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CFD Analysis on Simple and Helix Tube Type Heat Exchanger Using Ansys Software

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ABSTRACT
The present project deals with the overall heat transfer study in simple tube of double pipe heat exchanger and corrugated twisted tape fitted over tube (Specific tube) of double pipe heat exchanger. Corrugated twisted tape is twisted helix tape or helicoid flight which is mounted on surface of inner pipe. The heat transfer rate, thermal performance and effectiveness of corrugated twisted tape fitted on a tube are investigated by CFD analysis. The CFD analyses have been performed for the tube fitted with corrugated twisted tapes with different pitches and also on simple tube. Therefore applying the same parameter to the both simple double pipe heat exchanger and tube fitted with corrugated twisted tape, various thermal results are calculated.
Heat flux obtained for simple double pipe heat exchanger is 19.8w/m², whereas heat flux achieved for tube fitted with corrugated twisted tape is 20w/m². The calculated effectiveness of simple double pipe heat exchanger is 0.41; however calculated effectiveness value is 0.76 for tube fitted with corrugated twisted tape.
Based on above results, it has been determined that heat flux and effectiveness for tube fitted with corrugated twisted tape is more than simple tube, hence this can be suggested in future for more effectiveness.

Keywords – CFD, corrugated, effectiveness, heat flux, twisted tape**.**

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I. INTRODUCTION

Heat exchanger is a device that continuously transfers heat from one medium to other medium in order to carry process energy.

A Double pipe heat exchanger (DPHE) is for the most part utilized in moderate weight application ventures. Twofold pipe heat exchanger in its straightforward one pipe inside the another bigger pipe. Twofold pipe heat exchanger application are Pre-heating , petrochemical, nourishment preparing businesses , pharmaceutical, power and electric age. In the Double pipe type heat exchanger one fluid move through the annulus between two pipe and another fluid stream inside the internal pipe. An Outer Tube is an enormous weight vessel and internal cylinder and turned tape are significant parts in DPHE, In twofold pipe heat exchanger the diverse kind of enhancements are utilized like Twisted tapes ,balances, baffles. Here in my investigation I utilized contorted tapes for the upgrades.

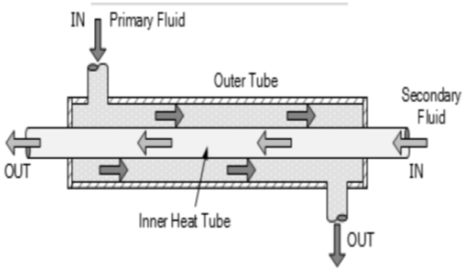

FIG.1.1 DOUBLE PIPE HEAT EXCHANGER

II. METHODOLOGY

CFD is a sophisticated computationally-based design and analysis technique. CFD software gives you the power to simulate flows of gases and liquids, heat and mass transfer, moving bodies, multiphase physics, chemical reaction, fluid-structure interaction and acoustics through computer modeling. This software can also build a virtual prototype of the system or device before can be apply to real-world physics and chemistry to the model, and the software will provide with images and data, which predict the performance of that design.

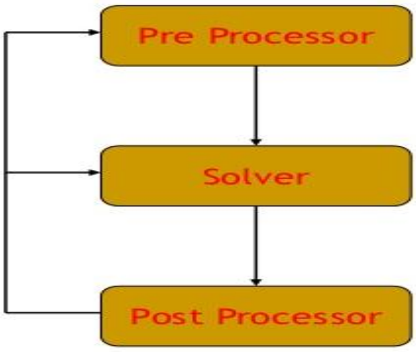

Fig.2.1 Methodology

CFD analysis of helical coil heat exchanger using ANSYS 17.0, Cad model Generation of 3D model by using CATIA V 5R20 and exporting to the IGES and then import in ANSYS fluent 17.0.

