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Analysis and Comparison of Shell and Helical Coil Heat Exchanger by Using Silica and Alumina

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Abstract: Shell and Helical coils are eminent coiled tubes which have been used in diversity of solicitations e.g. heat recovery, air-conditioning and preservation schemes, chemical reactors and dairy practices. Shell and Helical coil heat exchanger is the recent improvement of heat exchangers, to accomplish the industrial demand.

A shell and helical coil are necessary for various heat exchangers, nuclear reactors and in chemical engineering, for of large quantity of heat is conveying in a slight space with high heat transmission rates and slight habitation time distributions even it suffers through a disadvantage of larger pressure drop.

The unbiased of this work is to cheered the pressure drop inside a shell and helical coil heat exchanger, heat transfer progression can be improved by increasing secondary flow inside the coil and this can be allow by appropriate blending of the fluid inside the helical coil. For this, my planned work on CFD to scrutinize the helical coil by using ANSYS 18.2. A 3D design of CAD model of helical coil of tube outer diameter (do) 16 mm, inner diameter of helical coil (di) 12 mm, pitch of 26.3mm, pitch coil dia. 86 mm, tube length of 235 mm, shell diameter is 110 mm and shell length is 215 mm, is generated by using ANSYS fluent 18.2.

Keywords: Shell, Helical Coil, 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.

Shell and Helical coils are distinguished shell and coiled tubes which have been used in multiplicity of solicitations e.g. heat recovery, air-conditioning and refrigeration schemes, chemical reactors and dairy practices.

Shell and Helical coil heat exchanger is the modern improvement of heat exchangers, to fulfill the industrial demand. 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.

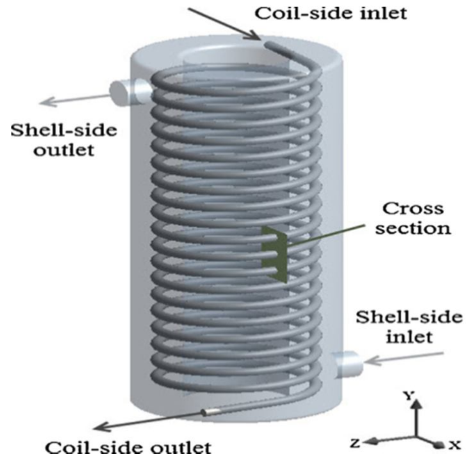

Figure 1 : Shell and Helical Coil Heat Exchanger

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

Shell and Helical coil is very compact in structure and it possess high heat transfer coefficient that why helical coils heat exchangers are widely used. In literature it has been informed that heat transfer rate of helical coil is larger than straight tube.

Pranita Bichkar et.al. [1] has done his study in Shell and Tube Heat Exchangers with the effects of types of baffles. This paper presents the numerical simulations carried out on different baffles i.e. single segmental, double segmental and helical baffles. This shows the effect of baffles on pressure drop in shell and tube heat exchanger. Single segmental baffles show the formation of dead zones where heat transfer cannot take place effectively. Double segmental baffles reduce the vibrational damage as compared to single segmental baffles. The use of helical baffles shows a decrease in pressure drop due to the elimination of dead zones. The less dead zones result in better heat transfer. The lower pressure drop results in lower pumping power, which in turn increases the overall system efficiency. The comparative results show that helical baffles are more advantageous than other two baffles.

Lei et al. [2] carried out a numerical investigation to study the impact of various baffle inclination angles on fluid flow and heat transfer of continuous helical shell and tube heat exchangers by using periodic model. From the results computed, it was observed that the best-integrated performance occurs approximately 45° helix angle. Performance of heat exchanger also depends on pressure drop. Leakage can reduce pressure drop and thus per compartment average heat transfer coefficient.

Vidula Vishnu Suryawanshi et.al. [3] done his study in design & Analysis of Helical Coil Heat Exchanger. In this paper CFD analysis is been carried out by various different diameter different material Future works required to be carried out for further improvement of helical heat exchangers are:CFD analysis and optimization of the curvature ratio using Dean number and Colburn factor for boundary conditions of constant wall temperature and constant wall heat flux for both laminar and turbulent flow. To analyse the results and optimize the heat transfer rate with varying the pitch of the helical coil.

Vishal Momale et.al. [4] Study in the performance analysis of conical helical tube heat exchanger with straight and conical shell using cfd. The analysis of conical helical tube heat exchanger is carried out using computational fluid dynamics. There is much improvement in heat transfer as the more shell fluid comes in contact with the tube fluid when we use conical shell instead of helical shell. The pressure drop will increase with conical shell arrangement. We can still increase heat transfer if we use baffles.

The Mohamed Ali et.al. [4] was performed the experimental investigation of Natural convection made to study, steady type Natural Convection was obtained from turbulent natural convection to water. The experiment have been carried for four coil diameter to tube diameter ratio for five and ten coil tubes and for five pitch outer diameter ratio. He correlated Rayleigh Number for two different coil sets and the heat transfer coefficient decreases with coil length for tube diameter do =0.012m but increases with coil length for do=0.008m. For tube diameter of 0.012 m with either five or ten coil turns, critical D/d0 is obtained for a maximum heat transfer coefficient.

