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MODELING AND ANALYSIS OF SHELL AND TUBE HEAT EXCHANGER WITH DIFFERENT BAFFLE MODEL USING CFD

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***Abstract*—The target of the venture is to dissect the warmth exchange productivity of shell and tube warm exchanger with various baffles. This venture exhibits an outline philosophy to look at different parameters of warmth exchanger. Two distinctive astound models are investigation with the assistance of CFD and look at the outcomes. Baffles are utilized to build the warmth exchange rate by coordinating the stream way of the liquid inside the shell and tube warm exchanger. A shell and tube warm exchanger is a class of warmth exchanger plans. As its name suggests, this sort of warmth exchanger comprises of a shell (an extensive weight vessel) with a heap of tubes inside it. One liquid goes through the tubes, and another liquid streams over the tubes (through the shell) to exchange warm between the two liquids. Two liquids, of various beginning temperatures, course through the warmth exchanger. The liquids can be either fluids or gasses on either the shell or the tube side. There can be numerous minor departure from the shell and tube plan. Ordinarily, the finishes of each tube are associated with plenums (once in a while called water boxes) through openings in tubesheets. The tubes might be straight or twisted in the state of a U, called U-tubes.**

Keywords—Heat Exchangers, Computational Fluid Dynamics, Shell and Tube, Boundary Conditions

I. INTRODUCTION (*HEADING 1*)

A baffle is designed to support tube bundles and direct the flow of fluids for maximum efficiency. Baffles are used to hold tubes in position (preventing sagging), both in production and operation. They reduce the vibration in long tubes during transmission of fluids. Prevent the effects of vibration, which is increased with both fluid velocity and the length of the exchanger. Direct shell-side fluid flow along tube field. This increases fluid velocity and the effective heat transfer co-efficient of the exchanger. Computational Fluid Dynamics are used to calculate the efficiency of different baffles and compared with final results. Analysing of critical flows & surface properties are quite easy with CFD. Heat exchangers are devices that facilitate the exchange of heat between two fluids that are at different temperatures while keeping them from mixing with each other. A shell and tube heat exchanger is a class of heat exchanger designs. It is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications. As its name implies, this type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids. Two fluids, of different starting temperatures, flow through the heat exchanger. One flows through the tubes (the tube side) and the other flows outside the tubes but inside the shell (the shell side). Heat is transferred from one fluid to the other through the tube walls, either from tube side to shell side or vice versa. The fluids can be either liquids or gases on either the shell or the tube side. There can be many variations on the shell and tube design. Typically, the ends of each tube are connected to plenums (sometimes called water boxes) through holes in tubesheets. The tubes may be straight or bent in the shape of a U, called U-tubes. A simple design of a shell and tube heat exchanger makes it an ideal cooling solution for a wide variety of applications. One of the most common applications is the cooling of hydraulic fluid and oil in engines, transmissions and hydraulic power packs. With the right choice of materials they can also be used to cool or heat other mediums, such as swimming pool water or charge air. One of the big advantages of using a shell and tube heat exchanger is that they are often easy to service, particularly with models where a floating tube bundle (where the tube plates are not welded to the outer shell) is available. Baffles are used to increase the heat transfer rate by directing the flow path of the fluid inside the shell and tube heat exchanger. Baffles are flow-directing or obstructing vanes or panels used in some industrial process vessels (tanks), such as shell and tube heat exchangers, chemical reactors, and static mixers. Baffles are an integral part of the shell and tube heat exchanger design. The shell side outline of a shell-and-tube warm exchanger; specifically the perplex separating, bewilder cut and shell distance across conditions of the warmth exchange coefficient and the weight drop are researched by numerically displaying a little warmth exchanger. The stream and temperature fields inside the shell are settled utilizing a business CFD bundle. An arrangement of CFD reenactments is performed for a solitary shell and single tube pass warm exchanger with a variable number of astounds and turbulent stream. The outcomes are seen to be delicate to the turbulence demonstrate determination. The best turbulence show among the ones considered is dictated by looking at the CFD aftereffects of warmth exchange coefficient, outlet temperature and weight drop with the Bell–Delaware strategy comes about. For two puzzle cut values, the impact of the confuse separating to shell distance across proportion on the warmth exchanger execution is researched by changing stream rate.