➢ **PRE PROCESSING**:

Create geometry and mesh for solving problem

❖ **CAD model**

✓ Generation of 3D model by using CATIA ver 5.0

❖ **FVM approach:-**

By this method we can solve algebraic equation to get initial solution.

✓ Set the transportation equation that needs to be solved. This can be solved by using ANSYS Fluent 14.0 in Fluent setup
✓ Set the fluid property
✓ Set the boundary conditions
✓ Set the Source term (Pressure)

➢ **SOLUTION:**

Solution Method

❖ **Pressure Velocity coupling scheme**

For 2D Problem we use Stream Function Vortices approach.

For 3D Problem we use Primitive variable approach.

Collocated grid should be used to solve pressure velocity coupling scheme.

❖ **Turbulence Modeling:-**

K-ε turbulence model for turbulent flow equation Momentum second order

Turbulence Kinetic energy second order (K)

➢ Turbulence dissipation rate second order(ε)

➢ **SOLUTION INITIALIZATION:-**

Initialized the solution to get the initial solution for the problem. By using SIMPLE solver (Semi – implicit method for pressure linked equation).

➢ **RUN SOLUTION:-**

Run the solution by giving 300 no of iteration for solution to converge.

➢ **POST PROCESSING:-**

❖ Post Processing:- For viewing and interpretation of Result, the result can be viewed in various formats like graph, value, animation etc.

Table 1 Geometric dimensions of shell and tube heat exchanger

Sr. no	**Part name**	**Specification**
1	Inner pipe (inner diameter) (di)	25 mm
2	Inner pipe (outer diameter) (do)	26.5 mm
3	Outer pipe (inner diameter) (Di)	54.5 mm
4	Outer pipe (outer diameter) (Do)	56 mm
5	Pipe length (L)	2000 mm

III. SIMULATION & MODELING

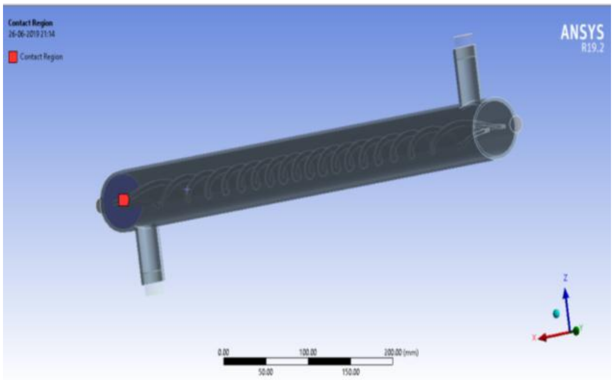

Fig.3.1 Twisted leaf Tube Heat exchanger model imported to ANSYS

Boundary condition :

MODEL CALCULATIONS:

