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A Review on Study of Heat Transfer Analysis of Helical Coil Heat Exchangers

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ABSTRACT

Now a day's a geometrically modified Helical coil heat exchangers are widely using in industrial applications like cryogenic state processes, air-conditioning, thermal nuclear reactors and waste heat recovery due to their compact size and high heat transfer coefficient. Advantage of using helical coils over straight tubes is that the residence time spread is reduced, allowing helical coils to be used to reduce axial dispersion in tubular reactors. In this study, numerical investigation of the influence of geometrical parameters such as tube diameter (d), coil radius(R), and coil pitch(p) on overall heat transfer coefficient in helical double tube heat exchangers are performed using a professional CFD software- FLUENT. In recent years, numerous styles were introduced for heat exchangers that apply to completely different applications; sadly, their heat transfer co-efficient wasn't reliable at different operational conditions. the standard of the heat changed rate wasn't optimized and there have been many deficiencies and errors in styles. The heat transfer of the copper material is enhanced in comparison with other material unfortunately thermal resistance is reduced with an increase in pressure drop thus enhancing the heat transfer on the heat exchanger. Helical architecture is often designed with a clear motive of compact size and also address heat transfer co-efficient and other ancillary attributes efficiently and effectively. So the better material is suggested for an industrial heat exchanger according to the applications is Copper with the basis of simulation results. The geometry and different dimension parameter of the helical coil show that the proposed study in different material properties and different mass flow rates to heat transfer are maximum in different parameter helical coil heat exchangers. Finally, the heat transfer increase for the copper material compared to another material but with the increase in pressure drop the corresponding thermal resistance decreases which allow the improved heat transfer rate and the rate increases from Aluminum to Bronze to Copper. With the drop in temperature, the thermal resistance is reduced which enhances the heat transfer rate. The simulation results show that the copper has a high heat transfer coefficient than Aluminum and Bronze while operating in identical conditions. Due to the extensive use of helical coils in various applications, knowledge about the flow patterns and heat transfer characteristics are important.

***KEYWORDS**: Heat Exchanger, Helical Coil, Heat Transfer, CFD, Heat transfer Coefficient, Pressure Drop*

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I. INTRODUCTION

Exchanging Heat is an operation wherever in the heat is transferred from mass of one fluid to another fluid that is often exploited in heating and cooling based mostly on the operation throughout the globe. In a typical sense, a device is outlined as a convenience or mechanical setup utilized for the procedure of warmth trades between two or a lot of liquids that area unit at varying temperatures.. Heat exchangers area unit valuable in various planning procedures such as folks with important influence plants, refrigerant and aerating and cooling frameworks, power frameworks, conservative device atomic force plants, nourishment getting ready plants, concoction reactors, HVAC, house, and aeronautical applications The most commonly used type of HE is the shell and tube heat exchanger. In the present study, a comparative analysis of a water to water Shell & Tube HE wherein, hot water flows inside the tubes and cold water inside the shell is made, to study and analyze the heat transfer coefficient and pressure drops for different mass flow rates and inlet and outlet temperatures Bell Delaware methods.

OBJECTIVES: The criterion of any heat exchanger is to develop in a manner of maximum transformation of heat from hot fluid to cold fluid in a plant in order to eliminate wastages of heat in effective ways. Design and development of heat exchangers are based on heat transfer per unit area where as some space is required and are modeled with respect to availability of space to install it. This project will help to understand and will provide CFD solution, at different aspects parameter through flow of fluid on differently constructed material of helical type heat exchanger which improve efficiency. The transfer of heat to and from process fluids is an essential part of most of the chemical processes. Therefore, heat exchangers are used extensively and regularly in process and allied industries and are very important during design and operation.

In the present study, a comparative analysis will be done of a water to water Spiral HE wherein, hot water flows inside the tubes and cold water inside the shell is made. The heat transfer coefficient and pressure drops for fixed mass flow rates and inlet and outlet temperature by using Fluent 14.0 (CFD) will analyzed.

