

# CFD Analysis of Double Pipe Parallel Flow Heat Exchanger

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**Abstract** - A heat exchanger is a device that is used to transfer thermal energy (enthalpy) between two or more fluids, between a solid surface and a fluid or between solid particulates and a fluid, at distinctive temperatures and in thermal contact. Heat exchangers are important engineering devices in many process industries since the efficiency and economy of the process largely depend on the performance of the heat exchangers. The present work is directed towards the modeling of shell and tube parallel flow heat exchanger in solid works 2014 and setting up of flow simulation in solid works by inserting boundary conditions, running the calculations, inserting surface parameters, using cut plots and flow trajectories to visualize the resulting flow field. Finally compared the flow simulation results with effectiveness-NTU method. There is a difference of 7.3% of flow simulation results with effectiveness NTU method.

**Keywords:** Shell & Tube parallel flow Heat Exchanger1, Solid works2, Boundary Conditions3, Flow simulation4 etc.

## 1. INTRODUCTION

A heat exchanger is a device that is used to transfer thermal energy (enthalpy) between two alternately more fluids, between a strong or solid surface and a fluid at distinctive temperatures and in thermal contact. Commonplace applications include warming (heating) or cooling of a fluid stream of concern and dissipation or buildup of single- or multi segment fluid streams. In mostly heat exchangers, high temperature exchange or heat transfer between fluids happens through a dividing divider (wall) or into and out of a divider (wall) in a transient way[1].

Shell and tube heat exchangers carry with it a series of tubes. One set of those tubes contains the fluid that has to be either heated or cooled. The second fluid runs over the tubes that area unit being heated or cooled in order that it will either offer the heat or absorb the heat needed. A group of tubes is termed the tube bundle and might be created from many sorts of tubes: plain, lengthways finned, etc. Shell and tube heat exchangers area unit usually used for high-pressure applications

This is because the shell and tube heat exchangers are robust due to their shape. Several thermal design features must be considered when designing the tubes in the shell and tube heat exchangers: Tube diameter, tube thickness, tube length, tube pitch, tube corrugation, baffle design.

## 2. MODELLING OF SHELL AND TUBE HEAT EXCHANGER

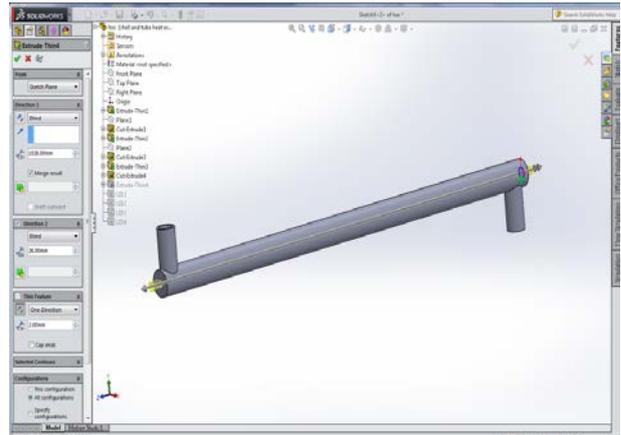


Figure: Extrusion of tube

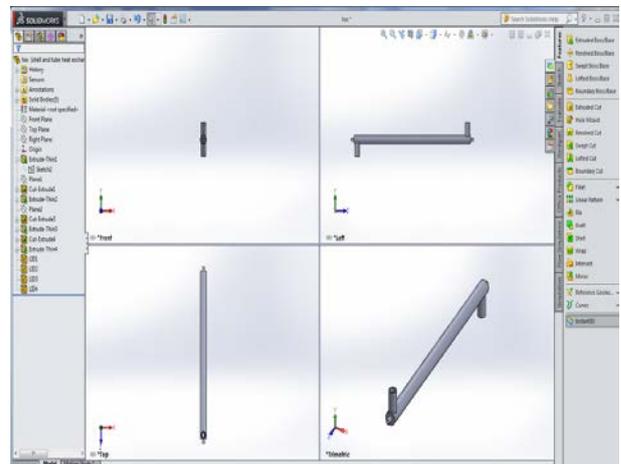


Figure: Different views of shell and tube heat exchanger

## 3. FLOW SIMULATION OF SHELL AND TUBE HET EXCHANGER

In this flow simulation of shell and heat tube exchanger heat transfer will occur between the hot inner tube flow and the colder outer flow in the shell. The shell has a wall thickness of 10mm and an inner diameter of 32mm where as the tube is 2mm thick and has an outer diameter of 19mm[2]

The mass flow rate of water in the shell is 0.8kg/s with an inlet temperature of 283.2k and the mass flow rate of water in tube is 0.2 kg/s at an inlet temperature of 343.2k. The

temperature distributions along the shell and tube will be shown from flow simulation results. The temperature of the hot water at the tube outlet will be used in comparison with effectiveness-NTU method for calculation of effectiveness of the parallel flow shell and tube heat exchanger.