1. Hot water inlet temperature, t_{hi} = 327 K
2. Hot water flow rate, m_h

Let time required for 1lit of water be x_h sec

Mass of 1lit water = 1kg

Therefore, m_h = 1/ x_h kg/s = 1/15.6 = 0.064 kg/s

3. Cold water inlet temperature, t_{ci} = 303K
4. Cold water flow rate, mc

m_c = 1/ x_C kg/s = 1/15.2 = 0.066 kg/s

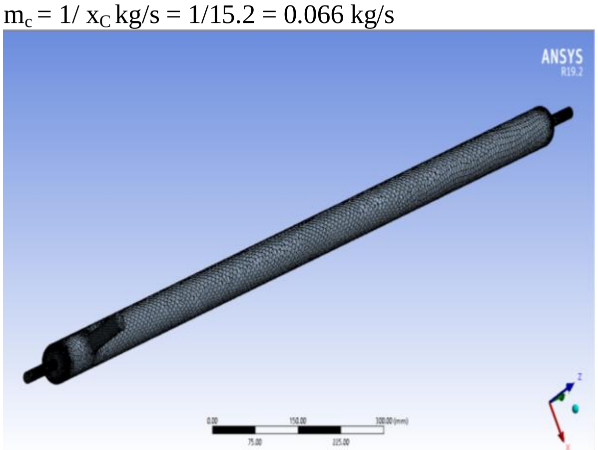

Fig.3.2 Twisted leaf Tube Heat exchanger applied meshing

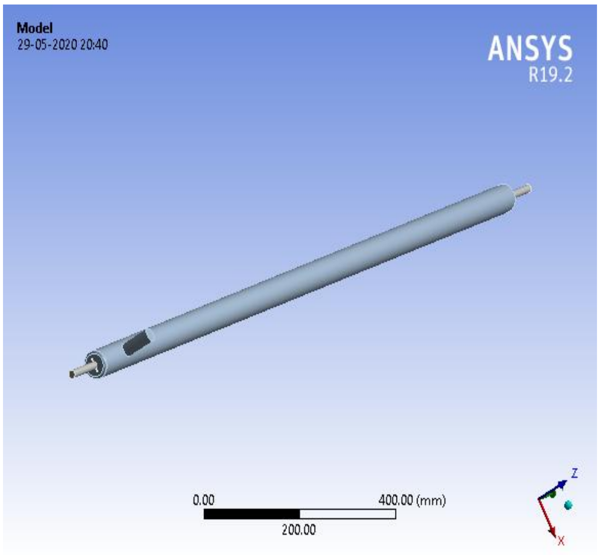

Fig.3.3 Twisted Tube Heat exchanger applied contact region

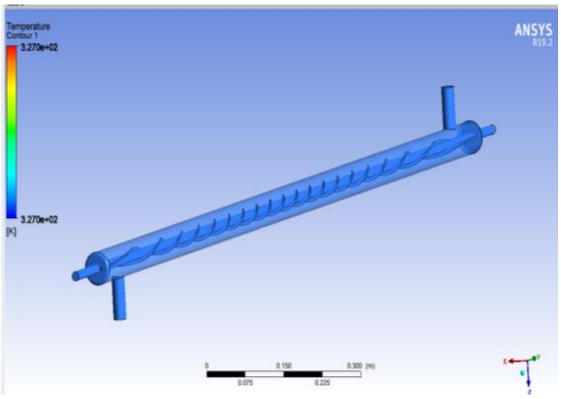

Fig.3.4 Hot inlet at 327 K Temperature

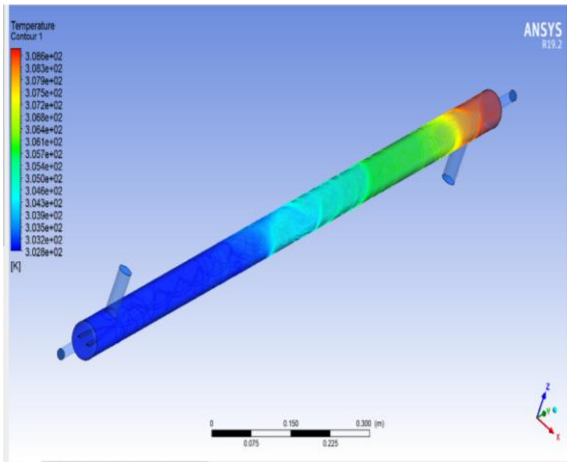

