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Hydrodynamic and Thermal Comparison of Shell-and-Tube and Helical Tube Heat Exchangers using CFD

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ABSTRACT

In this study, with the help of simulation tool ANSYS we tried for a comparative computational fluid dynamics(CFD) simulation of Shell and Tube heat exchangers(STHE) and Helical tube heat exchangers(HTHE). The outcomes are being analyzed, which are cost requirements, pressure drop, thermal efficiency, heat transfer coeffiecient and space requirements. Two heat exchangers were put under equal operating conditions so as to have a fair comparison. In both the situation we have a constant heat transfer surface area of 9.0562 m2, inlet temperatures of 90C in warm fluid and 15C in cold fluid. The result shows that HTHEs give higher heat transfer and thermal efficiency in comparision to STHEs. Particularly, heat transfer coefficient in the HTHE was 42.5584 W/m2 K having 1 kg/s mass flow rate which is higher than the 34.7566 W/m2 K of the STHE. This has been supported with the result that helical coil geometry is able to create more turbulence and secondary flow that facilitate effective heat transfer. The result shows that in comparision to STHEs pressure drop in HTHEs is much higher. This raised resistance to flow can translate to higher energy usage in fluid pumping, and the effectiveness of system is affected. In this study, the high thermal performance of HTHEs points to the possibility of the use of these sources in a situation where a high heat transfer rate is of paramount priority. Generally speaking, as the result are strong for the upcoming studies and to keep practicing thermal engineering, especially in the balancing of the heat transfer and future design of pressure drop in heat exchanger.

Keywords: *CFD; STHE; HTHE; Overall heat transfer coefficient; Thermal efficiency; Pressure drop.*

1.0 Introduction

1.1 Overview

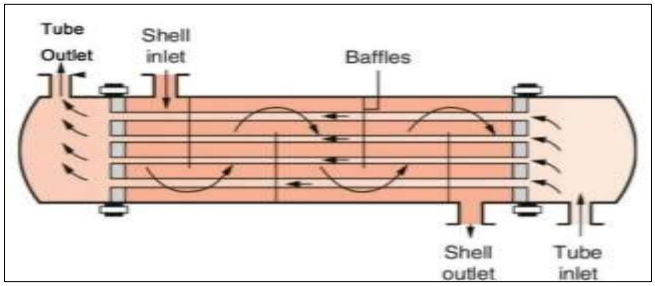
A heat exchanger is a device which is used for transferring the heat in two liquids at different temperature without actually mixing them. These gadgets are predominantly utilized in various areas of industry. Mainly they serve to exchange thermal energy between distinct fluid flows and are therefore important in processes like heating, cooling, condensation, evaporation and boiling.

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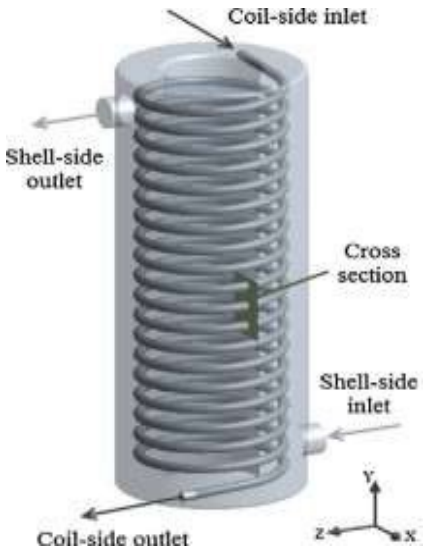
"Shell-and-Tube Heat Exchangers (STHEs)" is majorly used from various types of heat exchangers. They are used in industries where 'chemical processing, power generation and oil refining' is done. A typical STHE is a device in which one fluid travel with second fluid in the tubes of shell which are contained in a cylindrical shape shell. This design can let the effective exchange of heat between the two fluids. Another significant benefit of STHEs is the capability to work well in conditions of high pressure and high temperature. Also, they typically have a less significant pressure drop than many other types of heat exchangers, resulting in low-energy consumption with respect to pumping energy demands. They are also highly used because of their massive build, convenient maintenance and varying capacities to work in most of the surrounding conditions. The first figure shows the transverse view of STHEs.

Figure 1: Cross-sectional View of STHE



'Helical Tube Heat Exchangers (HTHEs)' are used in large variety of industry practices because of its high number of merits. They need a smaller space to install as they have a compact and space saving design yet they possess superior thermal performance. In comparison to traditional, heat exchanger designs, HTHEs can typically offer better heat transfer coefficients and thermal performance.

Figure 2: Cross-sectional View of HTHE



The HTHE is commonly a helix of coiled tubes in a shell that fluid flows through in a non-strauss pattern. The helical configuration gives rise to secondary flow patterns and enhanced turbulence that is crucial in promoting heat exchange between the fluids. Consequently, HTHEs are seen as one of the developed heat exchanger technologies, which has enhanced effectiveness and performance. They also fit in a tight space which not only saves on space, but might also facilitate less material consumption and lower cost of installations in some of the applications. Nevertheless, there could be a greater pressure drop and manufacturing difficulties due to the complicated geometry. The second figure is of an HTHE showing its transverse view.

Heat exchangers are classified into two types which are parallel flow and counterflow on the basis of flow of fluid in heat exchangers. 'In parallel flow arrangement, both the fluids enter from same side and flows in the same direction'. Because of temperature difference, hot fluid starts cooling up and cold fluid warms up. As the fluid flows in this arrangement it leads to lower overall heat transfer coefficient because of low temperature difference. 'In counter flow arrangement both the fluids enters from different sides and moves in opposite direction'. Such flow arrangements provide for significant temperature gradient through the passage and thus provide for higher high transfer coefficient. Due to this property of such arrangement, they are preferred in many industrial applications. In this study , we took opposite flow in our consideration for both heat exchanging devices.