R. Patil et.al. [5] suggested design methodology for helical coil heat exchanger. heat transfer coefficient based on the inside coil diameter hi, is obtained using method for a straight tube either one of Sieder –Tate relationships or plot of the Colburn factor ,JH vs Re. outside heat transfer coefficient is calculated using correlation for different range of Reynolds number. Helical coil heat exchanger is the better choice where space is limited and under the conditions of low flow rates or laminar flow.

N. Ghorbani et.al. [6] conducted experimental study of thermal performance shell and coil heat exchanger in the purpose of this article is to access the influence of tube diameter , coil pitch , shell side and tube side mass flow rate on the modified effectiveness and performance coefficient of vertical helical coiled tube heat exchanger. The calculation has been performed for the steady state and the experiment was conducted for both laminar and turbulent flow inside coil. It was found that the mass flow rate of tube side to shell ratio was effective on the axial temperature profiles of heat exchanger. He concluded that with increasing mass flow rate ratio the logarithmic mean temperature difference was decreased and the modified effective's decreases with increasing mass flow rate.

Sunil Kumar et.al. [7] has done his investigation on the optimize design of helical coil heat exchanger by using fins and the Compare pressure & temperature by conventional design. The final outcome of the study increase the total heat transfer rate inside the domain. And increase the pressure drop inside the domain. The water outlet temperature decrease up to 315k and cold outlet temperature increase up to 320 k. and total pressure drop increase with the temperature increases. Finally the CFD data were compared with previous data the total pressure drop increase up to 0.65 bar for case-2.the overall efficiency of the system incites up to 5% to 6%.

K. Abdul Hamid et. al. [8] has done work on pressure drop for Ethylene Glycol (EG) based nanofluid. The nanofluid is prepared by dilution technique of TiO_2 in based fluid of mixture water and EG in volume ratio of 60:40, at three volume concentrations of 0.5 %, 1.0 % and 1.5 %. The experiment was conducted under a flow loop with a horizontal tube test section at various values of flow rate for the range of Reynolds number less than 30,000. The experimental result of TiO_2 nanofluid pressure drop is compared with the Blasius equation for based fluid. It was observed that pressure drop increase with increasing of nanofluid volume concentration and decrease with increasing of nanofluid temperature insignificantly. He found that TiO_2 is not significantly increased compare to EG fluid. The working temperature of nanofluid will reduce the pressure drop due to the decreasing in nanofluid viscosity.

Palanisamy et. al [9] observes the heat transfer and the pressure drop of cone helically coiled tube heat exchanger by (Multi wall carbon nano tube) MWCNT/water nanofluids.

The MWCNT/water nanofluids at 0.1%, 0.3%, and 0.5% atom volume absorptions were equipped with the calculation of surfactant by using the two-step method. The investigations were showed under the turbulent flow in the Dean number range of 2200 <De <4200.

The tests were attended with tentative Nusselt number is 28%, 52% and 68% higher than water for the nanofluids volume concentration of 0.1%, 0.3% and 0.5% respectively. It is originate that the pressure drop of 0.1%, 0.3% and 0.5% nanofluids are found to be 16%, 30% and 42% respectively more than water.

Hemasunder Banka et. al. [10] has done an methodical investigation on the shell and tube heat exchanger by forced convective heat transfer to determine flow physical appearance of nano fluids by fluctuating volume fractions and mixed with water, the nano fluids are titanium carbide (TiC), titanium nitride (TiN) and ZnO nanofluid and dissimilar volume concentrations (0.02, 0.04, 0.07 & 0.15%) flowing under turbulent flow conditions. CFD analysis is done on heat exchanger by relating the properties of nano fluid with different volume fractions to obtain temperature distribution, heat transfer coefficient and heat transfer rate.

He found that heat transfer coefficient and heat transfer rates are growing by cumulative the volume fractions.

Jaafar Albadr et. al. [11] has done experimental study on the forced convective heat transfer and flow characteristics of a nanofluid consisting of water and different volume concentrations of Al_2O_3 nanofluid (0.3–2) % flowing in a horizontal shell and tube heat exchanger counter flow under turbulent flow conditions are investigated. The Al_2O_3 nanoparticles of about 30 nm diameter are used in the present study. The results show that the convective heat transfer coefficient of nanofluid is slightly higher than that of the base liquid at same mass flow rate and at same inlet temperature. The heat transfer coefficient of the nanofluid increases with an increase in the mass flow rate, also the heat transfer coefficient increases with the increase of the volume concentration of the Al_2O_3 nanofluid, however increasing the volume concentration cause increase in the viscosity of the nanofluid leading to increase in friction factor.

Saket A Patel et.al. [12] done CFD analysis of heat transfer enhancement in helical coil heat exchanger by varying helix angle. His attempts are made to enhance the overall heat transfer coefficient in HCHE by varying helix angle. Hot water flows in helical coil and cold water flows in shell side. Three different angles are analysing for that. Optimum helix angle is found out by CFD analysis. Results indicate that at 20 helix angle gives maximum overall heat transfer coefficient about 33% increases compared to 0^0 angle.

Jyachandraiah et.al.[13] focus his work on CFD analysis of HCHE by varying different volume flow rates at coil side with constant flow rate at shell side. various flow rate values are 40, 60, 80, 100 and 140 LPH. Result shows that dean number increase in coil side flow rate and the overall heat transfer coefficient increase with increase in flow rate at coil side. The greater effectiveness of 0.80 was obtained at 40 LPH.

