CFD Simulation Analysis for Different Tube Shapes Configuration in Shell & Tube Heat Exchanger by using SOLIDWORKS Software

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Abstract - Traditionally Shell-and-tube heat exchangers are designed using solid modeling software & analyzed by using Computational Fluid Dynamics (CFD) software, by using CFD now it is possible to design small heat exchangers. In this paper, shell-and-tube heat exchangers are modeled in SOLIDWORKS software and analyzed using CFD flow simulation of SOLIDWORKS. The designed heat exchangers are relatively small, have single shell and tube passes. The leakage effects are not permissible into account in the design process. Hence, we are preventing leakage from baffle orifices and no gap between baffles and the shell. This study is focused on improving the efficiency of heat exchanger. First, only Design the shell and tube type heat exchanger with straight tubes & analyzed with SOLIDWORKS CFD simulations, similarly two other designs are created with step and taper tube assembly. The designed model is analyzed on SOLIDWORKS CFD simulation. The results are compared with design models having different tube shapes by using different materials. The results are compared in temperature drop in shell & tube heat exchanger with straight tube, taper tube & step tube model. By this analysis we can find out which model gives better heat transfer rate.

Keywords: Computational Fluid Dynamics (CFD), SOLIDWORKS CFD Simulation, Temperature Drop, Mass Flow, Heat Transfer, Shell & Tube Heat Exchanger, Efficiency of Heat Exchanger, Tube Shape, Different Tube Shapes Configuration, Different Tube Materials etc.

I. INTRODUCTION

In the ventures heat exchangers are generally utilized gear in the enterprises. Heat exchangers are utilized to move heat between two cycle streams. One can understand their utilization that any cycles which include cooling, heating, buildup, bubbling or vanishing will require a heat exchanger for these reasons. Cycle liquids, as a rule are warmed or cooled before the cycle or go through a stage change. Diverse heat exchangers are named by their application. For instance, heat exchangers being utilized to gather are known as condensers, correspondingly heat exchanger for bubbling objects are called boilers. Execution and effectiveness of heat exchangers are estimated through the measure of heat move utilizing least zone of heat move and weight drop. A superior introduction of its productivity is finished by figuring over all heat move coefficient. Weight drops and region needed for a specific measure of heat move, gives an understanding about the capital expense and force prerequisites (Running expense) of a heat exchanger. For the most part, there is bunches of writing and hypotheses to plan a heat exchanger as indicated by the prerequisites.

Heat exchangers are of two sorts: -Where both media between which heat is exchanged are in direct contact with each other is Direct contact heat exchanger, where both media are separated by a wall through which heat is transferred so that they never mix, indirect contact heat exchanger the greater part of the heat exchangers is as a rule for higher weight work up to 552 bars is the shell and cylinder heat exchanger. Shell and cylinder type heat exchanger, circuitous contact type heat exchanger. It comprises of a progression of cylinders, through which one of the liquids runs. The shell is the holder for the shell liquid. For the most part, it is round and hollow fit as a fiddle with a roundabout cross segment. For this specific examination shell is thought of, which is commonly a one pass shell. A shell is the most ordinarily utilized because of its ease and straight forwardness and has the most noteworthy log-mean temperature-distinction (LMTD) remedy factor. Despite the fact that the cylinders may have single or different passes, there is one pass on the shell side, while the other liquid streams inside the shell over the cylinders to be warmed or cooled. The cylinder side and shell side liquids are isolated by a cylinder sheet. The unpredictability with exploratory strategies includes quantitative portrayal of stream marvels utilizing estimations managing each amount in turn for a restricted scope of issue and working conditions. Computational Fluid Dynamics is currently a set up mechanical plan apparatus, offering evident focal points. In this investigation, a full 360° CFD model of shell and cylinder heat exchanger is thought of. By displaying the math as precisely as could reasonably be expected, the stream structure and the temperature circulation inside the shell are gotten.

1.1 Types of Flow in Heat Exchanger

Based on the constructional design & mode of heat transfer a wide variety of heat exchangers is in used various process industries. Plate type heat exchanger (PHE), shell-and-tube heat exchanger, vertical mantle heat exchanger and micro heat exchanger are among the most popular once. Figure 1 below enlists various other types of heat exchanger & their specific classification.