Figure 3: Parallel Flow

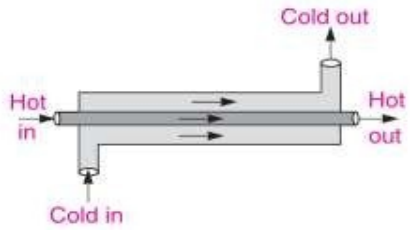
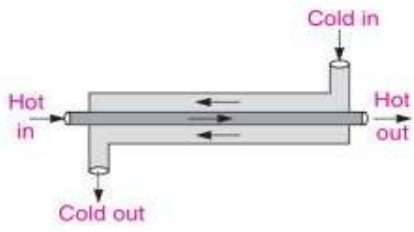


Figure 4: Counter Flow



Heat exchangers are of two distinguished types which are 'same flow' and 'opposite flow' on the basis of direction of movement of fluid.

'In same flow, the two fluids flow in the same direction and they will be present at the same end of heat exchanger'. As the fluid passes the cold fluid rises in temp and hot fluid cools down gradually due to heat transfer. But since temperature differentiation of two fluids keeps on decreasing in the flow way, total rate of heat exchange is comparatively low. This is a disadvantage since parallel flow is not very effective in terms of high thermal performance applications.

Conversely, a counterflow arrangement is where the two fluids are introduced at the opposite ends and moves towards opposite directions. This system assists in having a greater temperature differentiation among fluids in the whole length of exchanger. This provides increased performance and consistency in the heat exchange resulting in an increased heat exchange rate. These have made counterflow heat exchangers the most preferred in an industrial setup and this configuration is chosen in the given research so as to make proper and efficient comparison.

One of the main measure which has been used to describe the effectiveness of transfer of heat of a system or a material is 'Overall heat transfer coefficient(U)'.

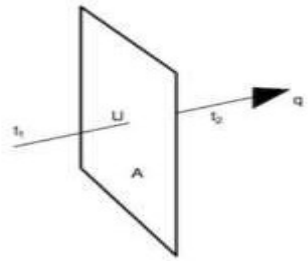
To analyze and equate the thermal result of heat exchaners for 'convection and conduction effects' "Equation of it follows Q = U * A * dT

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where, Q = heat transfer rate (W)

U = overall heat transfer coefficient (w/m2K) A = heat transfer area (m2) dT = temperature difference (K or°C)"

Figure 5: Heat Transfer through a Surface



The Fig. shows that the heat is transferred from the surface with area A and overall heat transfer coefficient U as the temperatures changes from t1 to t2'.

Thus, we can write

Q = U * A * (t2 – t1)

This implies, U = Q/A * (t2 – t1)

Thermal efficiency is 'the ratio of actual heat transferred to the maximum heat transfer'. It is denoted by the letter 'n'.

It can be represented either as ratio or in percentage form where the ratio is multiplied by 100 to get the desired percentage.

We know, n = (Q * 100) / Qmax %

where, Q = heat transfer rate (W)

Qmax = maximum heat transfer possible (W) .

Pressure drop describes the decrease in fluid pressure between the inlet and outlet of the system. It is an important parameter because it affects the energy required to circulate the fluid. 'Pressure drop' can be calculated in simple way in ANSYS workbench. Static pressure at the outlet is calculated when the inlet pressure is set to a reference value of 0Pa. The difference between these values represents the pressure drop. The pressure drop is determined by different factors such as density, viscosity, fluid velocity and the roughness of internal surfaces. The reason for a higher pressure drop across the heat exchanger is higher fluid velocity, increased surface roughness, greater viscosity and density.

1.2 Problem formulation

Because of their widely used setup both 'Helical tube heat exchangers (HTHEs)' and 'Shell and Tube heat exchangers (STHEs)'are used in different industrial applications. The performance and efficiency of these systems have a direct impact on important factors such as space requirements, operational cost, and energy consumption. Because each type has its own advantages and limitations, they are selected based on specific process needs. That is why features like thermal efficiency, pressure drop and heat transfer capability are used for evaluatuing and comparing their efficiency.

1.3 Objectives

- In order to identify which offers better heat transfer performance we will examine and equate the overall heat ransfer coefficient of both STHE and HTHE.

- To determine and compare the thermal efficiency of both STHE and HTHE under the same parameters and identify the more efficient system.
- To examine the impact of pressure drop in both heat exchangers and their effect on pumping power requirements.
- To carry out a theoretical comparison of the cost and space requirements for both types of heat exchangers.

2.0 Literature Review

Table 1: Literature Review

Ref. No.	Author(s)	Type of Study	Focus Area	Key Findings
[1]	Gurbir Singh et al.	CFD Analysis (STHE)	Simulation vs Experimental	Highlighted differences between experimental results and CFD simulations. CFD enables easier optimization and reduces analysis time compared to conventional experimental methods.
[2]	E.J. Fernandes et al.	CFD Analysis (STHE)	Material Selection	Aluminium shell with copper baffles showed the best performance. Materials having higher thermal conductivity enhance heat transfer and minimize energy losses.
[3]	Umer Zahid et al.	CFD Study	Optimization Parameters	Higher fluid velocity and greater thermal conductivity increase the heat transfer rate and enhance overall system performance.
[4]	V. K. Reddy et al.	CFD Analysis (HTHE)	Flow Rate Effect	Increasing inner tube flow rate raises LMTD and the overall heat transfer coefficient. Design changes further improve system performance.
[5]	Anand Patel et al.	Experimental Study	HTHE Performance	HTHE is compact and highly efficient. Counterflow arrangement performs better than parallel flow due to increased fluid interaction time.
[6]	P. Deshmukh et al.	CFD Analysis (HTHE)	Heat Transfer Characteristics	Presented a detailed approach for design, meshing, and analysis in ANSYS using realistic operating parameters.
[7]	Jayakumar et al.	Experimental + CFD	Heat Transfer in HTHE	Analyzed conjugate heat transfer under varying boundary conditions and confirmed CFD results using experimental data.
[8]	N. D. Shirgire et al.	Comparative Study	Mass Flow Rate Effect	Higher hot fluid flow lowers effectiveness, while increased cold fluid flow improves it. Overall heat transfer coefficient rises with increasing flow rate.

