Review of Helical Baffle Component Design and Analysis of Shell and Tube Heat Exchanger

Shahid Razi
Research Scholar, Department of Mechanical Engineering, NRI Institute of Research and Technology, Bhopal, India.

Sunil Shukla
Assistant Professor, Department of Mechanical Engineering, NRI Institute of Research and Technology, Bhopal, India.

Abstract*— Plate exchanger is the most efficient due to turbulent flow on both sides. High heat-transfer coefficient and high turbulence due to even flow distribution are important. However, a plate heat exchanger regenerator is restricted to low viscosities. With high viscosities, a special tubular may be required. Baffles serve two functions: Most importantly, they support the tubes in the proper position during assembly and operation and prevent vibration of the tubes caused by flow- induced eddies, and secondly, they guide the shell-side flow back and forth across the tube field, increasing the velocity and the heat transfer. This paper reviews of helical baffle designs and analysis in shell and tube type heat exchanger.

***Keywords*—Plate exchanger, Baffles, Tube, Flow, Stress, Heat, Temperature.**

I. INTRODUCTION

A Heat Exchanger might be characterized as a gear which moves energy from a hot liquid to a chilly liquid, either greatest or least rate inside least venture and running expense. In this cycle never two liquids blended in with one another. This gadget gives a flow of nuclear power between at least two liquids at various temperatures. Shell and tube heat exchangers are most adaptable sort of heat exchanger; they use in a wide assortment of designing applications like force age, squander heat recuperation, producing industry, cooling, refrigeration, space applications, petrochemical businesses and so on

Baffles are flow-coordinating or deterring vanes or boards utilized in some mechanical cycle vessels (tanks, for example, shell and tube heat exchangers, synthetic reactors, and static blenders. Baffles are a necessary piece of the shell and tube heat exchanger plan. A baffle is intended to help tube packages and direct the flow of liquids for greatest productivity. Baffle plan and resiliences for heat exchangers are talked about in the guidelines of the Tubular Exchanger Producers Affiliation (TEMA).

Utilization of baffles

The principle jobs of a baffle in a shell and tube heat exchanger are to:

Stand firm on tubes in situation (forestalling drooping), both underway and activity

Forestall the impacts of steam starvation, which is expanded with both liquid speed and the length of the exchanger

Direct shell-side liquid flow along tube field. This expands liquid speed and the successful heat move co- effective of the exchanger

In a static blender, baffles are utilized to limit the digressive part of speed which causes vortex arrangement, and accordingly advances blending. [1]

In a compound reactor, baffles are regularly joined to the inside dividers to advance blending [2] and consequently increment heat move and conceivably synthetic response rates.

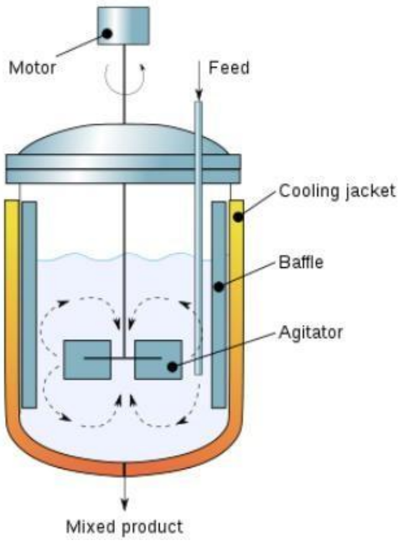

Figure 1: Baffles (Heat Exchanger)

Types of baffles-

Execution of baffles is settled based on size, cost and their capacity to loan backing to the tube packages and direct flow:

Longitudinal Flow Baffles (utilized in a two-pass shell)

Impingement Baffles (utilized for securing pack when entrance speed is high)

Orifice Baffles Single segmental Double segmental

Support/Blanking baffles

Deresonating (detuning) baffles used to reduce tube vibration

Establishment of baffles

As referenced, baffles manage the worry of help and liquid course in heat exchangers. In this manner it is essential that they are divided effectively at establishment. The base baffle separating is the more prominent of 50.8 mm or one fifth of the internal shell measurement. The greatest baffle dividing is subject to material and size of tubes. The Rounded Exchanger Makers Affiliation [3] sets out rules. There are likewise sections with a "no tubes in window" plan that influences the adequate dividing inside the plan. A significant plan thought is that no distribution zones or dead spots structure – the two of which are counterproductive to compelling heat move.