II. COMPUTATIONAL FLUID DYNAMICS

CFD gives numerical estimate to the conditions that administer smooth movement. Use of the CFD to dissect a liquid issue requires the taking after strides. To begin with, the numerical conditions portraying the liquid stream are composed. These are typically an arrangement of fractional differential conditions. These conditions are then discretized to create a numerical simple of the conditions. The area is then isolated into little matrices or components. At long last, the underlying conditions and the limit states of the particular issue are utilized to explain these conditions. The arrangement technique can be immediate alternately iterative. Furthermore, certain control parameters are utilized to control the joining, dependability, and exactness of the technique.

In this section we are for the most part worried with the stream solver part of CFD. This part is partitioned into five segments. In area two of this section we audit the general representing conditions of the stream. In segment three we talk about three standard numerical answers for the halfway differential conditions portraying the stream. In area four we present the strategies for fathoming the discrete conditions, in any case, this segment is predominantly on the limited contrast strategy. What's more, in segment five we examine different lattice era strategies and work structures. Exceptional issues emerging because of the numerical guess of the stream conditions are likewise examined and strategies to determine them are presented in the accompanying segment.

III. BOUNDARY CONDITIONS

The type of the limit conditions that is required by any incomplete differential condition relies on upon the condition itself and the way that it has been discretized. Regular limit conditions are characterized either in terms of the numerical qualities that must be set or as far as the physical sort of the limit condition. The physical boundary conditions that are commonly observed in the fluid problems are as follows:

1.Solid walls: Numerous limits inside a liquid stream area will be strong dividers, and these can be either stationary or moving dividers. In the event that the stream is laminar then the speed parts can be set to be the speed of the divider. At the point when the stream is turbulent, notwithstanding, the circumstance is more mind boggling.

2.Inlets: At an inlet, liquid enters the area and, consequently, its liquid speed or weight, or the mass stream rate might be known. Likewise, the liquid may have certain qualities, for example, the turbulence portrays which should be determined.

3.Symmetry boundaries: When the flow is symmetrical about some plane there is no flow through the boundary and the derivatives of the variables normal to the boundary are zero.

4.Cyclic or periodic boundaries: These limits come in sets and are utilized to determine that the stream has similar estimations of the factors at identical positions on both of the limits.

5.Pressure Boundary Conditions: The capacity to determine a weight condition at one or more limits of a computational district is an imperative and helpful computational apparatus. Weight limits speak to such things as restricted supplies of liquid, surrounding research facility conditions and connected weights emerging from mechanical gadgets. By and large, a weight condition can't be utilized at a limit where speeds are likewise indicated, since speeds are affected by weight inclinations. The main special case is when weights are important to indicate the liquid properties, e.g., thickness crossing a limit through a condition of state.

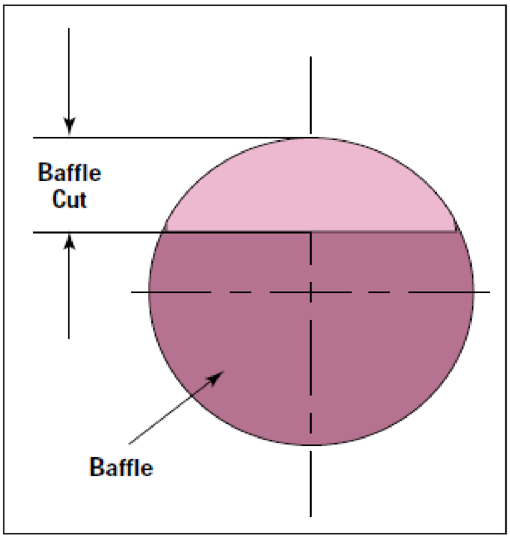
IV. HEAT EXCHANGERS

Heat exchangers are gadgets that encourage the trading of warmth between two liquids that are at various temperatures while shielding them from blending with each other. Heat exchangers are normally utilized as a part of practice in an extensive variety of uses, from warming and aerating and cooling frameworks in a family, to compound preparing and power plant.