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[9]	D.G. Prabhanjan et al.	Comparative Study	STHE vs HTHE	HTHE exhibits a higher heat transfer coefficient compared to STHE. Flow rate influences temperature rise but has minimal effect on the heat transfer coefficient.
[10]	N. Jamshidi et al.	Experimental Study	Design Parameters	Heat transfer improves with increased shell-side flow rate, larger coil pitch, and greater coil diameter.
[11]	Salimpour, M. R.	Experimental Study	Heat Transfer Coefficient	Coiled tubes exhibit higher heat transfer coefficients because of the presence of secondary flow effects.
[12]	Imran, M. et al.	CFD Analysis (HTHE)	Heat Transfer Rate	CFD accurately estimates heat transfer rate, and system performance improves as the flow rate increases.
[13]	Ozden, E. & Tari, I.	CFD Analysis (STHE)	Shell-side Flow	Shell-side configuration strongly influences temperature distribution and overall thermal efficiency.
[14]	Kern, D. Q.	Theoretical Study	Heat Exchanger Design	Presented standard methods and calculation procedures for the design of heat exchangers.
[15]	Cengel, Y. A. & Ghajar, A. J.	Theoretical Study	Heat Transfer Fundamentals	Described fundamental concepts such as heat transfer coefficient, thermal efficiency, and fluid flow behavior.
[16]	Manglik, R. M. & Bergles, A. E.	Experimental/Correlation Study	Pressure Drop & Heat Transfer	Established correlations to predict enhanced heat transfer and associated pressure drop in tubes.
[17]	Srinivasan, P. S. et al.	Experimental Study	Friction Factor	Coiled tubes exhibit a higher friction factor as a result of curvature-induced flow effects.
[18]	Mori, Y. & Nakayama, W.	Experimental Study	Curved Pipe Heat Transfer	Pipe curvature generates secondary flow, which leads to an increase in the heat transfer rate.
[19]	Kumar, V. et al.	Experimental Study	Heat Transfer Enhancement	Surface roughness enhances heat transfer but also results in higher frictional losses within the system.
[20]	Versteeg, H. K. & Malalasekera, W.	CFD/Theoretical Study	Numerical Methods	Described the finite volume method commonly applied in computational fluid dynamics simulations.

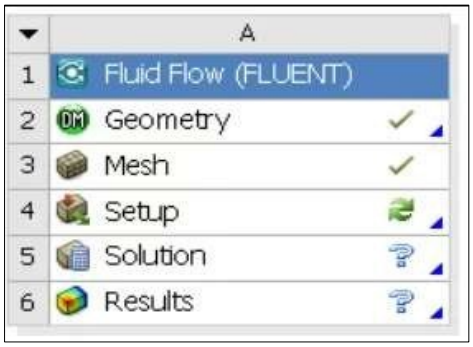
3.0 CFD Analysis

3.1 Introduction

In computation fluid dynamics (CFD) analysis, the first step is the creation of geometry of the physical model under study. This action determines the structure and form of the system that is being studied. When geometry is done, the next step is meshing, which involves splitting the model into a

huge array of small ones or nodes. This discretization enhances the precision of the numerical solution besides aiding in controlling and minimizing the overall computing time and cost.

Figure 6: Initial Screen of Ansys Fluent Workbench



Once meshing is complete, initial and boundary conditions are specified, which depend on the nature of the physical problem. These states are used to examine the flow of fluids in, out and inside the system. The governing equations of fluid flow and heat ransfer are solved by using an iterative numerical method in which it solves until it converges to a solution. Lastly, the results obtained are post-processed, and visualized and examined in detail. These are the results on which interpretation, discussion, as well as rational conclusions on the thermal and flow performance of the system, are to be built. In the figure 3 illustrates the initial interface of ANSYS Fluent Workbench. It indicates that the CFD workflow begins with geometry creation, followed by meshing, setup, solution, and finally results. The green indicators represent completed stages, circular arrows denote steps that require further action, and question marks indicate processes that cannot proceed due to missing or incomplete previous step.

3.2 Methodology adopted

Here the analysis is done using ANSYS software for Fluid Flow (Fluent).

3.3 Analysis procedure

The procedure of analysis will go on as follows :-

1. Geometrical Modelling
2. Meshing
3. Named Selections
4. Solution
   - Problem Setup
   - Models
   - Materials
   - Cell zone conditions
   - Boundary conditions
5. Run Calculation
6. Reports
7. Calculation of various parameters

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3.4 Geometry

The figure of both heat exchangers (STHE and HTHE) were 'developed in ANSYS Fluent Workbench'. Geometry development involved the use of tools such as sketching, extrusion, sweeping, and merging. The geometrical specifications of STHE & HTHE are shown in the Tables.

