WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

CFD Analysis of Heat Transfer in A Double Pipe Heat Exchanger Using Different Fluid

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A B S T R A C T

A heat exchanger is a device used to transfer thermal energy between two or more fluids, at different temperatures in thermal contact. They are widely used in aerospace, chemical industries, power plants, refineries, HVAC refrigeration, and in many industries. The optimal design and efficient operation of the heat exchanger and heat transfer network plays an important role in industry in improving efficiency and to reduce production cost and energy consumption. In this paper, significance of shape of inner pipe of double pipe heat exchanger was analyzed with respect to triangular, hexagonal and octagonal shaped inner pipes. The performance of double pipe heat exchangers was investigated with and without dent pattern using CFD analysis in ANSYS and efficient heat transfer results are identified from CFD outputs. On basis of the literature review, few factors influencing the efficiency of heat exchanger method to improve the efficiency are discussed.

Keywords: *CFD Analysis, Heat exchangers, Heat Transfer Analysis, Heat Conduction Equation, Temperature Equilibrium*.

1. Background:

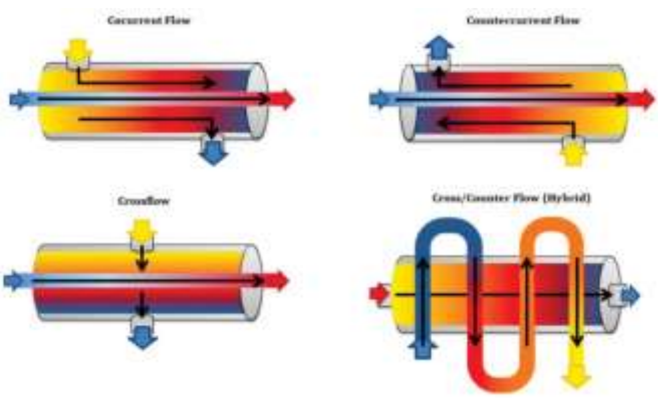
Various sorts of intensity exchangers capability in various ways, utilize different flow game plans, hardware, and configuration highlights. Something normal in all intensity ex-transformers is that, they all capability to straightforwardly or by implication uncover a hotter medium to a cooler medium. Heat exchangers are normally achieved with a bunch of cylinders inside a packaging of some sort.

Heat exchangers are generally classified on the following basis,

- According to heat exchange process nature.
- According physical state of the fluid.
- According to flow arrangements.

Heat exchangers may also be classified based on the physical state of the hot and cold fluid such as,

- Liquid to Gas.
- Liquid to Solid.
- Gas to Solid.

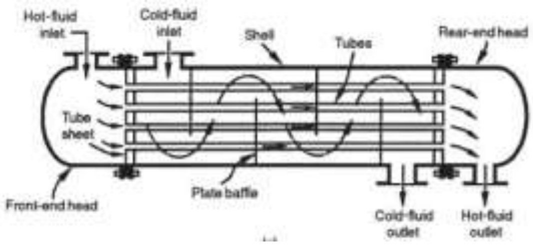


1.1 Tubular Heat Exchanger

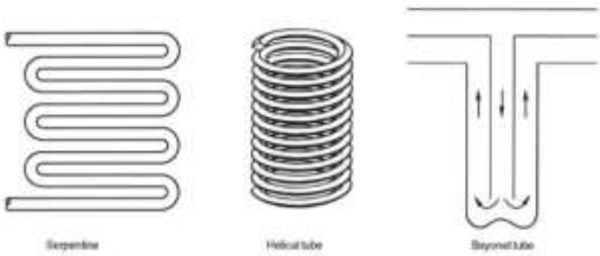
Tubular exchanger is for the most part work with roundabout cylinders, curved or rectangular or some other complex shape bent tubes relying on the application utilized. These sort of intensity exchangers are flexible in plan and math and can undoubtedly change the cylinder distance across, length and course of action of flow. That is the reason these intensity exchangers are viewed as over other intensity exchangers. Rounded heat exchangers are liked for applications connected with high strain, where the tension distinction between the fluids are high, these cylindrical intensity exchangers are prevalently utilized for fluid to fluid and fluid to stage change heat move application. These intensity exchangers are famously classified as shell and cylinder, twofold line and twisting cylinder exchangers. All essential surface of intensity exchangers are same, yet fins might be developed outside or inside the cylinder.