A. Computational Fluid Dynamics

Computational fluid dynamics, as the name implies it is a subject that deals with computational approach to fluid dynamics with numerical solution of the equations which bring about the flow of the fluid and although it is also called computational fluid dynamics; it does not just deal with the equations of the fluid flow, it is also generic enough to be able to solve simultaneously together the equations that direct the energy transfer and as well the equations that determine the chemical reaction rates and how the chemical reaction proceeds and mass transfer takes place; all these things can be tackled together in an identical format. So, this outline enables us to deal with a very complex flow circumstances in reasonably fast time, such that for a particular set of conditions, an engineer will be capable to simulate and see how the flow is taking place and what kind of temperature distribution there is and what kind of products are made and where they are formed, so that we can make changes to the parameters that are under his control to modify the way that these things are happening. So, in that case CFD becomes a great tool of design for an engineer. It is also a great tool for an analysis for an examination of a reactor or equipment which is not functioning well because in typical industrial applications.

III. METHODOLOGY

A. Pre Processing

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.

1) *Type of Solver:* Pick the solver for the problem from Pressure Based and density based solver.
2) *Physical Model:* Choose the required physical model for the problem i.e. laminar, turbulent, energy, multiphase, etc.
3) *Material Property:* Choose the Material property of flowing fluid.
4) *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.

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 18.2

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Pre-processing:
CAD Model: Generation of 3D model by using ANSYS fluent 18.2.

Table 1 : Parameters of Geometry of Shell and Helical Coil

S.No.	Dimensional Parameters	Dimensions
1	Pitch Coil Diameter	86 mm
2	Helical Coil Outer Diameter	16 mm
3	Helical Coil Inner Diameter	12 mm
4	Pitch	26.3 mm
5	Tube Length	235 mm
6	Shell Diameter	110 mm
7	Shell Length	215 mm

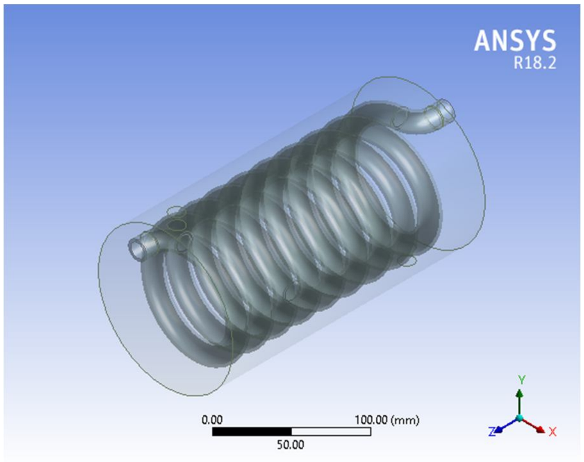

Figure 2 : 3D model of shell and helical coil heat exchanger

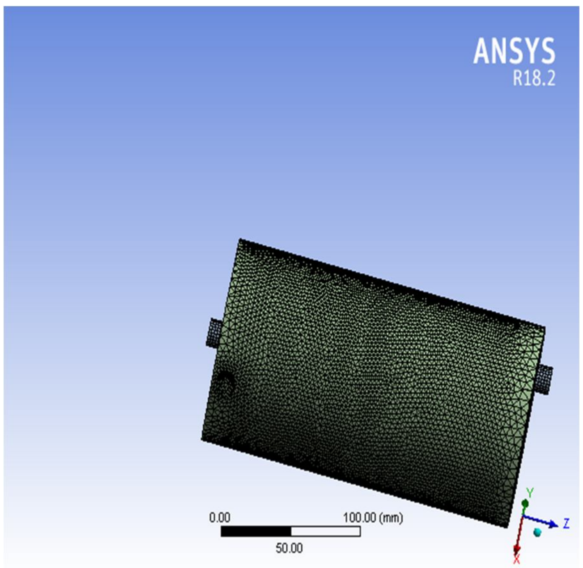

Figure 3: Meshing of Shell and Helical Coil Heat Exchanger

Table 2 : Shell and Helical Coil Meshing Statistics

Mesh type	Fine grid mesh
No. of nodes	166108
No. of elements	287186

- STEP 2

Fluent Setup:

After mesh setup generation define the following steps in the **ANSYS** fluent 18.2.

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

- STEP 3

Fluid Property

Table No. 3 Property of Al_2O_3 Nanofluid

Type of fluid	Al_2O_3
Density (ρ)	3600 kg/m^3
Viscosity (μ)	0.0001548 kg/m-s
Specific heat (C_p)	765 J/Kg-K
Thermal conductivity (k)	36 Watt/mK

Table No 4 Property of Water

Type of fluid	Water
Density (ρ)	998.2 kg/m^3
Viscosity (μ)	0.2 kg/m-s
Specific heat (C_p)	1670 J/Kg-K
Thermal conductivity (k)	0.162 Watt/mK

Table No.5 Property of SiO_2 Nanofluid

Type of fluid	SiO_2
Density (ρ)	2196.7 kg/m^3
Viscosity (μ)	0.00189 kg/m-s
Specific heat (C_p)	880 J/Kg-K
Thermal conductivity (k)	30 Watt/mK

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.