II. LITERATURE SURVEY

The subject of baffle in shell and tube heat exchanger (STHE) has a wide assortment of cycles. Countless works has been distributed with respect to STHE which portrays different elements influencing the warm productivity of the

STHE. Based on that a concise rundown is checked on as follows: Rajiv Mukherjee [1] clarifies the nuts and bolts of exchanger warm plan, covering such points as: STHE segments; characterization of STHEs as indicated by development and as per administration; information required for warm plan; tube side plan; shell side plan, including tube format, astounding, and shell side pressing factor drop; and mean temperature contrast. The essential conditions for tube side and shell side heat move and pressing factor drop. Connections for ideal condition are additionally engaged and clarified with some arranged information. This paper gives by and large plan to plan ideal shell and tube heat exchanger. The upgraded warm plan should be possible by complex PC programming anyway a decent comprehension of the fundamental standards of exchanger plans expected to utilize this product adequately.

M. Serna and A. Jimenez, [2] they have introduced a minimized definition to relate the shell-side pressing factor drop with the exchanger zone and the film coefficient dependent on the full Ringer Delaware strategy. Notwithstanding the determination of the shell side smaller articulation, they have built up a reduced pressing factor drop condition for the tube-side stream, which represents both straight pressing factor drops and bring misfortunes back. They have shown how the conservative details can be utilized inside an effective plan calculation. They have tracked down an agreeable execution of the proposed calculations over the whole math scope of single stage, shell and tube heat exchangers. Lei et al. [3] have showed the impacts of baffle tendency point on flow and heat move of a heat exchanger with helical baffles, where the helical baffles are isolated into internal and external parts along the spiral bearing of the shell. While both the inward and external helical baffles baffle the flow reliably, easily and delicately, and direct flow in a helical style in order to build heat move rate and abatement pressure drop and effect vibrations, the external helical baffle gets simpler to produce because of its moderately huge breadth of internal edge. Lutcha and Nemcansky [4] have done analyses to the improvement of cylindrical heat exchangers with helical baffles for examination of the flow field designs created by different helix points which is relied upon to decrease pressure at shell side and increment heat move measure altogether. Pardeep Kumar et al. [5] test examination has been completed to know the warm exhibition of Helix exchanger with plain copper tubes or with furrowed copper tubes of same size and particular by utilizing co-current flow. During this trial examination endeavors were made for the two exchangers at same working conditions and it was tracked down that furrowed copper tubes helix transformer have a superior warm presentation when contrasted with Sunilkumar Shinde et al. [6] were done examinations theconventional segmental baffle heat exchanger by utilizing the Kern strategy with fluctuated shell side flow rates. They assessed structure their outcomes high heat move Co-proficient and lower pressure drop are all the more successfully got in a helix transformer. The flow design in the shell side of the constant helical baffle heat exchanger is rotational and helical because of the math of ceaseless helical baffles brings about critical expansion in heat move coefficient.

III. COMPONENTS OF SHELL-AND-TUBE HEAT EXCHANGERS

The principal components of shell-and-tube heat exchangers are:

- Tubes
- Tubesheet
- Shell and Shell-Side Nozzles
- Tube-Side Channel and Nozzles
- Baffles
- Tie-rods

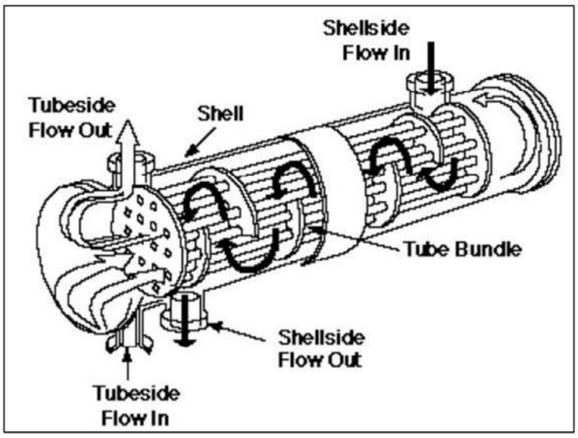

Figure 2: Schematic of a Shell-and-Tube Heat Exchanger

Tubes

Tubes are the fundamental parts of shell and tube heat exchangers, giving the heat move surface between one liquid flowing inside the tube and the other liquid flowing across the outside of the tube. The tubes might be consistent or welded and most usually made of copper or steel amalgams. Other composites of nickel, titanium, or aluminum may likewise be needed for explicit applications. Consistent tubing is delivered in an expulsion cycle; welded tubing is created by folding a strip into a chamber and welding the crease. Welded tubing is normally more conservative.