1.2 Shell and Tube Heat Exchanger

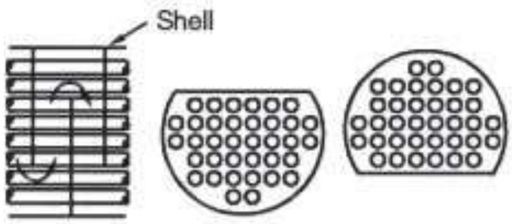
Heat exchangers are for the most part worked by bending the round tubes in a barrel shaped shell where cylinders are adjusted lined up with that of a pivotal to shell. One fluid flows through the inward line and other fluids flow across and along the cylinder. The significant parts of this intensity exchanger are tube, shell, interesting and head, front and head, baffles and tube shells and so on. Contingent on the longing heat move and strain drop execution, different interior development is utilized in shell and cylinder exchanger. For the most part, these exchangers are utilized to lessen warm pressure to forestall spillage and simplicity of cleaning working strain and temperature to control erosion.



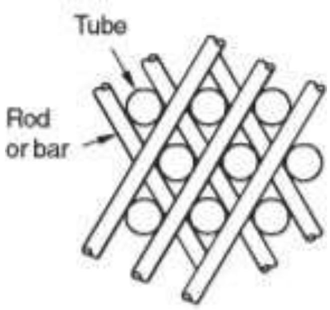
1.3 Tubes



1.4 Baffles



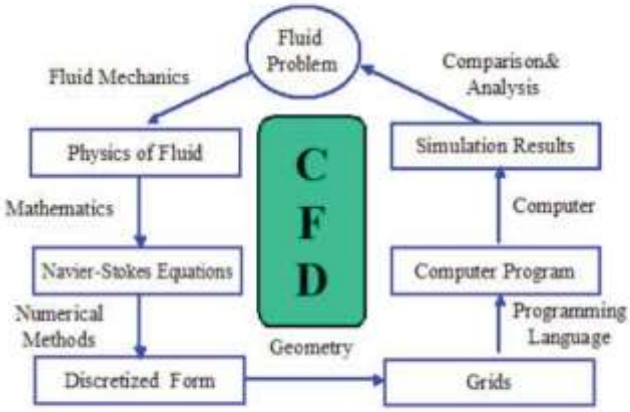
1.5 Tubes sheet



2. Theory and Related Work

Computational Fluid Dynamics Concept:

The simulation of fluid engineering systems using combination of mathematical modelling and numerical modelling is known as computational fluid dynamics. CFD enables engineer and scientists to perform various experiments in a virtual laboratory.These numerical simulations of fluid flow helps in various sectors such as meteorological phenomenon, environmental hazard, combustion in automobile engine and complex flow in furnace heat exchangers and chemical reactors.CFD gives an in-sight into various flow pattern that are difficult, expensive, in few cases impossible to study using experimental techniques.When compared with experiments simulation are cheaper and results can be obtained faster and simultaneously various phenomenons could be studied and monitored at same instant of time. The process of computational fluid dynamics are shown in the figure below



3. Equations

Navier Stoke Equation

Navier's stokes equations are generally consider governing equation in computational fluid dynamics.These equations are based on conservation law of physical properties of fluids. Fluids have important properties such as velocity, pressure, temperature and viscosity.The density of fluid is defined as mass per unit volume.If the fluid is incompressible then we can express density of fluid.