Table 2: Geometrical Specifications of STHE

Parameters	Specifications
Length of shell	10.406 m
Diameter of shell	1 m
Wall thickness	0.05 m
Tube length	11.406 m
Tube diameter	0.25 m
Surface area of fluid domain	9.0562 m^2

Table 3: Geometrical Specifications of HTHE

Parameters	Specifications
Length of shell	2.2 m
Diameter of shell	1.5 m
Wall thickness	0.05 m
Tube length span	2.7 m
Tube diameter	0.25 m
Number of turns	4
Surface area of fluid domain	9.0562 m^2

Both the figure shows geometry of STHE and Fig. that of HTHE created on Ansys Workbench.

Figure 7: Geometry of STHE

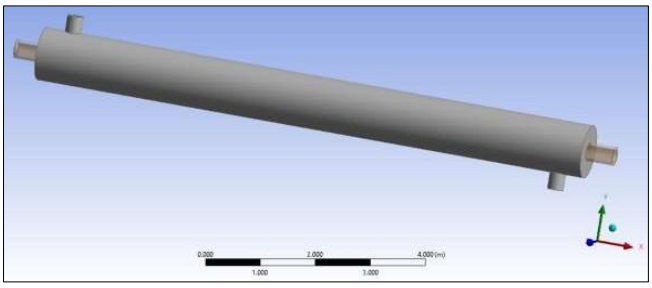
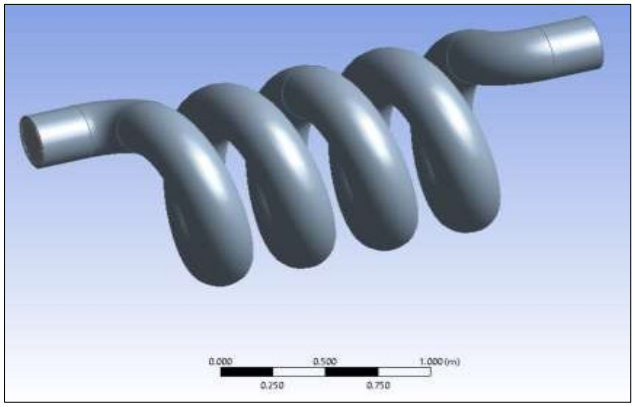


Figure 8: Geometry of HTHE



3.5 Meshing

'For both heat exchangers, a refined mesh was generated consisting of a combination of tetrahedral and hexahedral elements which has triangular and rectangular faces'. The mesh was created in ANSYS Meshing Workbench using the automatic meshing approach.

In STHE figure, mesh contain 84,370 nodes and 308,279 elements, with a pitch tolerance of 5.2023×10^{-3} m and high smoothing applied. In comparison, the HTHE model contains 91,574 nodes and 357,915 elements, with a pitch tolerance of 1.6559×10^{-3} m and similar high smoothing settings. Both the figures illustrate the meshing of the STHE and HTHE models, respectively.

Figure 9: Meshing of STHE

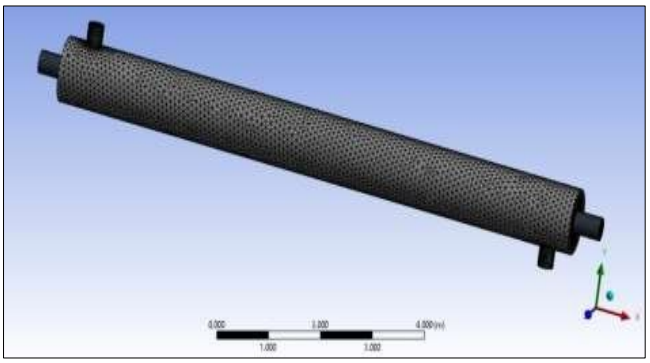
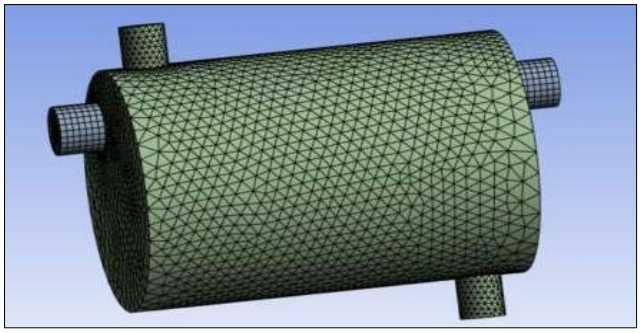


Figure 10: Meshing of HTHE



3.6 Named selections

Named selection is a subsection of the meshing process in which different surfaces are assigned specific names based on the required inlets and outlets for fluid flow. In this study, we used a counterflow arrangement in which inlets and outlets of fluids are situated at the opposite ends of heat exchanger. Both the figures illustrate the named selections for the STHE and HTHE models, respectively.

3.7 Solution

3.7.1 Problem setup

To achieve numerical soundness and computational stability, the mesh quality is first of all strictly checked by a detailed quality assessment report. After successful verification, the equation is

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then prepared for a 'pressure-based formulation' using an absolute velocity framework under steady-state conditions, thus allowing the reliable and stable convergence of the governing flow equations.