V. BAFFLE PLATES

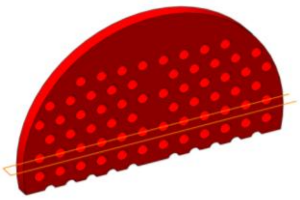
Baffles are flow-directing or obstructing vanes or panels used in some industrial process vessels (tanks), such as shell and tube heat exchangers, chemical reactors, and static mixers.Baffles are an integral part of the shell and tube heat exchanger design. A baffle is designed to support tube bundles and direct the flow of fluids for maximum efficiency.

Baffle cut:
Baffle cut is the tallness of the portion that is sliced in each bewilder to allow the shell side liquid to stream over the baffle.This is communicated as a rate of the shell inside diameter.Although this, as well, is a vital parameter for STHE outline, its impact is less significant than that of confuse separating.



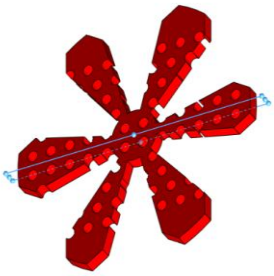
Baffle models:
Baffles are used to guide the direction of the flow inside the shell and also it support the tubes. Welding technique is used to fixed the baffle models.
Following baffle models are,

Single segmental model:



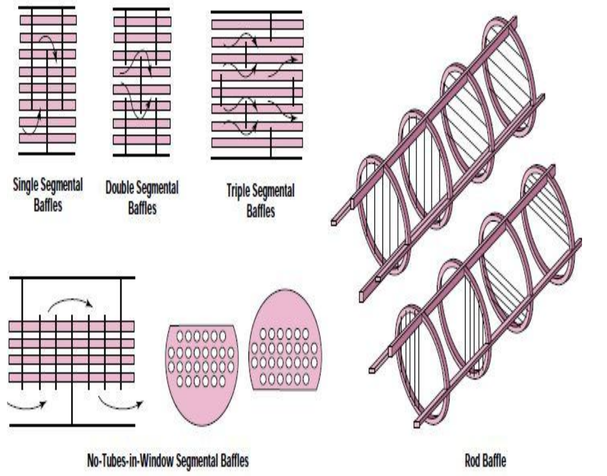
The overall diameter of the baffle is 400mm. the cut section where occurred at the length of 240mm.

Flower Baffle model:
The overall diameter of the baffle is 400mm.



Types of baffle:s
Implementation of baffles is decided on the basis of size, cost and their ability to lend support to the tube bundles.

i. Longitudinal Flow Baffles (used in a two-pass shell)
ii. Impingement Baffles (used for protecting bundle when entrance velocity is high)
iii. Orifice Baffles
iv. Single segmental
v. Double segmental
vi. Support/Blanking baffles



CONCLUSION

We have experimented on Flower baffle model and identified that, it has low pressure drop, increase in vorticity compared to the ordinary segmental baffle plate. So we can use the flower baffle plate for long time with better efficiency. The metal usage of the baffle also decreases in large manner.

References

The shell side design of a shell-and-tube heat exchanger; in particular the baffle spacing, baffle cut and shell diameter dependencies of the heat transfer coefficient and the pressure drop are investigated by numerically modeling a small heat exchanger. The flow and temperature fields inside the shell are resolved using a commercial CFD package. A set of CFD simulations is performed for a single shell and single tube pass heat exchanger with a variable number of baffles and turbulent flow. The results are observed to be sensitive to the turbulence model selection. The best turbulence model among the ones considered is determined by comparing the CFD results of heat transfer coefficient, outlet temperature and pressure drop with the Bell–Delaware method results. For two baffle cut values, the effect of the baffle spacing to shell diameter ratio on the heat exchanger performance is investigated by varying flow rate. [1].

Performance of heat exchangers with helical baffles, or helixchangers, is discussed using the results of tests conducted on units with uarious baffle geometries. An optimum helix angle is identified at which the conversion efficiency for converting pressure drop to heat transfer on the shell side of helixchangers is maximized. Designs for standard industry applications are optimized using the analysis of test results [2].

[1] 2010 Ender Ozden, Middle East Technical University, Turkey “Shell side CFD analysis of a small shell-and-tube heat exchanger”.

[2] 2007 D. Kral and P. Stehlik “Helical Baffles in Shell-and-Tube Heat Exchangers (Experimental Verification)”.