## 5. FLOW SIMULATION WORK

### 5.1 Inserting Surface Parameters

Right click on Surface Parameters in the Flow Simulation analysis tree and selecting the Environment Pressure for Tube Boundary Condition in the Flow Simulation analysis tree. Check the All Parameters box and click on the Excel button in the Surface Parameters window. Select the Local parameters. The minimum fluid temperature at the tube outflow region is 334.548 K and the average value at the same outflow region is 335.801 K. Select the Environment Pressure for Shell Boundary Condition in the flow Simulation analysis tree. Click on the Excel button once again in the Surface Parameters window. Select the Local parameters. The average fluid temperature at the shell outflow region is 285.06 K. Exit the Surface Parameters window. [3]

### 5.2 Inserting Cut Plots

Inserting cut plots for tube and shell by setting minimum and maximum temperatures.

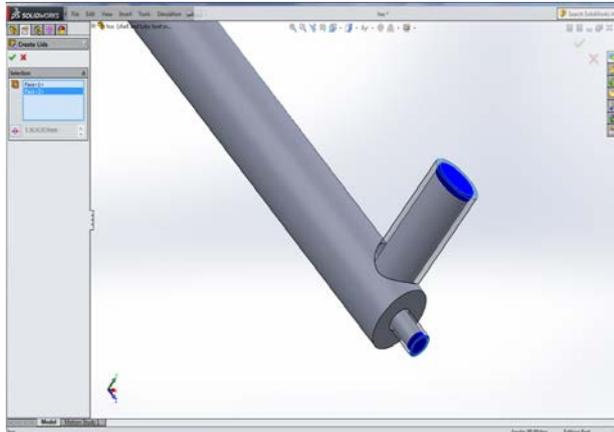


Figure: Creation of lids for shell outlet and tube outlet

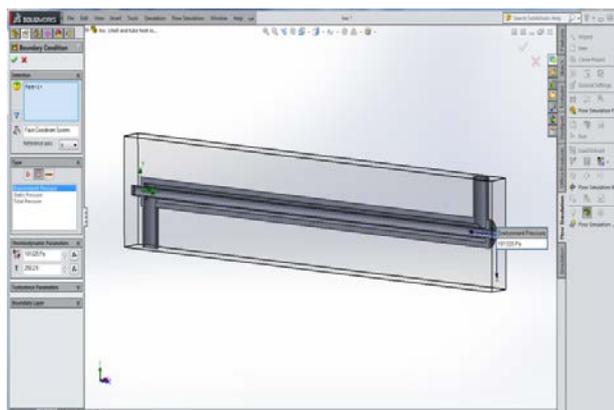


Figure: Environment pressure at tube outlet

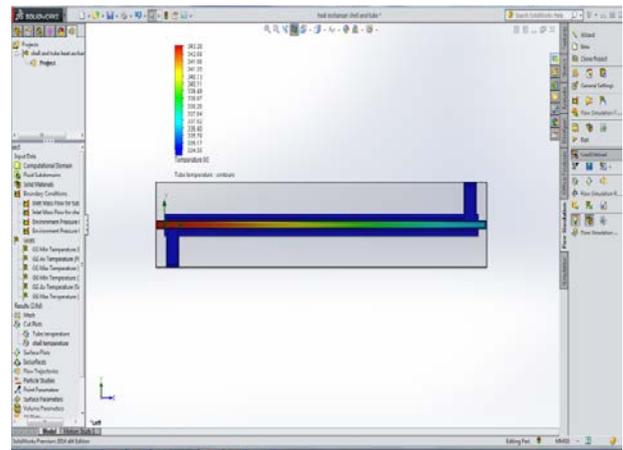


Figure: Temperature distribution along the tube

## 4. INSERTION OF GOALS

Inserting global goal by selecting minimum, average and maximum temperature of fluid and minimum, average and maximum temperature of solid as global goals as shown below