Figure 11: Named Selections of STHE

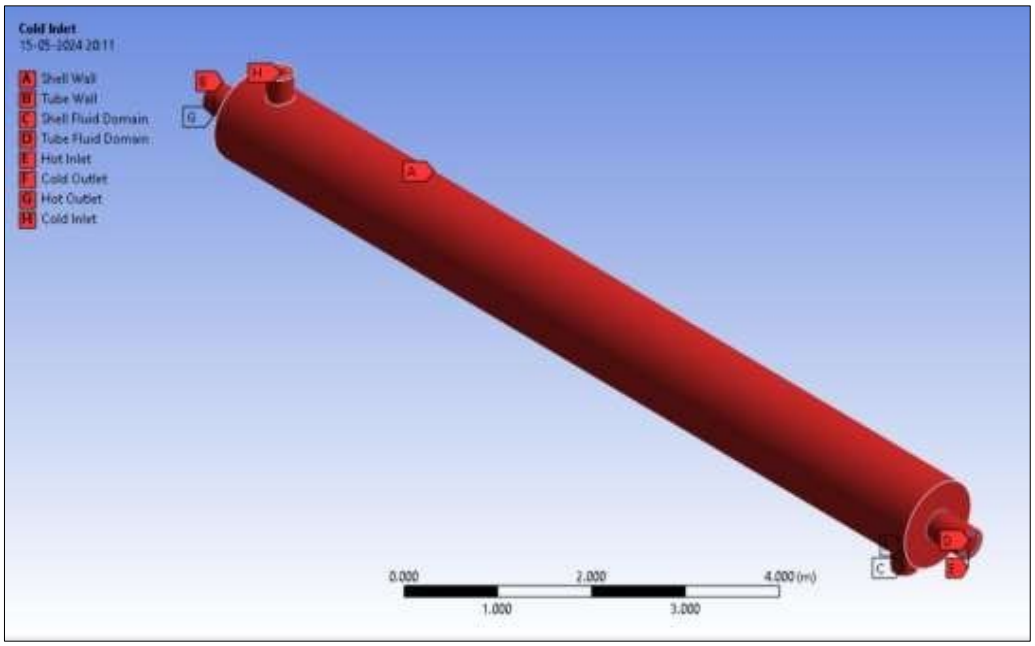
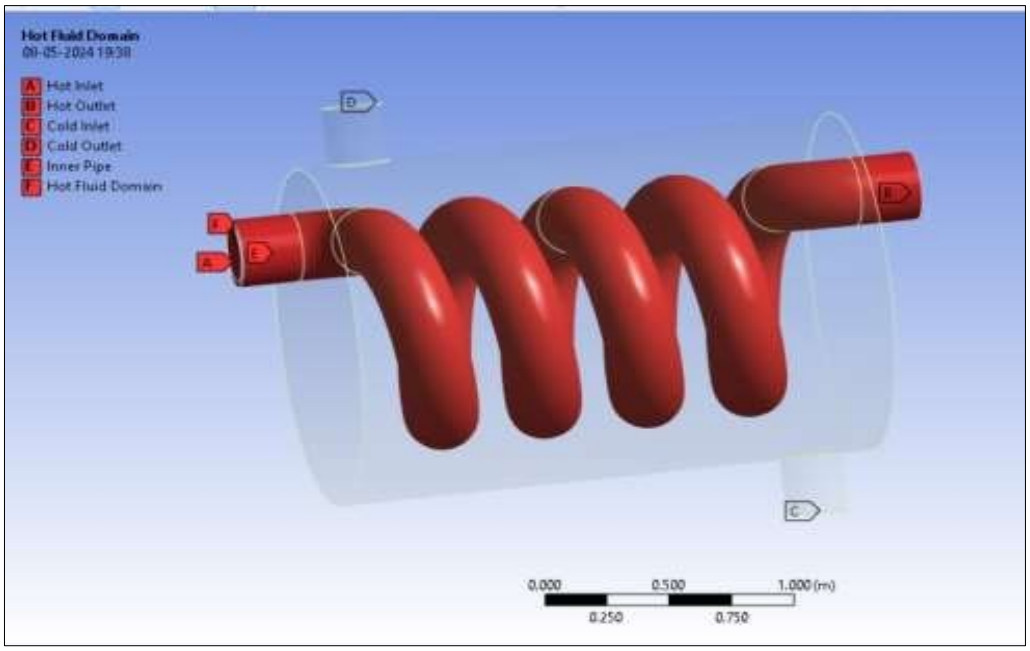


Figure 12: Named Selections of HTHE



3.7.2 Models

At this point we set the viscous model to laminar and only the energy equation is activated while all other parameters are not changed (kept off).

3.7.3 Materials

In this step, copper is selected as the solid material while water (liquid) as the fluid.

3.7.4 Cell zone conditions

At this stage, water is assigned as working fluid for both shell-side and tube –side regions whereas copper is used as the shell and tube walls.

3.7.5 Boundary conditions

Here, the intake boundary condition has been set to be a mass-flow intake, but the exit is set as a pressure exit to give adequate flow development and pressure stabilization of the computational domain. Thereafter, the corresponding thermos fluid parameters such as 'mass flow rate and temperature' are applied at intake boundaries according to simulation set up. Mass flow rate is systematically changed between 1 kg/s and 20 kg/s to sample computerized reaction of system to various operating conditions. In addition, to ensure a just and comparable analysis framework both heat exchanger models are subjected to constant boundary conditions and the same parameter specifications. The Table shows the boundary conditions for different inlets and outlets.

Table 4: Boundary Conditions for both Heat Exchangers

	Boundary Conditions Type	Mass-flow rate (in kg/s)	Temperature (in °C)
Hot Inlet	Mass-flow inlet	1– 20	90
Hot Outlet	Pressure outlet	-	-
Cold Inlet	Mass-flow inlet	1– 20	15
Cold Outlet	Pressure outlet	-	-

3.7.6 Solution methods

In the solution stage, the numerical methods were configured as follows:

1. Scheme: Coupled
2. Flux Type: Automatically selected
3. Gradient: Least squares cell-based method
4. Pressure: Second-order discretization
5. Momentum and Energy: Second-order upwind scheme
6. Pseudo Time Method: Global time step

3.7.7 Run calculation

The solution is initialized using the Hybrid Initialization method. The simulation is then executed with 100 iterations and a reporting interval of 1. The computation continues until the results achieve convergence.