IV. RESULTS & DISCUSSION

1) Strain drop data was gathered for the shell and helical warmness exchanger design for the Al_2O_3 nanofluid with ethylene glycol as its foundation.
2) CFD simulations for the copper shell and helical heat exchanger have been completed.
3) overall performance metrics used in all circumstances to evaluate pressure drop and temperature distribution static pressure effects on warm fluid for shell and helical coil warmth exchangers using alumina as a nanofluid and water as its foundation
4) static pressure effects on warm fluid for shell and helical coil warmth exchangers using alumina as a nanofluid and water as its foundation

TABLE 6 Effects of static pressure in hot fluid

Case	Fluid	Pressure drop (Pa)
1	Al_2O_3 Nano fluid	2820

5) Effects of static pressure on cold fluid for shell and helical coil heat exchanger when alumina is used as a nanofluid and water as its base.

TABLE 7 Effects of static pressure in cold fluid.

Case	Fluid	Pressure drop (Pa)
1	Al_2O_3 Nano fluid	1448

6) Effects of total pressure on hot fluid for shell and helical coil heat when alumina is used as a nanofluid and water as its base.

TABLE 8 Effects of Total Pressure in hot fluid.

Case	Fluid	Pressure drop (Pa)
1	Al_2O_3 Nano fluid	2999.4

7) Effects of total pressure on cold fluid for shell and helical coil heat exchanger when alumina is used as a nanofluid and water as its base

TABLE 9 Effects of Total Pressure in cold fluid.

Case	Fluid	Pressure drop (Pa)
1	Al_2O_3 Nano fluid	1708

8) Effects of static temperature on hot fluid for shell and helical coil heat exchanger when alumina is used as a nanofluid and water as its base.

TABLE 10 Effects of static temperature in hot fluid.

Case	Fluid	Temperature (K)
1	Al_2O_3 Nano fluid	342.5

9) Effects of static temperature on cold fluid for shell and helical coil heat exchanger when alumina is used as a nanofluid and water as its base.

TABLE 11 Effects of static temperature in cold fluid.

Case	Fluid	Temperature (K)
1	Al_2O_3 Nano fluid	326.7

10) Effects of total temperature on hot fluid for shell and helical coil heat exchanger when alumina is used as a nanofluid and water as its base .

TABLE 12 Effects of total temperature in hot fluid.

Case	Fluid	Temperature (K)
1	Al_2O_3 Nano fluid	343.7

11) Effect of total temperature on cold fluid for shell and helical coil heat exchanger when alumina is used as a nanofluid and water as its base.

TABLE 13 Effects of total temperature in cold fluid.

Case	Fluid	Temperature (K)
1	Al_2O_3 Nano fluid	322.9

12) Effects of static pressure on hot fluid for shell and helical coil heat exchanger when silica is used as a nanofluid and water as its base.

TABLE 14 Effects of static pressure in hot fluid

Case	Fluid	Pressure drop (Pa)
1	SiO_2 Nano fluid	2483

13) Effects of static pressure on cold fluid for shell and helical coil heat exchanger when silica is used as a nanofluid and water as its base.

TABLE 15 Effects of static pressure in cold fluid.

Case	Fluid	Pressure drop (Pa)
1	SiO_2 Nano fluid	1558

14) Effects of total pressure on hot fluid for shell and helical coil heat exchanger when silica is used as a nanofluid and water as its base.

TABLE 16 Effects of Total Pressure in hot fluid.

Case	Fluid	Pressure drop (Pa)
1	SiO_2 Nano fluid	2548

15) Effects of total pressure on cold fluid for shell and helical coil heat exchanger when silica is used as a nanofluid and water as its base.

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TABLE 17 Effects of Total Pressure in cold fluid.

Case	Fluid	Pressure drop (Pa)
1	SiO_2 Nano fluid	1038

16) Effects of static temperature on hot fluid for shell and helical coil heat exchanger when silica is used as a nanofluid and water as its base.

TABLE 18 Effects of static temperature in hot fluid.

Case	Fluid	Temperature (K)
1	SiO_2 Nano fluid	332

17) Effects of static temperature on cold fluid for shell and helical coil heat exchanger when silica is used as a nanofluid and water as its base.

TABLE 19 Effects of static temperature in cold fluid**.**

Case	Fluid	Temperature (K)
1	SiO_2 Nano fluid	329

18) Effects of total temperature on hot fluid for shell and helical coil heat exchanger when silica is used as a nanofluid and water as its base .

TABLE 20 Effects of total temperature in hot fluid.

Case	Fluid	Temperature (K)
1	SiO_2 Nano fluid	337.4

19) Effects of total temperature on cold fluid for shell and helical coil heat exchanger when silica is used as a nanofluid and water as its base.

TABLE 21 Effects of total temperature in cold fluid.

Case	Fluid	Temperature (K)
1	SiO_2 Nano fluid	334.1

- Case-1 Al_2O_3 nanofluid is used as water as its base fluid in shell and helical coil, Static Pressure drop by using hot fluid when mass flow rate is 0.05m/s

Figure-4 Static pressure in shell and helical coil for hot fluid

The largest stress reduction obtained is 2820 Pa. The strain drop is originally 47.1 Pa at the lowest region of the coil and 221 Pa at the middle portion, with a 173.nine Pa rise in pressure drop from lower to centre part of coil. The strain drop from 221 Pa to 2820 Pa is steadily increasing from the centre to the pinnacle of the coil, and the mass glide rate is 0.05m/s.