The tubes might be either exposed or with expanded or improved (finned) surfaces outwardly. Finned surface tubes are utilized when one liquid has a generously lower heat move coefficient than the other liquid. They give two to four fold the amount of heat move zone outwardly as the comparing exposed tube, and this are proportion assists with counterbalancing a lower outside heat move coefficient.

Ordinary tube breadths are 5/8", ¾" and 1". Tubes of more modest measurement can be utilized however they are more hard to clean precisely. Tubes of bigger width are some of the time utilized either to encourage mechanical cleaning or to accomplish lower pressure drop. The typical tube divider thickness goes from 12 to 16 BWG (from 0.109 crawls to 0.065 inches thick). Tubes with more slender dividers (18 to 20 BWG) are utilized when the tubing material is moderately costly like titanium.

Tubesheets

The The tubes are held set up by being embedded into openings in the tubesheets and afterward either ventured into grooves cut into the openings or welded to the tubesheet where the tube juts from the surface. This forestalls the liquid on the shell side from blending in with the liquid on the tube side. The tubesheet is generally a solitary round plate of metal that has been appropriately bored and scored to take the tubes (in wanted example - square or three-sided), the gaskets, the spacer poles, and the screw circle where it is attached to the shell.

The distance between the focuses of the tube opening is known as the tube pitch; regularly the tube pitch is 1.25 occasions the external measurement of the tubes. Other tube pitches are much of the time used to diminish the shell side pressing factor drop and to control the speed of the shell side liquid as it flows across the tube group. Three-sided pitch is frequently applied as a result of higher heat move and minimization it gives. Square pitch encourages mechanical cleaning of the outside of the tubes.

Two tubesheets are needed aside from U-tube groups. A moved joint is the normal term for a tube-to-tube sheet joint coming about because of a mechanical extension of the tube against the tubesheet. This joint is regularly accomplished utilizing roller expanders; subsequently the term moved joint. Less oftentimes, tubes are extended by pressure driven cycles to influence a mechanical bond. Tubes can likewise be welded to the front or inboard face of the tubesheet. Strength welding assigns that the mechanical strength of the joint is given fundamentally by the welding system and the tubes are just delicately extended against the tubesheet to take out the cleft that would some way or another exist. Seal welding assign that the mechanical strength of the joint is furnished principally by the tube extension with the tubes welded to the tubesheet for better hole insurance. The expense of seal-welded joints is generally advocated by expanded unwavering quality, decreased support costs, and less cycle spills. Sealwelded joints are required when clad tubesheets are utilized, when tubes with divider thickness under 16 BWG (0.065 inch) are utilized, and for certain metals that can't be sufficiently extended to accomplish a worthy mechanical bond (titanium and Combination 2205 for example).

Where blending between the two liquids should be evaded, a twofold tubesheet, for example, is appeared in Figure 3 might be given. The space between tubesheets is available to the environment so any spillage of either liquid ought to be immediately identified.

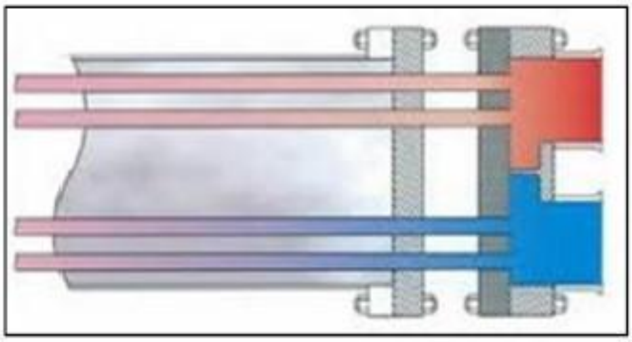

Figure 3: Double Tubesheet

The tubesheet, notwithstanding its mechanical necessities, should withstand destructive assault by the two liquids in heat exchanger and should be electrochemically viable with the tube and all tube-side material.

Shell and Shell-Side Nozzles

The shell is basically the holder for the shell-side liquid, and the spouts are the gulf and leave ports. The shell typically has a roundabout cross segment and is regularly made by rolling a metal plate of suitable measurements into a chamber and welding the longitudinal joint. Little breadth shells can be made by cutting the line of the ideal width to the right length. The roundness of the shell is significant in fixing the greatest measurement of the baffles that can be embedded, and hence the impact of shell-to-baffle spillage.