Fig.3.5 Hot outlet at 308 K Temperature

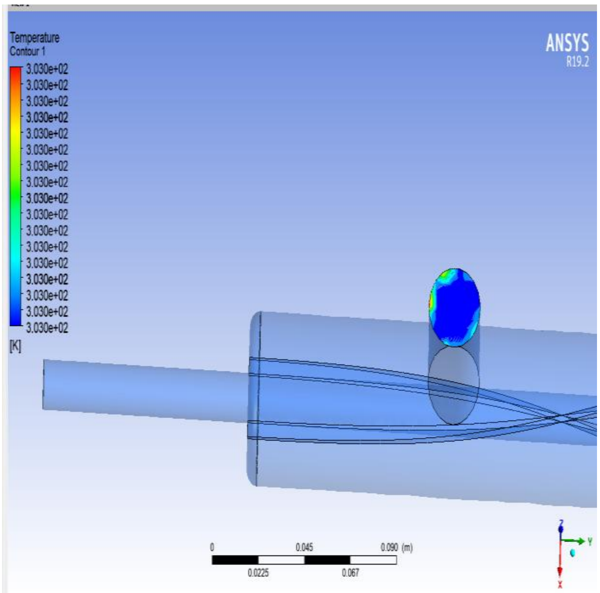

Fig. 3.6 Cold inlet at 303 K Temperature with zooms in

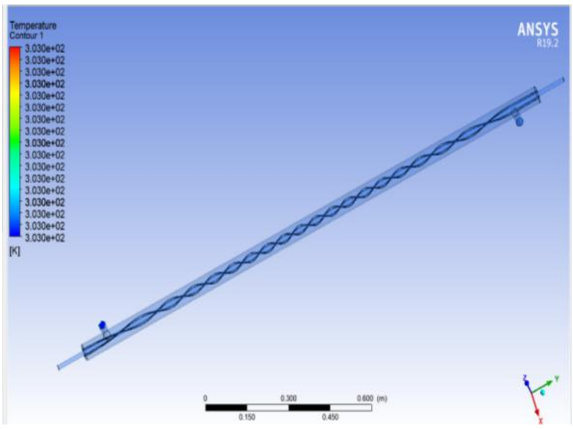

Fig.3.7 Cold inlet at 303 K Temperature

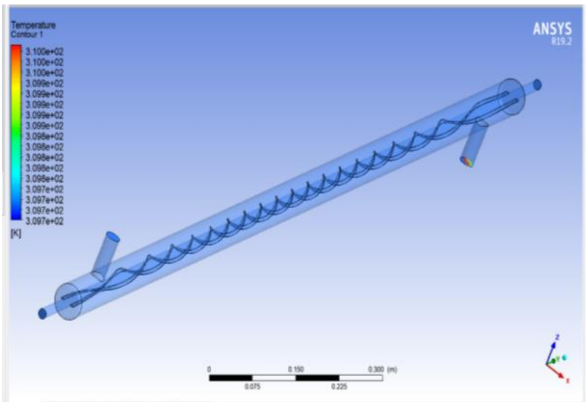

Fig 3.8 Cold Outlet at 312 K Temperatures

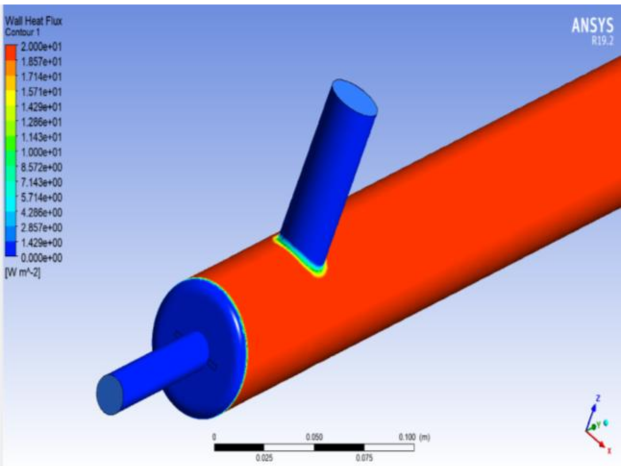

Fig.3.9 Heat flux on helix tube heat exchanger zoom in

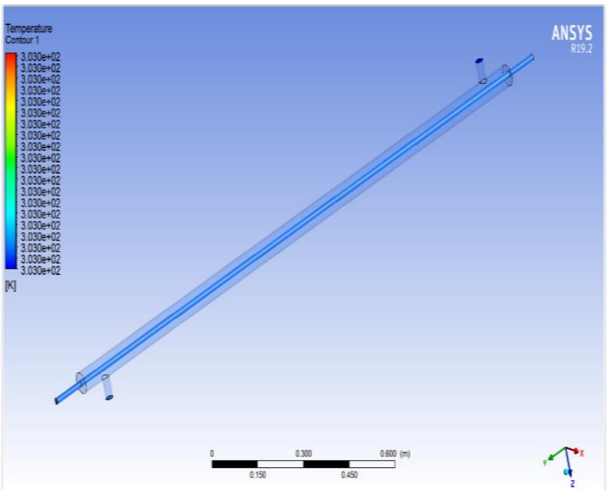

Fig. 3.12 Cold inlet at 303 K Temperature with zooms in

4.3 Simple Tube Heat exchanger

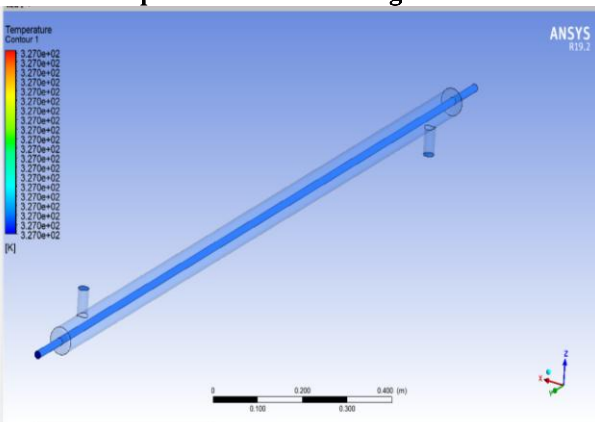

Fig.3.10 Hot inlet at 327 K Temperature

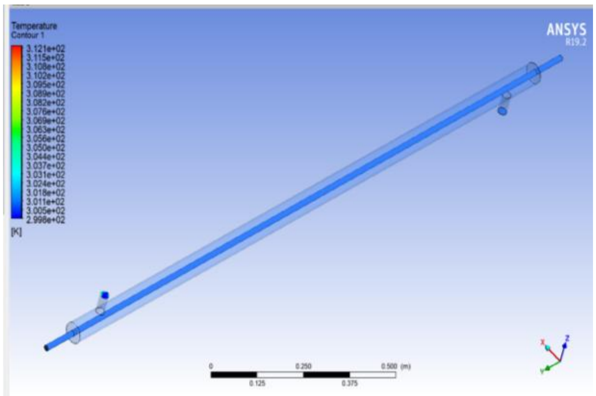