- Case-2 Al_2O_3 nanofluid is used as ethylene glycol as its base fluid in shell and helical coil, Static Pressure drop by using cold fluid when mass flow is 0.05m/s.

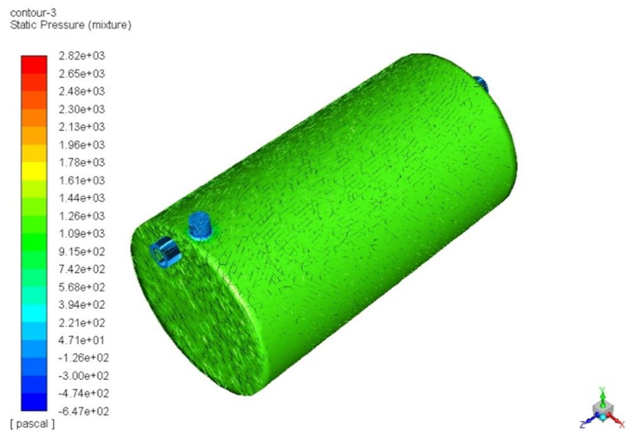

Figure-5 Static pressure in shell and helical coil for cold fluid

- Case-3 Al_2O_3 nanofluid is used as ethylene glycol as its base fluid in shell and helical coil, Total Pressure drop by using hot fluid when mass flow rate is 0.05m/s.

Figure-6 Total pressure in shell and helical coil for hot fluid

- Case-4 Al_2O_3 nanofluid is used as ethylene glycol as its base fluid in shell and helical coil, Total Pressure drop by using cold fluid when mass flow rate is 0.05m/s.

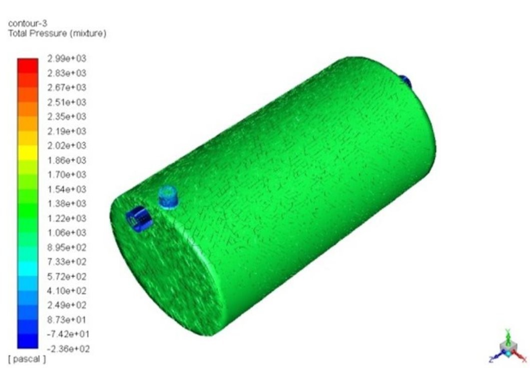

Figure-7 Total pressure in shell and helical coil for cold fluid

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- Case-5 Al_2O_3 nanofluid is used as ethylene glycol as its base fluid in shell and helical coil, Static Temperature by using hot fluid when mass flow rate is 0.05m/s.

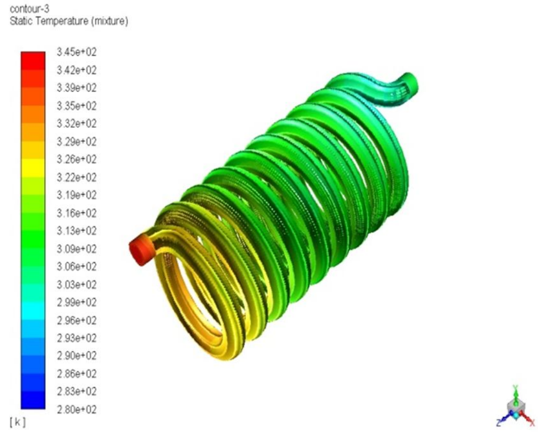

Figure-8 Static Temperature in shell and helical coil for hot fluid

- Case-6 Al_2O_3 nanofluid is used as ethylene glycol as its base fluid in shell and helical coil, Static Temperature by using cold fluid when mass flow rate is 0.05m/s.

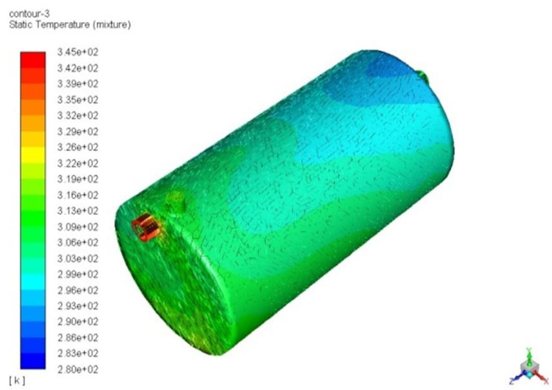

Figure-9 Static Temperature in shell and helical coil for cold fluid

- Case-7 Al_2O_3 nanofluid is used as ethylene glycol as its base fluid in shell and helical coil, TotalTemperature by using hot fluid when mass flow rate is 0.05m/s.

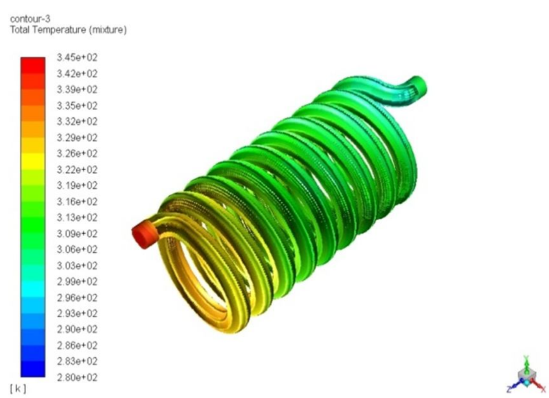

Figure-10 Total Temperature in shell and helical coil for hot fluid

- Case-8 Al_2O_3 nanofluid is used as ethylene glycol as its base fluid in shell and helical coil, TotalTemperature by using cold fluid when mass flow rate is 0.05m/s.