3.7.8 Reports

In this section, the results are extracted in terms of fluxes, forces, surface integrals, and volume integrals. The relevant parameters are then evaluated and further analyzed to draw meaningful conclusions.

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3.8.9 Points taken into consideration for fair comparison

The surface area of the fluid domain inside the tube is maintained constant at 9.0562 m². Additionally, identical cell zone settings and boundary conditions are applied to both heat exchanger models to ensure a fair comparison. Both the figures illustrate that both heat exchangers have the same fluid domain surface area.

Figure 13: Tube Fluid Domain of HTHE

Details View

Details of Body	
Body	Hot Fluid Domain
Volume	0.55649 m³
Surface Area	9.0562 m²
Faces	8
Edges	7
Vertices	0
Fluid/Solid	Fluid
Shared Topology Method	Default
Geometry Type	DesignModeler

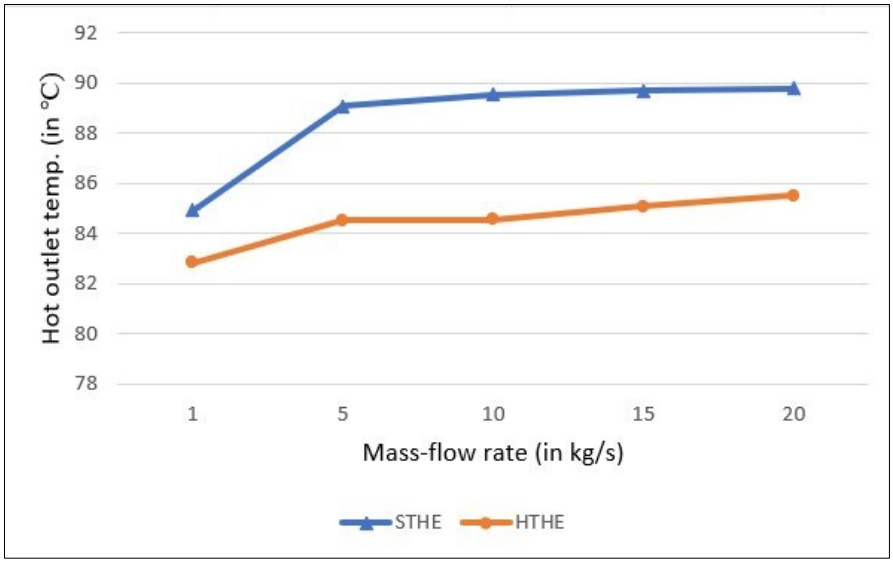
Figure 14: Tube Fluid Domain of STHE

Details View

Details of Body	
Body	Tube Fluid Domain
Volume	0.55988 m³
Surface Area	9.0562 m²
Faces	3
Edges	2
Vertices	0
Fluid/Solid	Fluid
Shared Topology Method	Default
Geometry Type	DesignModeler

4.0 Results and Discussions

Figure 15: Variation of Temp. at Hot Outlet at Different Mass-flow Rate

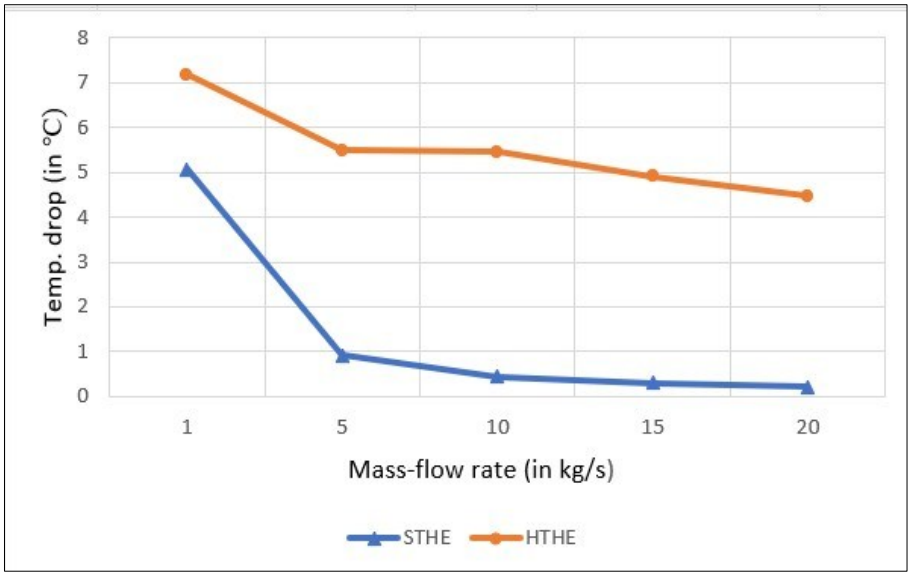


4.1 Temperature variation at different mass-flow rates

The systematically tested hot outlet temperature of both the heat exchanger configurations is varied within a scope of mass flow rates from 1kg/s to 20 kg/s.

As from the results we can observe that helical tube heat exchanger (HTHE) has a lower outlet temperature than shell and tube heat exchanger (STHE), which shows that HTHE produces a higher temperature drop and it gives better thermal performance. Understanding the impact of flow rate as the mass flow rate increases as shown in figure the temperature of both the setups of heat exchanger gradually decreases.

