Modelling And Analysis of Shell and Helical Coil Heat Exchanger and Determining Its Effectiveness by Using Different Materials

K. Supriya[1], A. Naga Pavan kumar[2], A.omkar[3], B. Raja[4], B. Vamsi[5], K. Venkateswara Rao[6]
[12] Assistant Professor, DVR & Dr. H S MIC College of Technology, Kanchikacherla, Andhra Pradesh-India, 521180 [3456] students, DVR & Dr. H S MIC College of Technology, Kanchikacherla, Andhra Pradesh-India, 521180.
[123456] Department of Mechanical Engineering, DVR & Dr. H S MIC College of Technology, Kanchikacherla, Andhra Pradesh-India, 521180.

Abstract- A heat exchanger is equipment which facilitates the flow of thermal energy between two or more fluids at different temperatures. By analysis and experimentation of systematic data degradation which are done previously leads to the conclusion that the maximum heat transfer rates is obtained in case of the inward counter flow configuration. The references shows that effectiveness of counter flow heat exchanger is maximum compare to parallel flow.
In this project with the addition of counter flow heat exchanger we are going to change the materials of the heat exchanger to improve the effectiveness of heat exchanger, and how it is making the changes in COP of refrigeration. For this simulation we are using FLOW SIMULATION method in solid works.

Keywords: Effectiveness, Flow simulation

1. INTRODUCTION

In this project we are introducing shell and helical coil heat exchanger at the condensation process of a refrigerator. Instead of leaving coil to atmospheric air we are adding a shell around a coil and, in this shell the refrigerant will flow and the condensate will flow through the coil in counter flow direction.
In regular domestic refrigerators only the refrigerant is in motion and the atmospheric air will be stagnate so, we replaced the condenser with shell and helical coil heat exchanger to make both coolant and refrigerant to be in motion and we reduce the thickness of the helical coil and we change the material of the helical coil to increase effectiveness and heat exchange rate in heat exchanger.
A shell and helical coil heat exchanger is a type of heat transfer device commonly used in various industrial applications. It is a compact, efficient, and versatile heat exchanger that is widely used due to its high heat transfer rate, small footprint, and low maintenance requirements.
The aim of modeling and analysing a shell and helical coil heat exchanger is to determine its effectiveness in transferring heat between two fluids. This is done by using different types of materials to construct the heat exchanger and studying the effects on its performance.
The modelling process involves the use of mathematical equations, simulations, and flow simulation to predict the heat transfer rate and pressure drop in the heat exchanger. By varying the material properties, such as thermal conductivity and heat capacity, the impact of different materials on the heat exchanger's effectiveness can be analysed.
The analysis of the heat exchanger's performance can be used to optimize its design and select the most suitable materials for specific applications. Factors such as cost, durability, and thermal stability need to be considered when selecting the material.
In conclusion, modeling and analysing a shell and helical coil heat exchanger is an important process for determining its effectiveness and optimizing its design. By using different types of materials, it is possible to improve the performance of the heat exchanger and meet specific industrial requirements.

2.LITERATURE SURVEY

2.1 MODELLING AND ANALYSIS OF HEAT EXCHANGER

A literature survey for a modelling and analysis of a shell and helical coil heat exchanger to determine its effectiveness using different types of materials can involve a review of previous studies and research works related to heat exchangers, materials science, and thermodynamics.

The survey may begin by exploring the basic principles and design concepts of shell and helical coil heat exchangers. This can include the types of materials commonly used in the construction of heat exchangers, their properties, and their performance characteristics.

The literature survey can also examine the different methods of modelling and analysis that have been used in the study of heat exchangers. This can include analytical and numerical methods, experimental techniques, and computer simulations.

In addition, the survey can explore the various factors that affect the effectiveness of heat exchangers, such as the flow rate of the fluids, the temperature difference between the fluids, and the heat transfer coefficients of the materials.

To determine the effectiveness of a shell and helical coil heat exchanger using different types of materials, the literature survey may also involve a review of studies that have investigated the performance of specific materials in heat exchangers. This can include studies on the thermal conductivity, heat transfer coefficients, and corrosion resistance of various materials.

Overall, a literature survey for the modelling and analysis of a shell and helical coil heat exchanger to determine its effectiveness using different types of materials can provide valuable insights into the design and performance of heat exchangers, as well as the properties and characteristics of different materials used in their construction.

3. MODELLING

Following are the dimensions of a shell and helical coil.