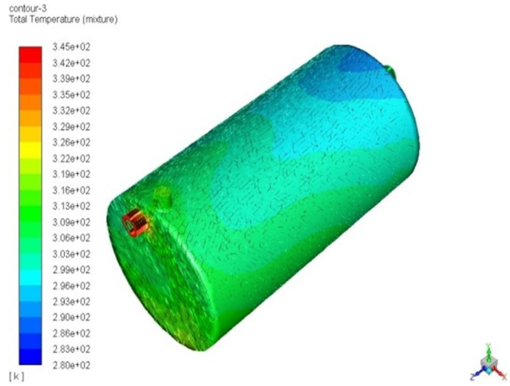

Figure-11 Total Temperature in shell and helical coil for cold fluid

- Case-9 SiO_2 nanofluid is used as water as its base fluid in shell and helical coil, static pressure by using hot fluid when mass flow rate is 0.05m/s.

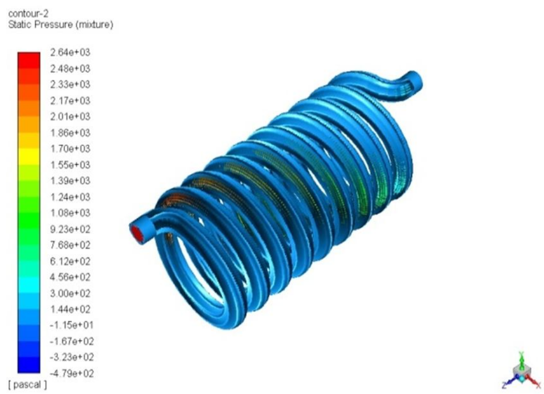

Figure-12 Static pressure in shell and helical coil for hot fluid

- Case-10 SiO_2 nanofluid is used as water as its base fluid in shell and helical coil, Static pressure by using cold fluid when mass flow rate is 0.05m/s.

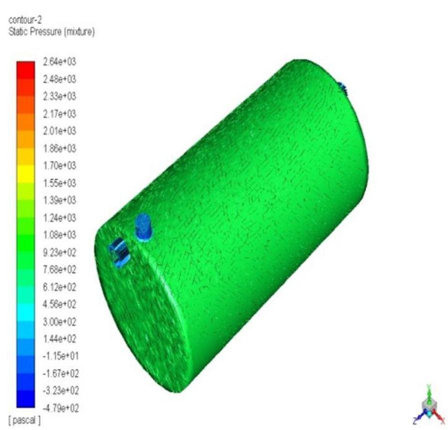

Figure-13 Static Pressure in shell and helical coil for cold fluid

- Case-11 SiO_2 nanofluid is used as water as its base fluid in shell and helical coil, Total Pressure drop by using hot fluid when mass flow rate is 0.05 m/s.

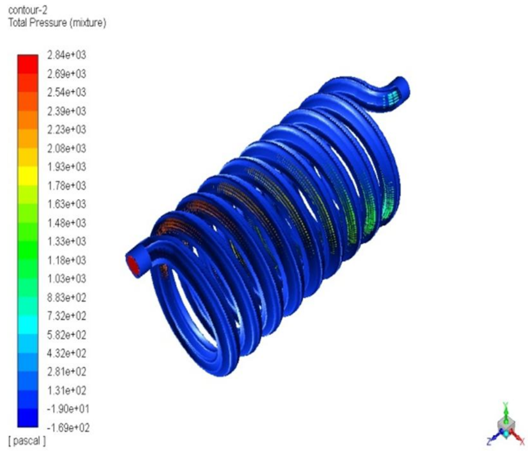

Figure 14 Total pressure in shell and helical coil for hot fluid

- Case-12 SiO_2 nanofluid is used as water as its base fluid in shell and helical coil, Total Pressure drop by using cold fluid when mass flow rate is 0.05 m/s

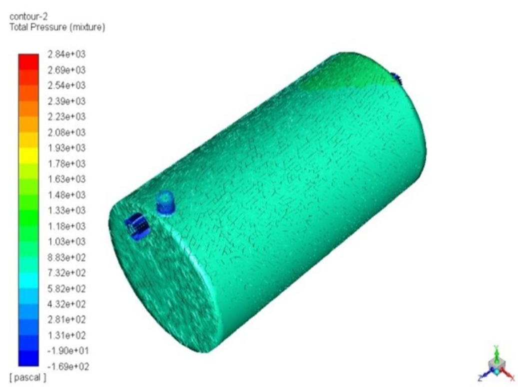

Figure 15 Total pressure in shell and helical coil for cold fluid

- Case-13 SiO_2 nanofluid is used as water as its base fluid in shell and helical coil, Static Temperature by using hot fluid when mass flow rate is 0.05 m/s.