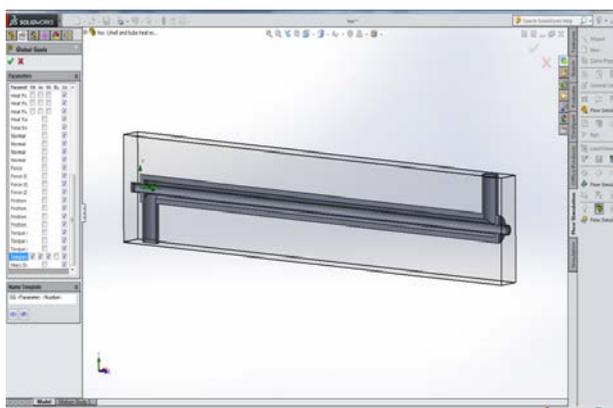


Figure: Insertion of global goals

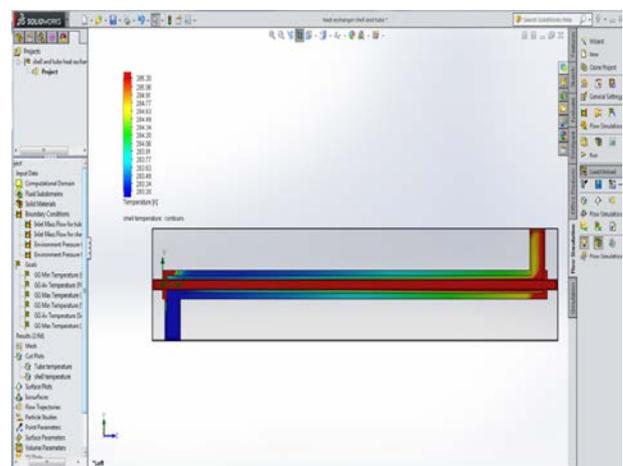


Figure: Temperature distribution along the shell

### 5.3 Flow Trajectories Of Shell And Tube Heat Exchanger

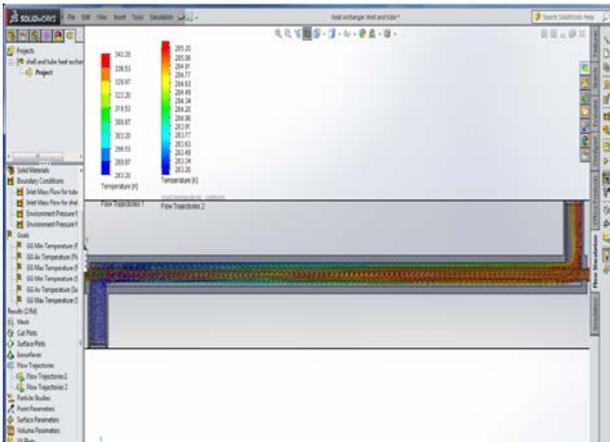


Figure: shell and tube heat exchanger flow trajectories

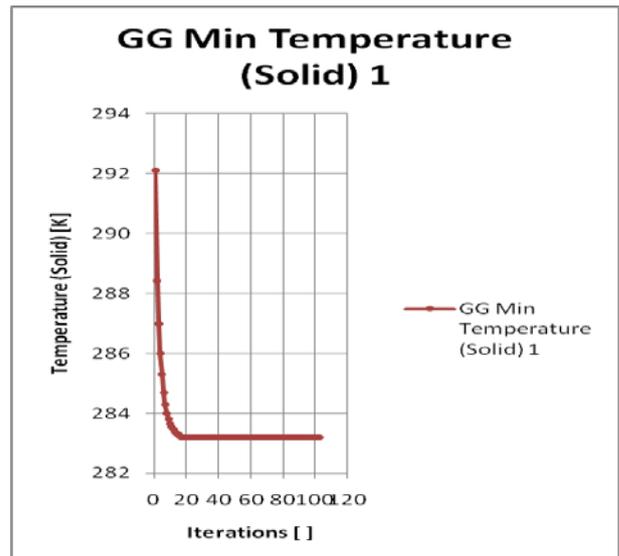
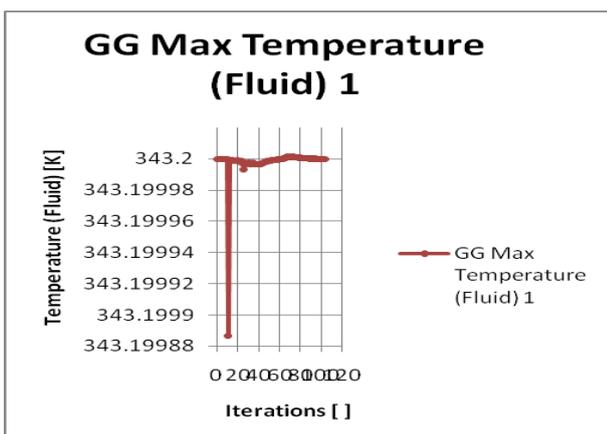
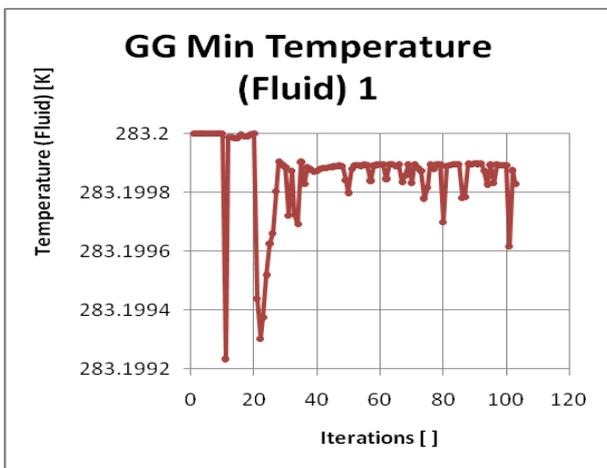
### 5.4 Plotting Of Goals

heat exchanger shell and tube.SLDPRT [Project (shell and tube heat exchanger study)]

Goal Name	Unit	Value	Averaged Value	Minimum Value	Maximum Value	Progress (%)	Use In Convergence
GG Min Temperature (Fl)	[K]	283.1998279	283.1998584	283.1996172	283.1998987	100	Yes
GG Av Temperature (Fl)	[K]	296.0703932	296.078448	296.0703932	296.1620245	100	Yes
GG Max Temperature (Fl)	[K]	343.2	343.2000005	343.2	343.2000014	100	Yes
GG Min Temperature (Sol)	[K]	283.2000088	283.2000078	283.2000044	283.2000107	100	Yes
GG Av Temperature (Sol)	[K]	286.5987362	286.6013389	286.5927095	286.6623022	100	Yes
GG Max Temperature (S)	[K]	343.190658	343.1906982	343.1905487	343.1908773	100	Yes

Iterations: 103  
 Analysis interval: 37

Graphs have been generated for minimum, average and maximum temperature of fluid to the Number of Iterations and similarly for solid.



### RESULTS AND DISCUSSION

By following the above steps the modeling of Shell and Tube heat exchanger has been done using solid works software and also using solid work flow simulation the flow analysis is done to calculate the effectiveness of the shell and tube heat exchanger.