4. Method and Result

Modelling

Geometry of Finite Element Model (FEM)

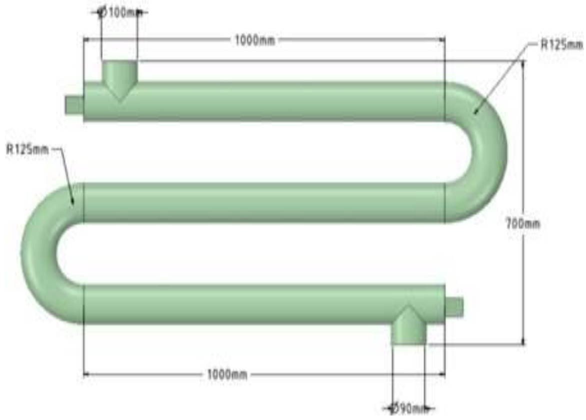
The principal intention of this finite detail version in ANSYS is to analyze the transfer of heat in a double pipe heat-exchanger. We have built a double pipe warmness exchanger, in which the ethanol is flowing withinside the internal pipe of the heat exchanger and the water is flowing from the outside pipe. To apprehend the heat transfer analysis, we've taken into consideration 3 styles of internal pipes, particularly triangular, hexagonal and octagonal. Flow charge of 0.1 kg/sec and turbulent depth of five percent of turbulent viscosity ratio of 10 turned into taken into consideration, to analyze heat transfer rate.

Geometric Properties

The material is build using the below geometric properties for double pipe heat exchanger.

S.No	**Parameters**	**Values/Specimen**	**SIunits**
1	Material	Copper	-
2	Pipeouterdiameter	100.0	mm
3	Pipeinner diameter	90.00	mm
4	Pipe Thickness	10.00	mm
5	Pipe Length	3250.00	mm

Material Properties



S.no	**Parameters**	**Values**	**SIunits**
1	Density of copper	8960.00	kg/m^3
2	Specific Heat of Copper	376.8120	j/kg-k
3	ThermalConductivityof Copper	394.00	w/m-k

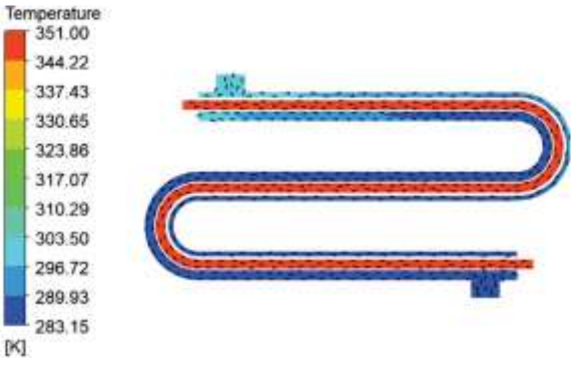
Boundary condition and meshing

The numerical model is constructed by considering few boundary conditions and parameters. For this double pipe heat exchanger, the external tube is made up of brass and the internal tube is made up of copper. The ethanol flows from the inner pipe of the heat exchanger and the external pipe is supplied with water. The temperature condition of ethanol was considered as78^0 at inlet and the water temperature was considered as 10^0 at the inlet. Different types of inner tubes are considered such as triangle, hexagon, octagon.These are considered to investigate temperature change across the pipe length. Fine meshing was done to produce accurate results.

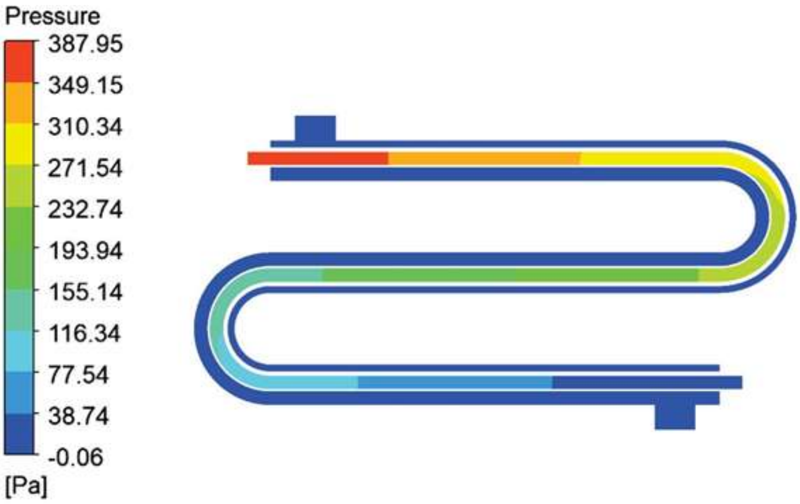
5. Results

Heat transfer Effect in Presence of Triangular Inner Pipe:

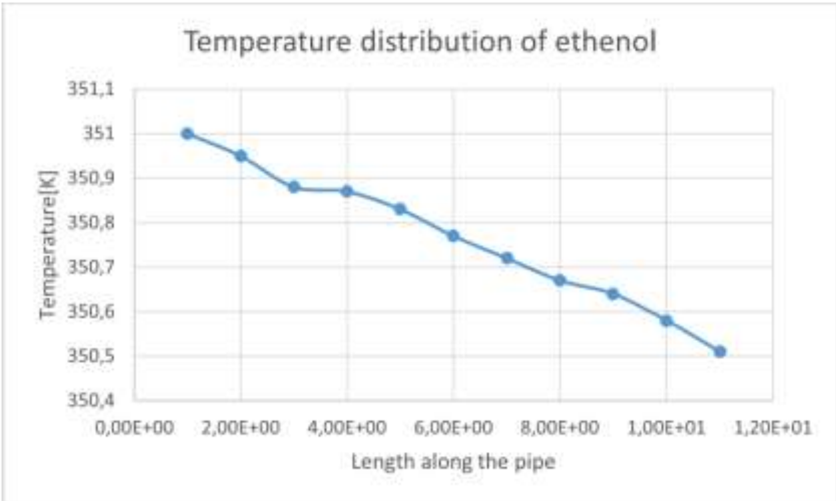
A double pipe heat exchanger was constructed by employing triangular shaped inner pipe to investigate the heat transfer along the length of the heat exchanger.The external tube was considered to be brass and the inner tube was considered to be copper. Ethanol is the fluid that flows into the inner pipe of the double pipe heat exchanger,and water was carried in externa lpipe.The temperature of ethanol was considered to be about78^0catthe inlet of the tube and the water temperature was considered to be 10^0c at the inlet of the tube.After the simulation it was observed that there is a decrease of 0.5^0c temperature in inlet when compared to the outlet. And the temperature of water gradually increases. A counter flow type of heat exchanger was constructed in this simulation. Below are the counter plots for temperature and pressure distribution.



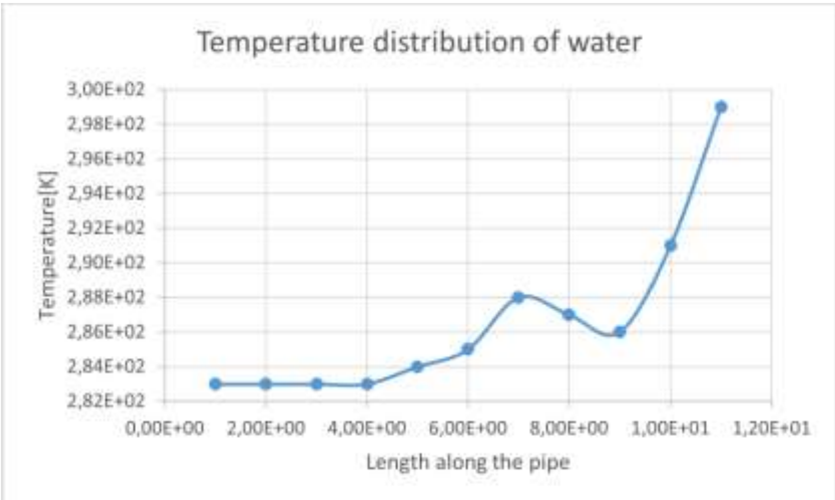
Temperature distribution in triangle-shaped inner pipe.



Pressure distribution in triangle-shaped inner pipe.



Temperature Distribution Graph for ethanol in the triangular inner pipe.



Temperature Distribution Graph for water in the triangular inner pipe.

6. Conclusion

This thesis pursuit at studying heat transfer parameter beneath different shapes of tubes consisting of triangular, hexagonal and octagonal. In this have a look at we attempted to research the diverse feasible methods to boom heat transfer in double pipe heat exchanger. In our research we located that introducing dent sample across the outside floor of internal pipe of heat exchanger outcomes with premiere output. The periotic utilization of those techniques facilitates in restoring the premiere efficiency in heat exchangers earlier than the scaling and faulting parameters effect the heat exchangers efficiency..

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