The delta spout regularly has an impingement plate (See Figure 4) set only underneath to redirect the approaching liquid fly from affecting straightforwardly at high speed on top line of tubes. Such effect can cause disintegration, cavitation or potentially vibration. To put the impingement plate in and still leave sufficient flow territory between the shell and plate for the flow to release without unreasonable pressing factor misfortune, it very well might be important to discard a few tubes from the round trip design.

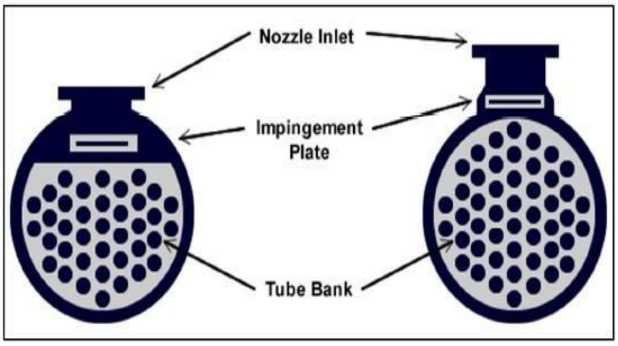

Figure 4: Nozzle Impingement Plate Tube-Side Channel and Nozzles

Tube-side channel and spouts just control the flow of the tube-side liquid into and out of the tubes of the exchanger. Since the tubeside liquid is by and large more destructive, these channels and spouts will regularly be made out of combination materials (viable with the tubes and tubesheet obviously). They might be clad rather than strong compound. The channel closes are furnished with channel covers. They are round plates that bolt to the channel ribs and can be taken out for tube assessment without upsetting the tube side funneling. In more modest heat exchangers, hats with flanged spouts or strung associations for the tube-side funneling are frequently utilized rather than channels and channel covers.

PASS DIVIDERS

A pass divider is required in one channel or hood for an exchanger having two tube-side passes, and they are required in the two channels and hats for an exchanger having multiple passes. On the off chance that the channels or hoods are projected, the dividers are fundamentally cast and afterward looked to give a smooth bearing surface on the gasket between the divider and the tubesheet. On the off chance that the channels are moved from plate or developed from pipe, the dividers are welded set up.

The game plan of dividers in multi-pass exchangers is to some degree self-assertive, the typical purpose being to give almost similar number of tubes in each pass, to limit the quantity of tubes lost from the tube tally, to limit the pressing factor contrast across any one pass divider (to limit spillage and consequently the infringement of MTD deduction), to give satisfactory bearing surface to the gasket and to limit creation intricacy and cost.

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Baffles

Baffles (See Figure 5) serve three functions:

1. They help the tubes in legitimate situation during gathering and activity and forestall vibration of the tubes brought about by flow-initiated vortexes
2. They guide the shell-side flow to and fro across the tube field, expanding the speed and heat move coefficient
3. They keep up the tube dividing

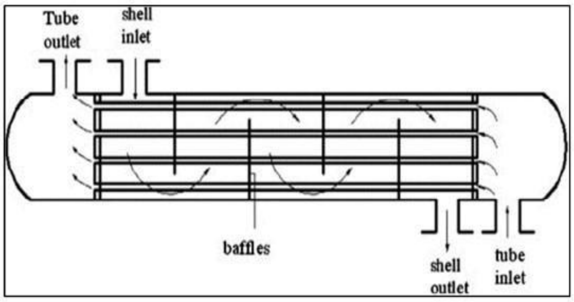

Figure 5: Segmental Baffles

A section, called the baffle cut, will be removed to allow the liquid to flow corresponding to the tube pivot as it flows starting with one baffle space then onto the next. Segmental cuts with the tallness of the portion roughly 25% of the shell measurement are ordinarily the ideal. Baffle cuts bigger or more modest than the ideal ordinarily bring about ineffectively appropriated shell side flow with enormous vortexes, no man's lands behind the baffles and pressing factor drops higher than anticipated.

The separating between segmental baffles is known as the baffle pitch. The baffle pitch and the baffle cut decide the cross flow speed and subsequently the pace of heat move and the pressing factor drop. The baffle pitch and baffle cut are chosen during the heat exchanger configuration to yield the most noteworthy liquid speed and heat move rate while regarding the permissible pressing factor drop. The baffle separating ought to be correspondingly picked to make the free flow regions through the "window" (the zone between the baffle edge and shell) and across the tube bank generally equivalent.