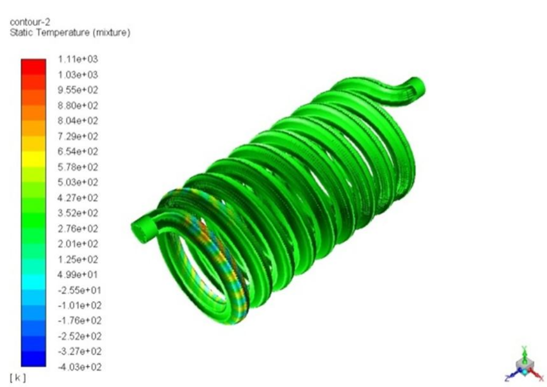

Figure 16 Static Temperature in shell and helical coil for hot fluid

- Case-14 SiO_2 nanofluid is used as water as its base fluid in shell and helical coil, Static Temperature by using hot fluid when mass flow rate is 0.05 m/s.

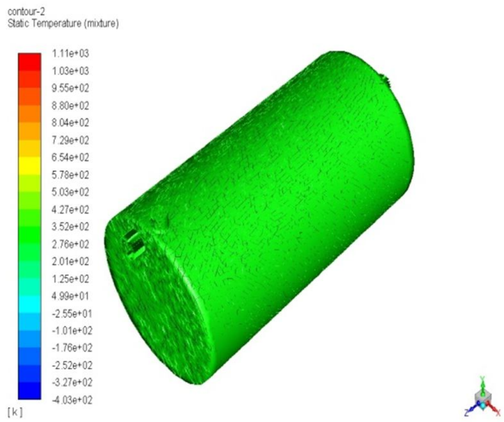

Figure 17 Static Temperature in shell and helical coil for cold fluid

- Case-15 SiO_2 nanofluid is used as water as its base fluid in shell and helical coil, total Temperature by using cold fluid when mass flow rate is 0.05 m/s.

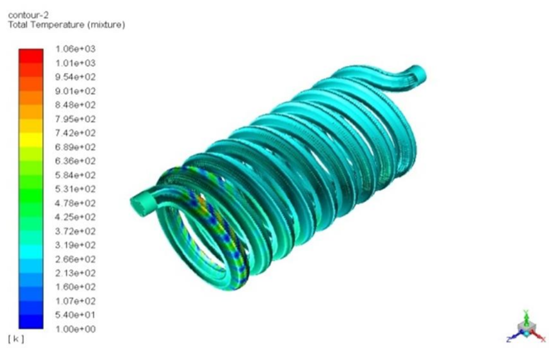

Figure 18 Total Temperature in shell and helical coil for hot fluid

- Case-16 SiO_2 nanofluid is used as water as its base fluid in shell and helical coil, TotalTemperature by using cold fluid when mass flow rate is 0.05 m/s.

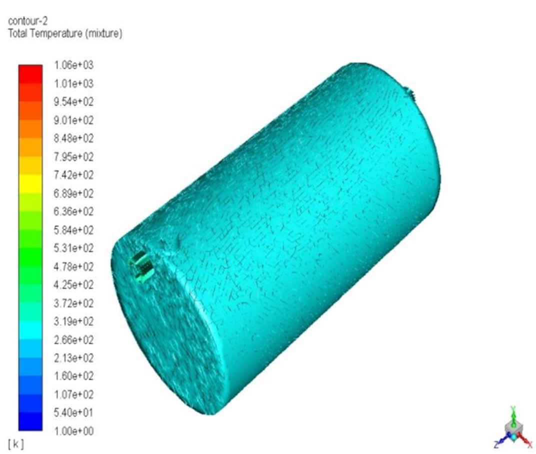

Figure 19 Total Temperature in shell and helical coil for hot fluid

Table No.22 CFD Analysis results

Properties	Al_2O_3 Nanofluid using ethylene glycol as its base
Max static pressure on the shell and helical coil heat exchanger when mass flow rate is 0.05 m/s and Al_2O_3 nanofluid is used as water as its base.	2820 Pa
Max static pressure on the shell and helical coil heat exchanger when mass flow rate is 0.05 m/s and Al_2O_3 nanofluid is used as water as its base.	1448 Pa
Max total pressure on the shell and helical coil heat exchanger when mass flow rate is 0.05 m/s and Al_2O_3 nanofluid is used as water as its base.	2999.4 Pa
Max total pressure on the shell and helical coil heat exchanger when mass flow rate is 0.05 m/s and Al_2O_3 nanofluid is used as water as its base.	1708 Pa
Max static temperature on the shell and helical coil heat exchanger when mass flow rate is 0.05 m/s and Al_2O_3 nanofluid is used as water as its base.	342.5 K
Max static temperature on the shell and helical coil heat exchanger when mass flow rate is 0.05 m/s and Al_2O_3 nanofluid is used as water as its base.	326.7 K
Max total temperature on the shell and helical coil heat exchanger when mass flow rate is 0.05 m/s and Al_2O_3 nanofluid is used as water as its base.	343.7 K
Max total temperature on the shell and helical coil heat exchanger when mass flow rate is 0.05 m/s and Al_2O_3 nanofluid is used as water as its base.	322.9 K
Max static pressure on the shell and helical coil heat exchanger when mass flow rate is 0.05m/s and SiO_2 nanofluid is used as water as its base	2483 Pa
Max static pressure on the shell and helical coil heat exchanger when mass flow rate is 0.05m/s and SiO_2 nanofluid is used as water as its base	1558 Pa
Max total pressure on the shell and helical coil heat exchanger when mass flow rate is 0.05m/s and SiO_2	2548 Pa