3.1. Shell dimensions

S.No	Dimensional parameters	Dimensions (mm)
1.	Core diameter	220
2.	Shell length	295.65
3.	Inner diameter	110
4.	Shell thickness	4

3.2. Helical coil dimensions

S.No	Dimensional parameters	Dimensions (mm)
1.	Tube outer diameter (d_o)	12.5
2.	Tube inner diameter (d_i)	10
3.	Tube thickness	1.25
4.	Mean coil diameter	165
5.	Coil outer diameter	177.5
6.	Pitch	18.75
7.	No.of turns	12

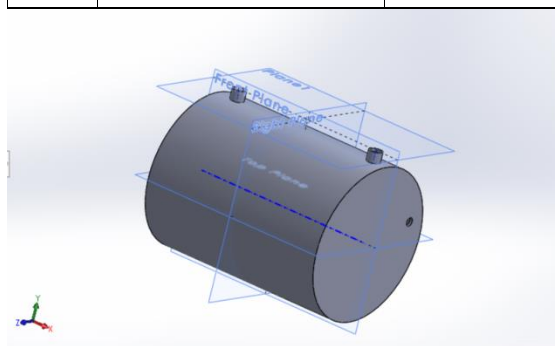


Fig.1. Solidworks model of shell

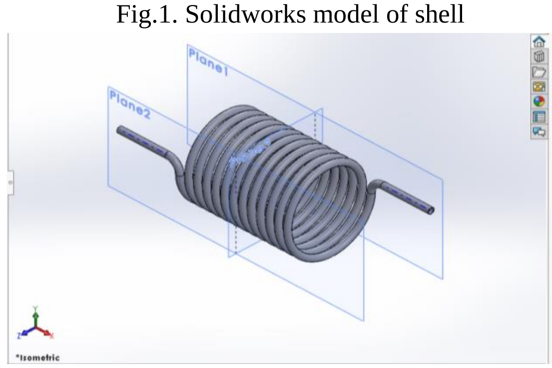


Fig.2. Solidworks model of helical coil

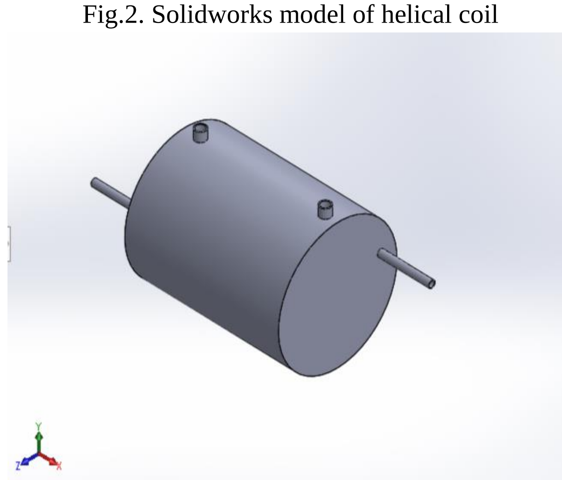


Fig.3 Shell and helical coil heat exchanger

4. SIMULATION

In this project we used FLOW SIMULATION METHOD in solid works software. In this analysis we are going to find the outlet fluid temperatures by using input parameters like inlet fluid temperatures and refrigerant properties, here we also changed the coil materials. We used different materials like copper, aluminium and silver. We all know that heat transfer takes place between two fluids here we took one is refrigerant R22 and another one is Nano fluid. We used AL_2O_3 as a Nano fluid. We considered the properties of aluminium oxide like specific heat ratio, molecular mass, dynamic viscosity, specific heat, thermal conductivity of it.

MATERIALS AND ITS PROPERTIES:

material	density	Specific heat	Thermal conductivity
Copper	8979	381	387.6
Aluminium	2719	871	202.4
Silver	10490	236	419

PROPERTIES OF NANO FLUID:

Property	Values
Specific heat ratio	1.035
Molecular mass	0.10196 kg/mol
Dynamic viscosity	1.09 Pa*s
Specific heat	880J/(Kg*k)
Thermal conductivity	35W/(m*k)

4.1 FORMULAE

The effectiveness (ϵ) of a heat exchanger is defined as the ratio of the actual heat transfer to the maximum possible heat transfer.