Figure 16: Variation of Temp. Drop at Different Mass-flow Rates



4.2 Calculation of overall heat transfer coefficient (U)

The heat transfer coefficient represents the rate of heat transfer per unit surface area for each unit temperature difference.

We know that U = Q0 / (Area * LMTD)

where,

- Q0t = mass-flow at hot inlet * 4203.5[J kg^-1 K^-1]* (Temperature at warm inlet – Temperature at warm outlet)
- HT Area = area at fluid liquid interface and
- LMTD = ((Temperature at hot inlet – Temperature at cold outlet) - (Temperature at hot outlet – Temperature at cold inlet)) / ln((Temperature at hot inlet - Temperature at cold outlet) / (Temperature at hot outlet – Temperature at cold inlet)).

Both the figures shows the static temperature at both intake and outake of STHE and HTHE respectively keeping mass-flow rate at 1kg/s.

Figure 17: Static Temperature at Hot and Cold Outlet in STHE

Area-Weighted Average Static Temperature	[C]
cold_inlet	15
cold_outlet	22.609544
hot_inlet	90
hot_outlet	84.934466
Net	60.672354

The analysis shows that, the hot and cold outlet temperatures for the STHE are 84.93 °C and 22.61 °C, respectively, while for the HTHE, they are 82.83 °C and 19.63 °C, respectively when the mass flow rate is at 1Kg/s.

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Figure 18: Static Temperature at Hot and Cold Outlet in HTHE

Area-Weighted Average Static Temperature	[C]
cold_inlet	15
cold_outlet	19.633886
hot_inlet	90
hot_outlet	82.831548
Net	51.865745

Using the above formula for evaluating U, the following values are obtained:
For STHE,

- Q0 = 21287.9 W
- HT Area = 8.92 m2
- LMTD = 68.6546 K
- U = 34.7566 W/m2 K
- For HTHE,
- Q0 = 30118.3 W
- HT Area = 10.243 m2
- LMTD = 69.091 K
- U = 42.5584 W/m2 K

Analysis results indicate that the STHE exhibits an overall heat transfer coefficient of 34.7566 W/m²K, in contrast to the HTHE which shows 42.5584 W/m²K." Therefore, the CFD results indicate that HTHE has a higher heat transfer coefficient than STHE, making it more effective and thermally efficient.

4.3 Calculation of thermal efficiency (n)

Thermal efficiency represents the fraction of actual heat transfer achieved compared to the maximum possible, and when this ratio is multiplied by 100, it is expressed as a percentage.

We know, n = (Q0 * 100)/Qmax %

where,

- Q0 = mass-flow at hot inlet * 4203.5[J kg^-1 K^-1] * (Temperature at hot inlet – Temperature at hot outlet) and
- Qmax = min (Chot , Ccold) * (Temp. at hot inlet – Temp. at cold inlet).
- After using the above formula the calculated values are 42.5584 W/m2K for helical tube heat exchanger and 34.7566 W/m2K for shell and tube heat exchanger for overall heat transfer coefficient:-
- For STHE,
- Qmax = 315187.5 W
- Q0 = 21287.9 W
- n = 6.75 %
- For HTHE,
- Qmax = 315112.5 W

- Q0 = 30118.3 W
- n = 9.56 %

The CFD results shows that the helical tube exchanger has a higher efficiency of 9.56% as compared to shell and tube heat exchanger which receives an efficiency of 6.75% when the mass flow rate was 1Kg/s. Thus, HTHEs possess higher thermal efficiency as compared to STHEs.

4.4 Calculation of pressure drop

Pressure drop refers to the reduction in fluid pressure observed at the outlet of a tube as the fluid passes through the heat exchanger. In ANSYS Workbench, the pressure drop is determined by setting the inlet boundary condition of the heat exchanger to 0 Pa and then measuring the static pressure at the outlets; the difference directly represents the pressure loss across the exchanger.

The pressure drop is calculated by evaluating the static pressure at hot fluid inlet and outlet as the comparision focuses only on effect of different tube arrangements. Figures 19 and 20 illustrate the static pressure distribution at the hot fluid inlet and outlet for the shell and tube exchanger and the helical tube exchanger, respectively.

Figure 19: Static Pressure at Hot Inlet and Outlet in STHE

Area-Weighted Average Static Pressure	[Pa]
hot_inlet	0.24183679
hot_outlet	0
Net	0.1209184

Figure 20: Static Pressure at Hot Inlet and Outlet in HTHE

Area-Weighted Average Static Pressure	[Pa]
hot_inlet	0.844736
hot_outlet	-0.00019575683
Net	0.42229402

At a mass flow rate of 1 kg/s, the CFD analysis indicates that the shell and tube exchanger experiences a pressure drop of 0.242 Pa, while the helical tube exchanger shows a comparatively higher drop of 0.845 Pa. STHEs demonstrate a lower pressure drop in comparison to HTHEs.

4.5 Temperature distribution along the heat exchanger

Both figures shows the temperature distribution along the STHEs and HTHEs. The temperature varies from 84.93℃ to 90℃ within the tube (right to left) and from 15℃ to 22.61℃ over the tube (right to left). Similarly, in Figure 22, the temperature varies from 82.83℃ to 90℃ within the tube (right to left) and from 15℃ to 19.63℃ over the tube (right to left).