Fig 3.13 Cold Outlet at 312 K Temperatures

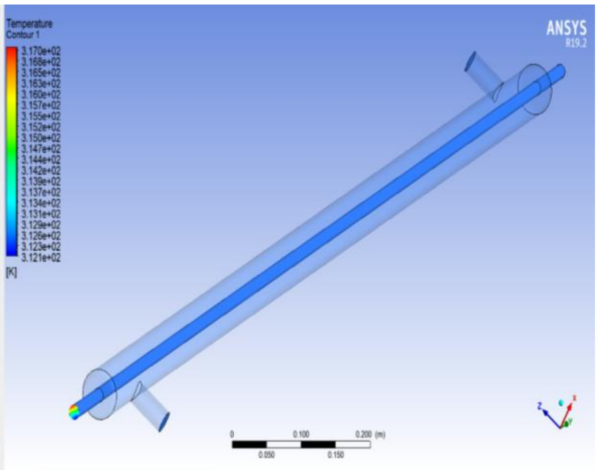

Fig.3.11 Hot outlet at 317K Temperature

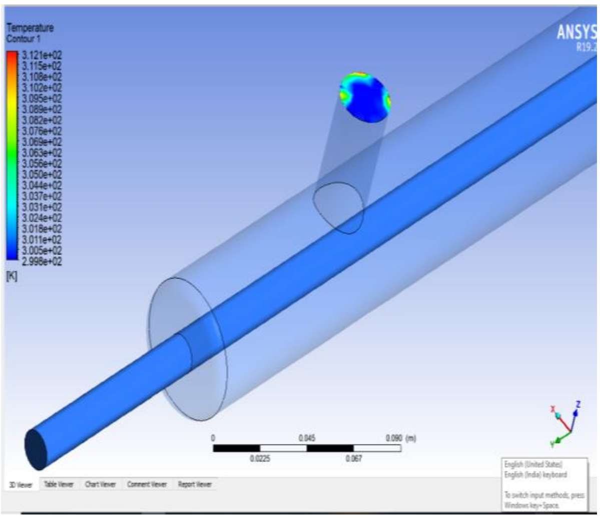

Fig. 3.14 Cold Outlet at 312 K Temperature zoom in

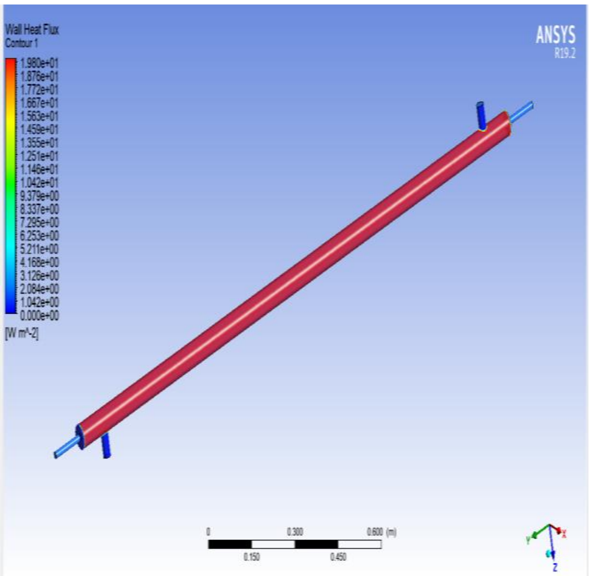

Fig. 3.15 heat flux results

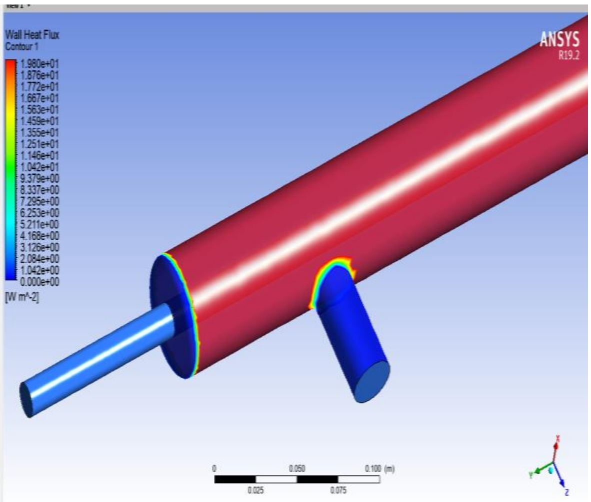

Fig. 3.16 heat flux results zoom in

IV. CONCLUSION

The heat transfer enhancement, thermal performance and friction factor characteristics of corrugated twisted tape inserted tube will be investigated computational experimentally. The experiments will be performed for the tube fitted with corrugated twisted tapes with different pitches and also for different wave numbers. Based on the experimental results, following will be parameters which could be summarized as follows:

To simulate the concentric heat exchangers with plain tube and Twisted Tape Inserts to determine the tube wall temperature variation along the flow length and the pressure difference across the tube wall by CFD analysis.

To investigate the effect on heat transfer rate in concentric heat exchangers with plain tube and Twisted Tape Inserts.

The highest heat flux among the inserts tested and amount by which it is higher than the value of the plain tube.

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