nanofluid is used as water as its base	
Max total pressure on the shell and helical coil heat exchanger when mass flow rate is 0.05m/s and SiO_2 nanofluid is used as water as its base	1038 Pa
Max static temperature on the shell and helical coil heat exchanger when mass flow rate is 0.05m/s and SiO_2 nanofluid is used as water as its base	332 K
Max static temperature on the shell and helical coil heat exchanger when mass flow rate is 0.05m/s and SiO_2 nanofluid is used as water as its base	329 K
Max total temperature on the shell and helical coil heat exchanger when mass flow rate is 0.05m/s and SiO_2 nanofluid is used as water as its base	337.4 K
Max total temperature on the shell and helical coil heat exchanger when mass flow rate is 0.05m/s and SiO_2 nanofluid is used as water as its base	334.1 K

V. CONCLUSION

In this paper, analytical investigations are done on the shell and helical coil heat exchanger, to determine pressure drop and temperature distribution of a water as a base fluid and Al_2O_3 and SiO_2 as a nanofluid on shell and helical coil flowing under laminar flow conditions. By observing the CFD analysis results, the pressure drop is more in hot fluid of Al_2O_3 and SiO_2 nanofluid with water as a base fluid in shell and helical coil heat exchanger.

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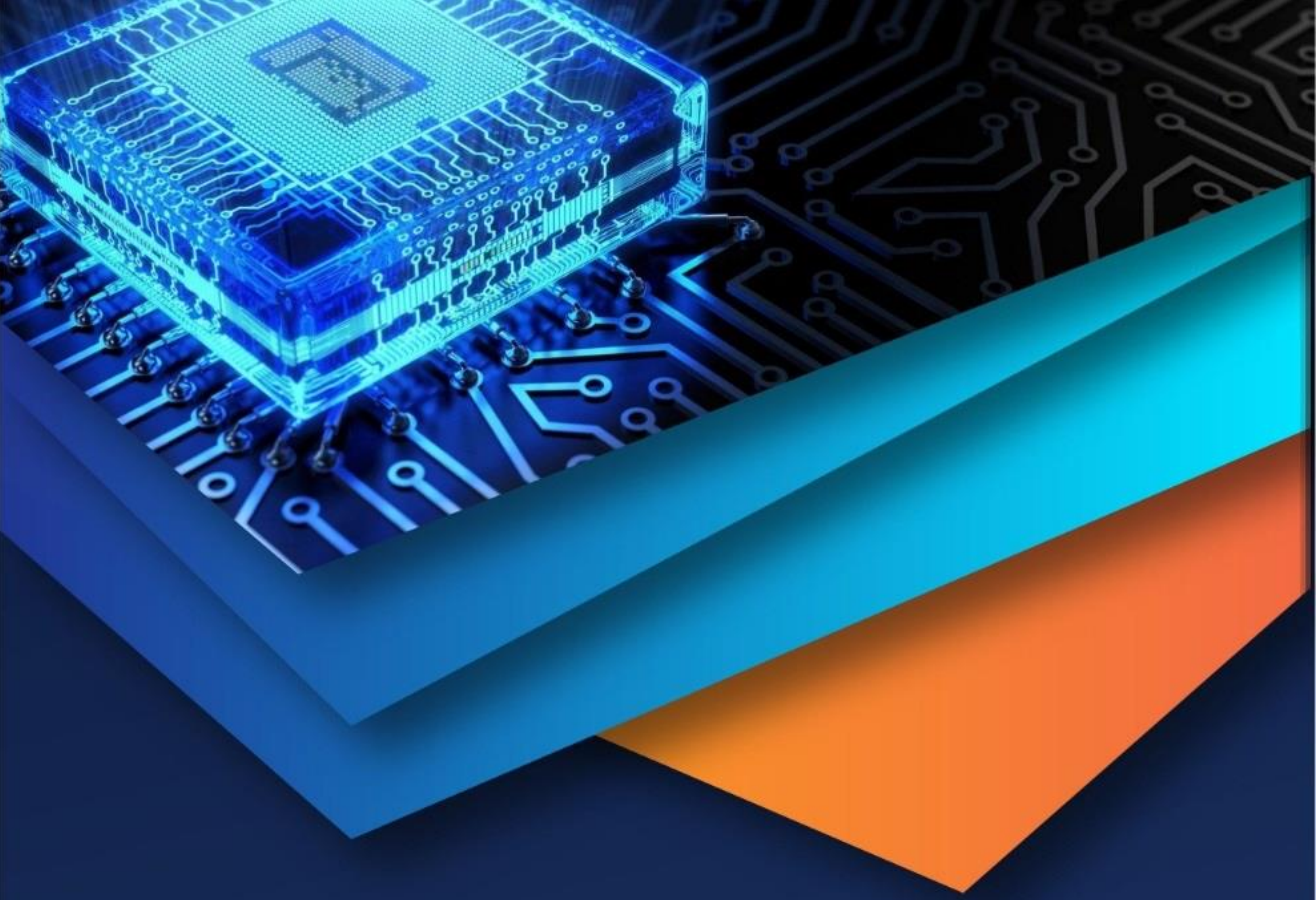

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