The mass flow rate of water in the shell is 0.8kg/s with an inlet temperature of 283.2k and the mass flow rate of water in tube is 0.2 kg/s at an inlet temperature of 343.2k. Then after setting up these boundary conditions we can observe the temperature difference of about 2-3 degrees. By using the flow simulation software we can get the effectiveness of the heat exchanger as 0.1459.

By using NTU method we can get the effectiveness as 0.133.so we nearly get 7.3 % difference between the NTU method and the flow simulation method. This difference is mainly due to the reason that the calculation is done for unit length and there were so many assumptions like the mass flow rate is constant and the radiation and convectional losses are neglected.

### CONCLUSION

The design and CFD analysis on shell and tube heat exchanger has been done and the results were compared with the effectiveness NTU method. We had observed a considerable amount of deviation from the actual value to the value that is obtained in the simulation.

### REFERENCES

- [1] Cengel, Y. A., Heat Transfer: A Practical Approach, 2<sup>nd</sup> Edition, McGraw- Hill, 2003.
- [2] Solid Works Flow Simulation 2010

- [3] Sadik Kakaç and Hongtan Liu (2002). *Heat Exchangers: Selection, Rating and Thermal Design* (2nd ed.). CRC Press. ISBN 0-8493-0902-6.
- [4] Shell and Tube Heat Exchanger Design Software for Educational Applications
- [5] Heat exchanger shell side and tube side pressure drop calculator Calculate shell side / tubeside pressure drop for an exchange.