Main Objectives are:
- To Analyze and Design the Spiral heat exchanger for various given material.
- To Calculate the Heat Transfer for various material and
- To compare the heat transfer characteristic between Copper, Bronze and metal on various working parameter by using Fluent14.0.

II. LITERATURE REVIEW

The first steps towards the getting an ideas to do some conceptual change in design and analysis as it is require, literature review done , taken as a references and found some useful decision making in the form conclusion and report are in the form of their descriptive summary below.

J.S. Jayakumaret. al [1] presented the effects of the fixed thermal and transfer properties of the system on estimation of the heat transfer coefficients. The CFD based experimentation analysis show that estimated co-efficient is within the permissible range of real-time scenario and the correlation between the two was also presented.

Usman Ur Rehman [2] studied the heat transfer and flow distribution in a shell and tube heat exchanger and compared them with the experimental results. The model showed an average error of around 20% in the heat transfer and the pressure difference.

Nawras H. et.al [3] illustrated the performance of elliptical tubes based on the mechanical and thermal parameters employed for polymer heat exchangers. The mechanical analysis proves that the streamlined shape of the outer tube had an optimal thermal performance based on analysis over different geometries of the tube and materials.

K. Abdul Hamid et. al. [4] has done work on pressure drop for Ethylene Glycol (EG) based nano fluid. The nano fluid 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 nano fluid pressure drop is compared with the Blasius equation for based fluid. It was observed that pressure drop increase with increasing of nano fluid volume concentration and decrease with increasing of nano fluid temperature insignificantly. He found that TiO_2 is not significantly increased compare to EG fluid. The working temperature of nano fluid will reduce the pressure drop due to the decreasing in nano fluid viscosity.

Shiva Kumar et. al [5] have worked on both straight tube and helical tube heat exchanger. He has compared CFD results with the results obtained by the simulation of straight tubular heat exchanger of the same length under identical operating conditions. Results indicated that helical heat exchangers showed 11% increase in the heat transfer rate over the straight tube. Simulation results also showed 10% increase in nusselt number for the helical coils whereas pressure drop in case of helical coils is higher when compared to the straight tube.

Hemasunder Banka et. al. [6] has done an analytical investigation on the shell and tube heat exchanger using forced convective heat transfer to determine flow characteristics of nano fluids by varying volume fractions and mixed with water , the nano fluids are titanium carbide (TiC), titanium nitride (TiN) and ZnO nano fluid and different volume concentrations (0.02, 0.04, 0.07 & 0.15%) flowing under turbulent flow conditions. CFD analysis is done on heat exchanger by applying 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 increasing by increasing the volume fractions.

Daniel Flórez-Orrego et.al [7] bestowed a detail study on flow and therefore the heat transfer over a device designed supported cone formed helical coil. The simulations result shows similarities within the elements related to rate contours of the warmth exchanger. moreover, deviations and errors within the analysis were found owing to uneven flame radiation with a deviation around twenty third was recorded. The reliable correlation with the nusselt range values shows that the design provide improved performance.

Timothy J. Rennie [8] studied each parallel and counter fluid flows in cycle for heat exchanger designed supported double pipe coiling frame work with a scope of warmth transfer characteristics associated. The simulation analysis proves thatthe overall heat transfer constants is directly proportional to the inner dean range however the fluid flow conditions within the outer pipe had a serious contribution on the general heat transfer coefficient.

Usman ur Rehman [9] studied the heat transfer and flow distribution during a shell and tube device and compared them with the experimental results. The model showed a mean error of around two hundredth within the heat transfer and therefore the pressure distinction.

Nawras H. et.al [10] illustrated the performance of elliptical tubes supported the mechanical and thermal parameters used for chemical compound heat exchangers. The mechanical analysis proves that the efficient form of the outer tube had an best thermal performance supported analysis over completely different geometries of the tube and materials.

