base fluid in tapered coil, total temperature is 340 K.

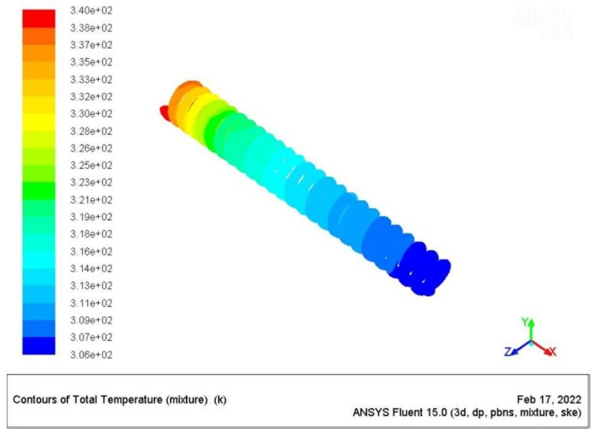

Figure 10 : Total Temperature in tapered helical coil using SiO_2 as a nano fluid and ethylene glycol as a base fluid

17) *Case-6: Tube Diameter is 10 mm, SiO2 nanofluid is used as water as its base fluid in tapered coil, temperature is 339.4 K*

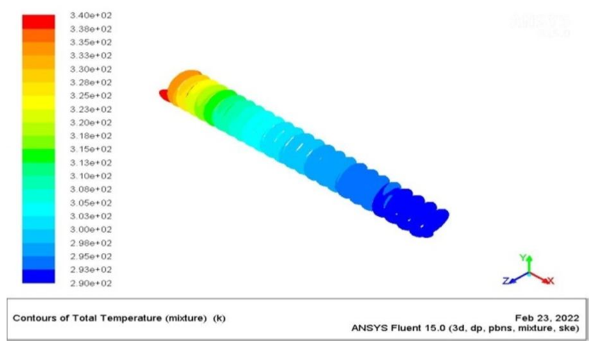

Figure 11 : Total Temperature in tapered helical coil using SiO_2 as a nano fluid and water as a base fluid

18) *Case-7:* Tube Diameter is 10 mm, ZnO nanofluid is used as ethylene glycol as its base fluid in tapered coil, temperature is 342 K

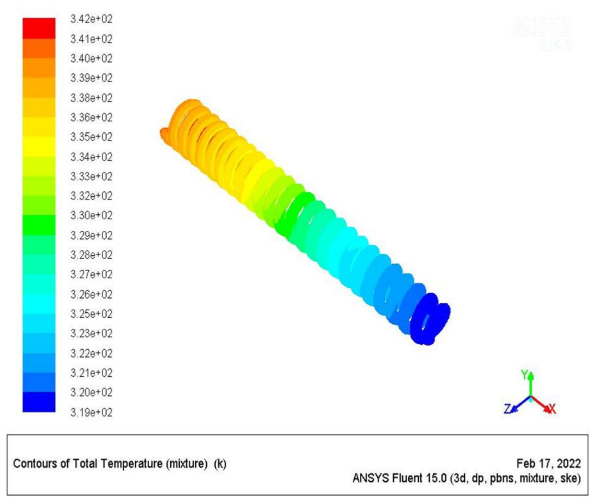

Figure 12 : Total Temperature in tapered helical coil using ZnO as a nano fluid and ethylene glycol as a base fluid

19) Case-8: Tube Diameter is 10 mm, ZnO nanofluid is used as water as its base fluid in tapered coil, temperature is 340 K.

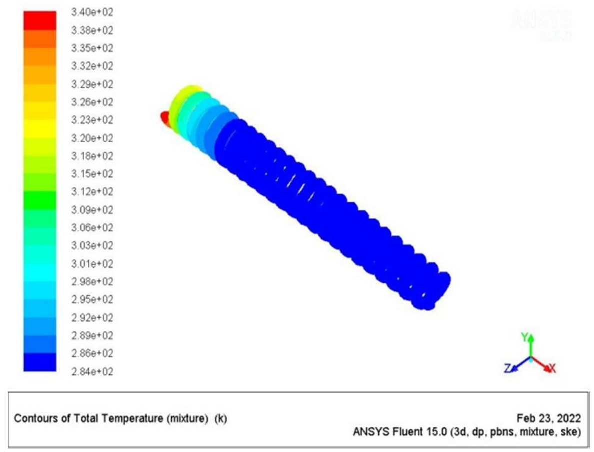

Figure 13 : Total Temperature in tapered helical coil using ZnO as a nano fluid and water as a base fluid

From above it is clear that when we used the ZnO nanofluid using ethylene glycol as a base fluid in tapered helical coil then pressure drops increases in ZnO because of presence of metal particles and the base fluid properties. The numerical study considers the effect of ZnO nanofluid using ethylene glycol as its base fluid and SiO_2 nanofluid using ethylene glycol and ZnO nanofluid using water as its base fluid and SiO_2 nanofluid using water as its base fluid in tapered helical coil on the flow and heat transfer characteristics of tube.

VI. CONCLUSION

In this paper, analytical investigations are done on the tapered helical coil heat exchanger, to determine pressure drop and temperature distribution of water and ethylene glycol as a base fluid and a Silicon Dioxide and zinc oxide as a nanofluid on copper coil flowing under laminar flow conditions. By observing the CFD analysis results, we know that the material which has high thermal conductivity that fluid will give high pressure drop. The pressure drop is more in Zinc oxide nanofluid with ethylene glycol as a base fluid in helical coil heat exchanger.

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