- ∈ = actual heat transfer / maximum possible heat transfer

Actual heat transfer

$$Q = m_h C_{ph} (t_{h1} - t_{h2}) = m_c Cpc \ (t_{c2}-t_{c1})$$

Where,

$m_h . C_{ph} = C_h$ = hot fluid capacity rate

$m_c . C_{pc} = C_c$ = Cold fluid capacity rate

Maximum possible heat transfer

$$= Q_{max} = C_h (t_{h1} - t_{c1}) \text{or}$$

$$= C_c (t_{h1} - t_{c1})$$

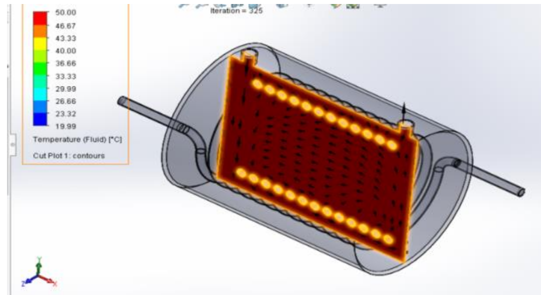
Qmax is the minimum of these two values

$$Q_{max} = C_{min} (t_{h1} - t_{c1})$$

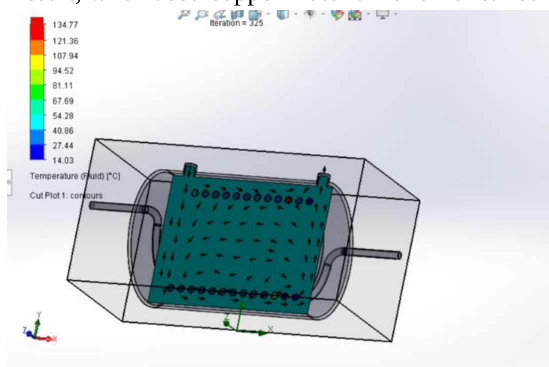
$$\in = C_h (t_{h1} - t_{h2}) / C_{min} (t_{h1} - t_{c1}) \text{ or}$$

$$= C_c (t_{c2} - t_{c1}) \ / C_{min} (t_{h1} - t_{c1})$$

4.2 RESULTS



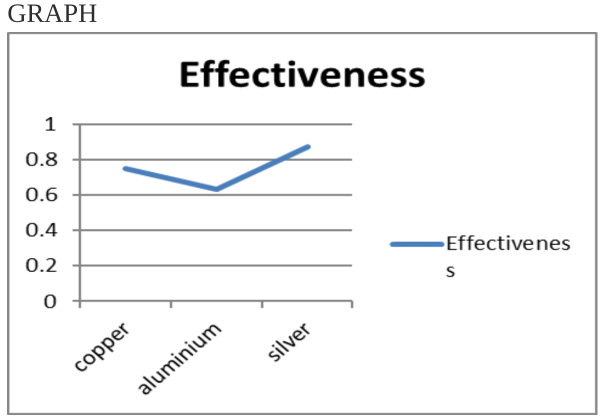
Result, when used copper material for a helical coil



Result, when used silver material for a helical coil

Result, when used aluminium as a helical coil material

GRAPH



5. CONCLUSION

Thus the design and analysis of helical coil heat exchanger is done and has the following conclusions.

- The performance of both shell and helical coil heat exchanger are analysed. The heat transfer to Nano fluid is high for a silver coil heat exchanger than copper and aluminium coils.
- The heat transfer is high for Nano fluid (AL2O3) than base fluid.
- The effectiveness of shell and helical coil heat exchanger is good for silver coil when compared to copper and aluminium coils.
- Even though silver has a better thermal conductivity copper and aluminium has better specific heat and less weight in comparison to both copper and aluminium. The Al and Cu are preferred in various applications. But, we can see here silver coil is having more effectiveness and thermal conductivity.

REFERENCE

[1]Amitkumar S Putterwar, A.M.Andhare-"Design and thermal evaluation of shell and helical coil heat exchanger", International journal of research in engineering and technology. eISSN: 2319-1163

[2] Devendra Borse, Jayesh V. Bute- "A Review on Helical Coil Heat Exchanger", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 6 Issue II, February 2018.

[3] Sreejith K., T.R. Sreesastha Ram, Jaivin A. Varghese, Manoj Francis, Mossas V.J., Nidhin M.J., Nithil E.S., Sushmitha S.-"Experimental Investigation of a Helical Coil Heat Exchanger", : International Journal of Engineering And Science, Vol.5, Issue 8 (August 2015), PP -01-05.

[4] R. K. Patil, B. W. Shende, and P. K. Ghost, "Designing a helical-coil heat exchanger." pp. 1–8, 1984.

[5] S.Kumar and K. V. Karanth, "Numerical Analysis of a Helical Coiled Heat Exchanger using CFD," pp. 126–130, 2013.

[6] N. Jamshidi, M. Farhadi, D.D. Ganji, K. Sedighi, Experimental analysis of heat transfer enhancement in shell and helical tube heat exchangers, Appl. Therm. Eng. 51 (2013) 644–652, https://doi.org/ 10.1016/j.applthermaleng.2012.10.008.