Tuckerman and Pease [11] exploited silicon micro-channels, with water because the operating fluid, to dissipate power from an electronic chip. The micro-channels were engraved {during a in an exceedingly in a very} atomic number 14 sample with an overall dimension of 1cm2. The tiny characteristic length scale of silicon small channels prompted the scientific community to analyze the chance of new transport physics.

III. METHODOLOGY

Descriptive analysis that's finding facts and surveys, whereas applied and elementary analysis aims to seek out a resolution to social issues or industrial issues. There are primarily two varieties of analysis approach that's a quantitative and qualitative analysis

These are is more subdivided into experimental and simulation approaches. The experimental approaches are characterized with larger control over the atmosphere whereas simulation approaches it includes the development artificial atmosphere at intervals that relevant info and knowledge may be generated, during this project, a comparative analysis of helical device with totally different material using machine Fluid Dynamic (CFD) are done. The comparative analysis is completed in terms of style contour variations and flow of fluid Transmit. The below fig.1 showing the step by step procedure on Ansys CFD and on applying relevant boundary condition result may be analyzed and simulation of fluid flow will be done.

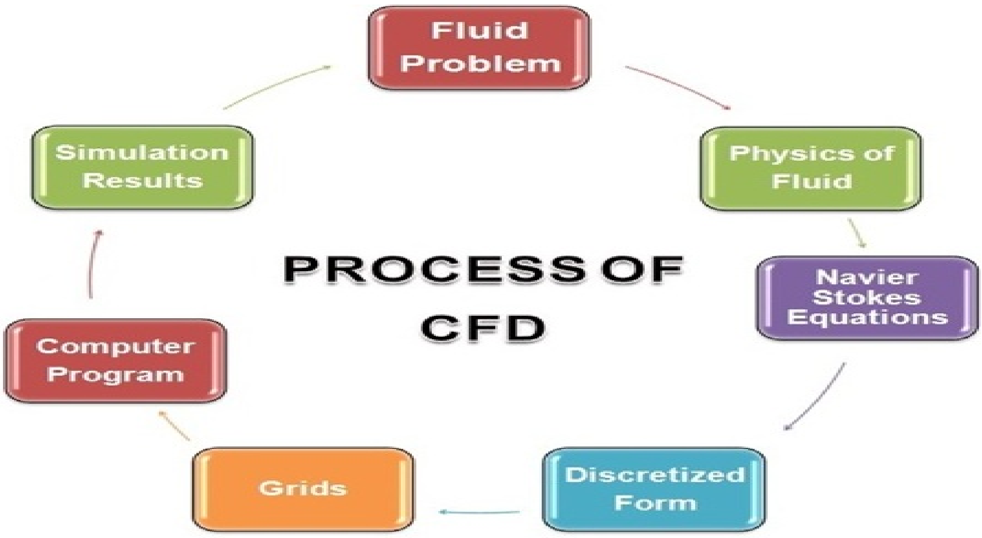

Fig.1 Steps involved in CFD

The step considered on Fluent as an important phase that determines the constraint imposed by the environment, application or other over the heat transfer requirement and performance. In addition, the problem type and physical model are vital constraint variables that determine the robustness of the heat exchanger as discussed in Ansys fluent 14.0 are namely

- Type – Solid (3D)
- Scope – Operational Pressure
- Model – Turbulence framework with twin expressions

FLUID PROPERTY: - The current factor incorporated as a boundary condition is the subjective and alters with reference to the material and fluid properties in consideration as presented in given table 1& 2 below.