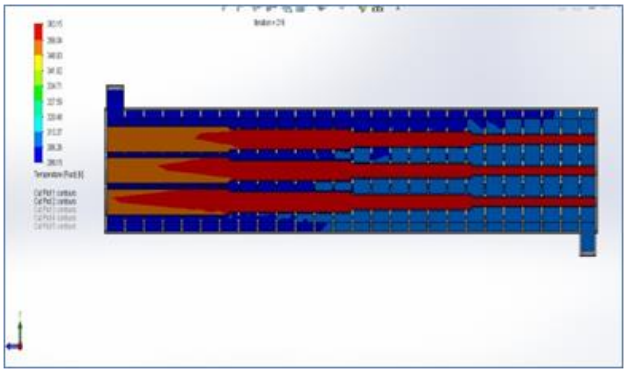

Figure 15: Temperature Distribution – Straight Baffle with Step Tube with Steel Material

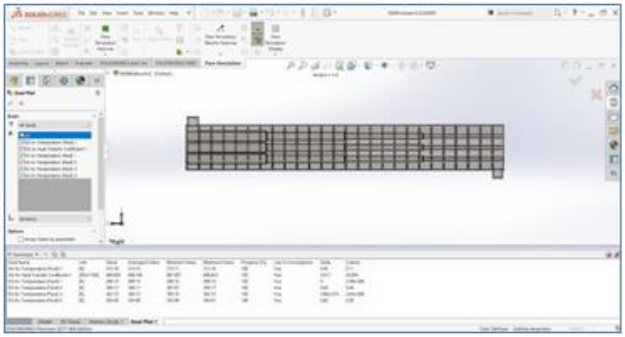

Figure 16: Temperature Distribution Output – Straight Baffle with Uniform Tube with Steel Material

Table 1: Various Tube Analysis Result Table For Steel Material

S.No.	Mass Flow Rate	Type of tubes	Steel		
			Inlet Tempe-rature	Outlet Tempe-rature	Tempe-rature Drop
1	2.1	STRIGHT TUBES	363	257	6
2		STEP TUBES	363	253	10
3		TAPER TUBES	363	356	7

Table 2: Various Tube Analysis Result Table For Copper Material

S.No.	Mass Flow Rate	Type of Tubes	Copper		
			Inlet Tempe-rature	Outlet Temperature	Tempe-rature Drop
1	2.1	STRIGH TUBES	363	353.25	9.75
2		STEP TUBES	363	348.62	14.38
3		TAPER TUBES	363	352.32	10.68

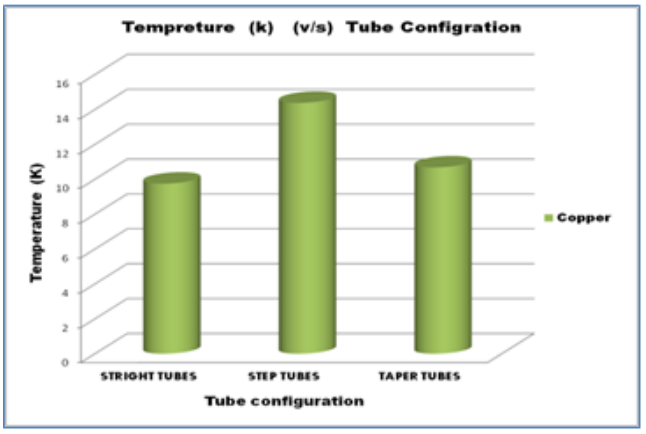

Figure 17: Result Graph for Copper Materials

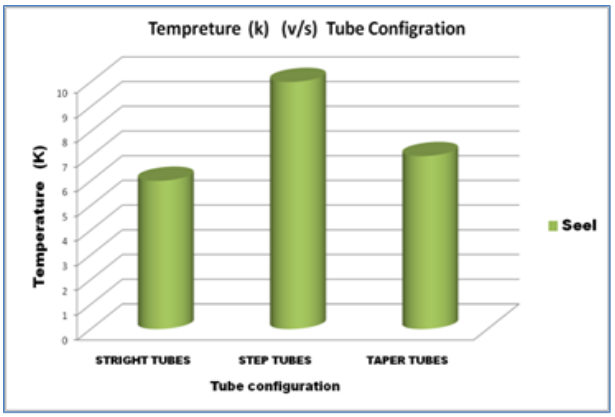

Figure 18: Result Graph For Steel Materials

VI. CONCLUSION

The small shell-and-tube heat exchanger is designed in SOLIDWORKS with sufficient detail to resolve the flow and temperature fields. From the CFD simulation the point wise results are listed below

- Initially three model of shell and tube heat exchanger with straight tube, taper tube & step tube is designed in SOLIDWORKS with using steel and copper material.
- These designs of heat exchanger are analyzed in CFD flow simulation part of SOLIDWORKS.
- This analysis having constant mass flow rate in various cross section tubes shows the results in temperature difference with straight, taper & step tube.

- Comparing the results with steel material for all models the heat transfer rate for step tube gives the better result as compare to other one. This result is also compared with copper material.
- Compare the results with steel and copper material with three different designs of heat exchanger, result shows the heat transfer rate by using step tube gives the better result compared to other design, so if we use this design for shell & tube heat exchanger then we will get better output.

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