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Figure 21: Temperature Distribution along STHE

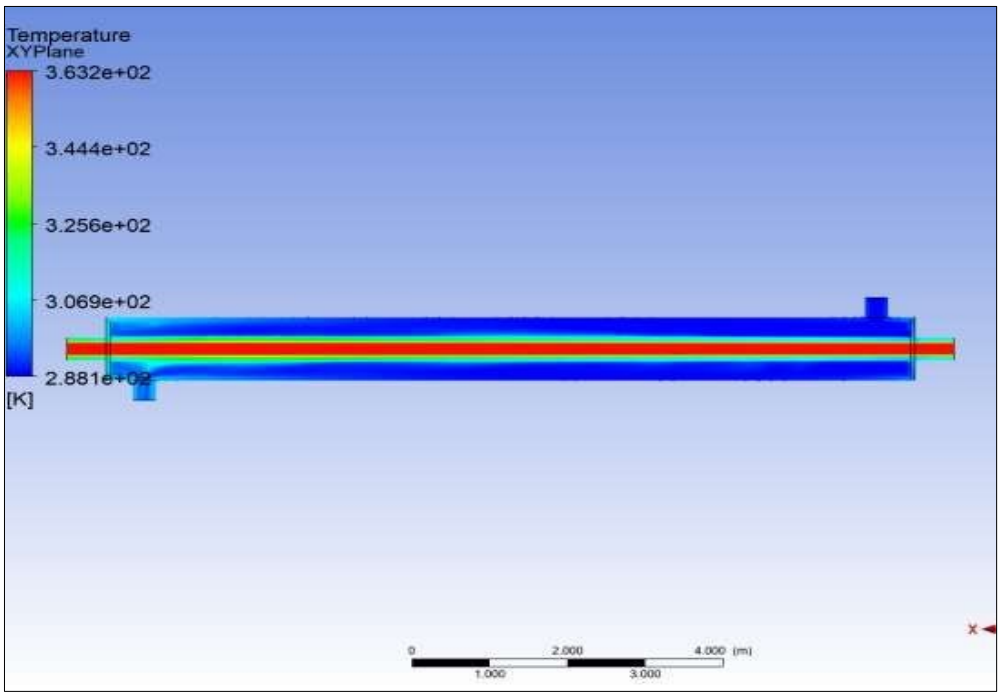
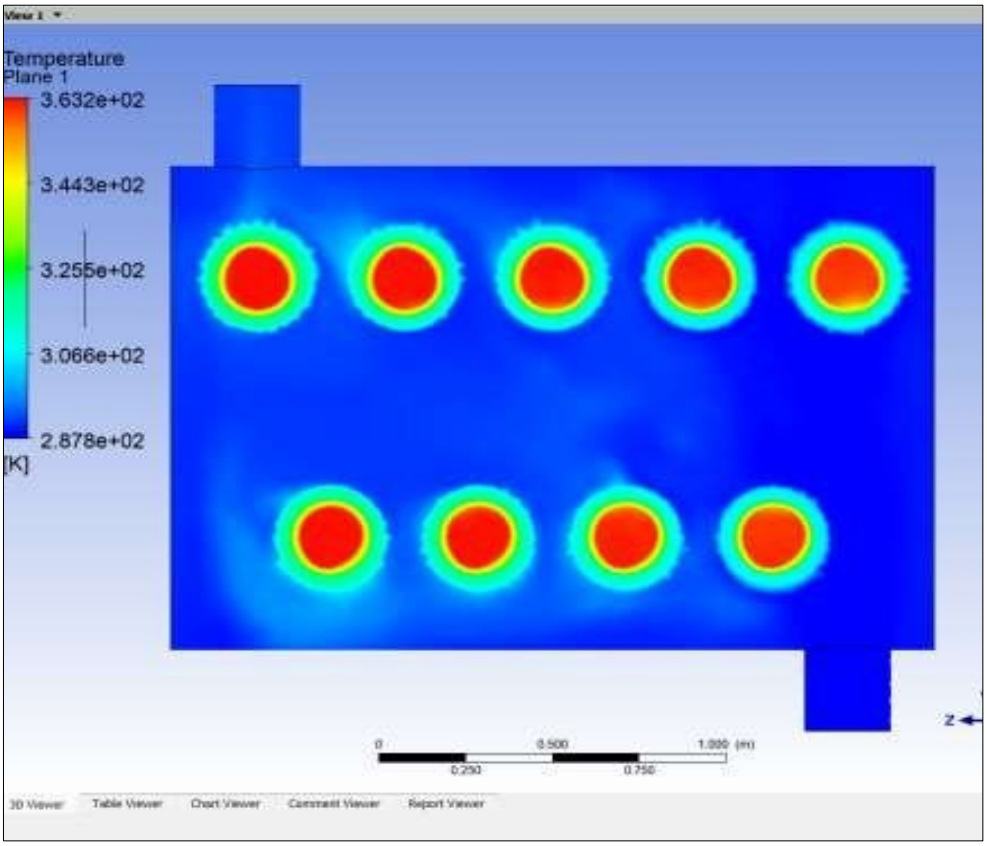


Figure 22: Temperature Distribution along HTHE



5.0 Conclusions

'Shell tube and helical tube types of heat exchangers' are majorly used in industry. To choose between STHE and HTHE is widely decided by their performance strengths and design constraints. The CFD shows that 'the shell and tube heat exchanger (STHE)' has lower total heat transfer coefficient and poor thermal efficiency compared to 'the helical tube heat exchanger (HTHE), HTHE are more used when the case is of high heat transfer performance in design consideration. Further, the small geometrical layout of the HTHE greatly diminishes the space demands, further enhancing its usage in applications where space optimization and installability are the crucial factors, relative to the relatively larger STHE geometrical layout.

As the reduced power loss means lower pumping power requirements, lower pressure drop observed in shell and tube exchangers makes them advantageous in such situations. In addition, their straightforward design contributes to easier maintenance and supports reliable long-term operation

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