Table No.1

Types of Fluid	Water
Density	998.2kg3/m
Viscosity	.0010003kg/m3
Specific Heat	4182jule/g.kal
Thermal Conductivity	0.6 watt/kal

Table No.2

Temperature	332K
Mass flow rate (Different)	0.02kg/s
Turbulence intensity ratio	.5%
Turbulence viscosity ratio	10%
Wall temperature	293k
Outlet	Pressure outlet
Operating condition pressure	101325Pa

IV. RESULT AND DISCUSSION

We firmly believe in the theory that every Joule (energy not used) lost means every Joule (energy needs to be produced) generate which in developing countries like India with ever increasing power demand could mount to significant socio-economic and environmental losses. In this thesis, we illustrated the need for heat exchangers that could offer a high heat transfer co-efficient that exploits coil's highly complex design based on helical architectures. Furthermore, a comparative analysis of the helical design of the coil with different materials (like Aluminum, Bonze, and Copper) and different flow rates was presented.

It well-documented fact that various design implementations of the coils has been introduced with inlet and outlet for the flow of the fluid. The important feature of the thesis is to provide a comprehensive analysis of the product life of the cycle associated with a heat exchanger in terms of material, pressure temperature, thermal conductivity, maximum heat transfer rate, and design. The heat transfer of the copper material is enhanced in comparison with other material unfortunately thermal resistance is reduced with an increase in pressure drop thus enhancing the heat transfer on the heat exchanger. Helical architecture is often designed with a clear motive of compact size and also addresses heat transfer co-efficient and other ancillary attributes efficiently and effectively. So the better material is suggested for an industrial heat exchanger according to the applications is Copper with the basis of simulation results.

Simulation results show that while we go to the different materials pressure drop is increasing from Aluminum to Bronze and Bronze to Copper and Temperature drop is decreases so the thermal resistance is decreased hence the heat transfer rate is also increased. Heat transfer coefficient, pressure drop and corresponding rate are higher in case of Copper in identical conditions. Also the comparison between different material and different mass flow rate are also studied. The geometry and different dimension parameter of helical coil shows that proposed study in different material properties and different mass flow rate to heat transfer is maximum in different parameter helical coil heat exchanger. Finally, the heat transfer increase for the copper material compared to another material but with increase in pressure drop the corresponding thermal resistance decreases which allows the improved heat transfer rate and the rate increases from Aluminum to Bronze to Copper. With the drop in temperature the thermal resistance is reduced which enhances the heat transfer rate. The simulations results show that the copper has high heat transfer co-efficient than Aluminum and Bronze while operating in identical conditions. Method for solving CFD analysis of helical coil heat exchanger would be carried out using "ANSYS 14.0" while the feasibility of model is analyzed via CAD model Generation of 3D model by using "Catia ver 5.0".

V. CONCLUSION

It is possible with helical coil heat exchanger to transfer heat at a faster rate compare to other type of heat exchanger. On simulating the results as per defined value of boundary condition in CFD it will shows that while going to adopt the different materials, being all materials have specific thermal .roperties? Pressure drop will increase from Aluminum to Bronze and Bronze to Copper and Temperature drop is decreases so the thermal resistance is decreased hence the heat transfer rate is also increased. Heat transfer coefficient, pressure drop and corresponding rate are higher in case of Copper in identical conditions. Also the comparison between different material and different mass flow rate are also studied. The designed geometry and different dimension parameter of helical coil shows that proposed study in different material properties and different mass flow rate the heat transfer is maximum in different parameter helical coil heat exchanger. Finally, the heat transfer increase for the copper material compared to another material but with increase in pressure drop the corresponding thermal resistance decreases which allows the improved heat transfer rate and the rate increases from Aluminum to Bronze to Copper. With the drop in temperature the thermal resistance is reduced which enhances the heat transfer rate. The simulations results show that the copper has high heat transfer co-efficient than Aluminum and Bronze while operating in identical conditions.

VI. FUTURE SCOPE

In an engineering transformation is necessary even somehow possible to modification in existing one and taking advantage of the possible feasible solution. The present study can be extended by taking the following variables:-

1. Investigation can be done with a mass flow rate.
2. Study with different geometrical parameter like PCD, Pitch and Pipe dia.

Comparison with different Velocity inlet

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