The direction of the baffle cut is significant for heat exchanger introduced on a level plane. At the point when the shell side heat move is reasonable heating or cooling with no stage change, the baffle cut ought to be even. This makes the liquid follow an all over way and forestalls separation with hotter liquid at the highest point of the shell and cooler liquid at the lower part of the shell. For shell side buildup, the baffle cut for segmental baffles is vertical to permit the condensate to flow towards the power source without huge fluid robbery by the baffle. For shell side heating up, the baffle cut might be either vertical or even contingent upon the assistance.

For some, high speed gas flows, the single segmental baffle arrangement brings about an unfortunately high shell side pressing factor drop. One approach to hold the primary benefits of the segmental baffle and diminish the pressing factor drop (and, lamentably, somewhat, the heat move coefficient as well) is to utilize the twofold segmental baffle as demonstrated in Figure 6. Accurate correlation should be put forth on a defense to-case premise, however the harsh impact is to divide the nearby speed and in this way lessen the pressing factor drop by a factor of 4 from a practically identical size single segmental unit.

For adequately huge units, it is feasible to go to significantly increase segmental plans and at last to strip and pole baffles, the significant point being consistently to guarantee that each tube is decidedly obliged at intermittent distances to forestall hanging and vibration.

Different sorts of baffles are in some cases utilized, for example, twofold segmental, triple segmental, helical baffle, EM baffle and Pole baffle. A large portion of these sorts of baffles are intended to give liquid flow ways other than cross flow. These baffle types are commonly utilized for bizarre plan conditions. Longitudinal baffles are here and there gave to isolate the shell making different passes on the shell side. This kind of heat exchangers is now and again helpful in heat recuperation applications when a few shell side passes permit the liquids to accomplish an extreme temperature cross.

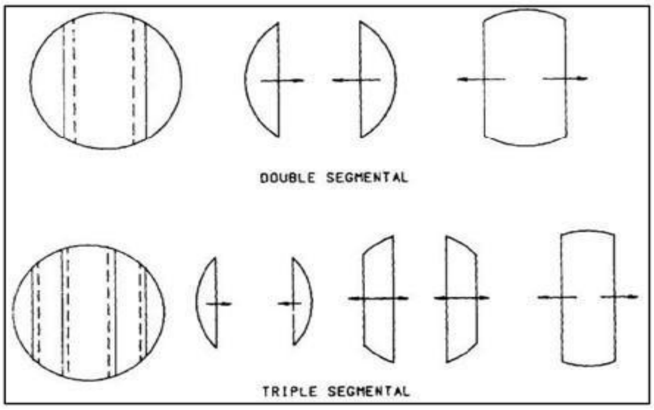

Figure 6: Double and Triple Segmental Baffles Tie **Rods**

Tie rods and spacers are used for two reasons:

1. Hold the baffle assembly together; and
2. Maintain the selected baffle spacing.

The tie poles are gotten toward one side to the tubesheet and at the opposite finish to the last baffle (See Figure 7). They hold the baffle gathering together. The spacers are set ludicrous bars between each baffle to keep up the chose baffle pitch. The base number of tie pole and spacers relies upon the distance across of the shell and the size of the tie pole and spacers.

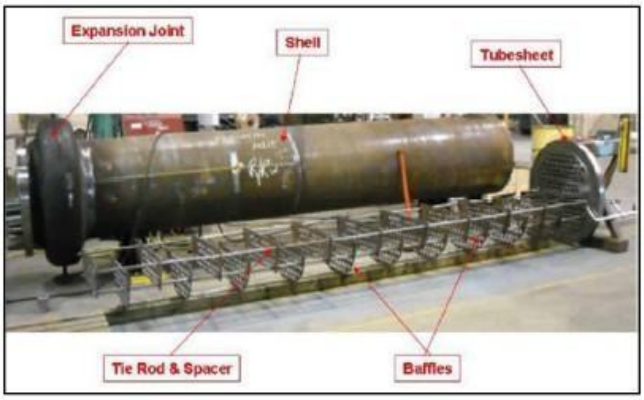

Figure 7: Tie Rods

V. CONCLUSION

The Shell and tube heat exchangers in their different development changes are likely the most broad and usually utilized essential heat exchanger setup in the process enterprises. There are numerous adjustments of the essential arrangement which can be utilized to tackle extraordinary issues. Baffles serve two capacities: above all, they support the tubes in the legitimate situation during gathering and activity and forestall vibration of the tubes brought about by flow-instigated whirlpools, and furthermore, they control the shell-side flow to and fro across the tube field, expanding the speed and the heat move coefficient. The target of this paper is to investigation of baffle with every one of the segments for the general heat move applications.

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