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Analysis of Shell and tube Heat exchanger with Different Method: A Review

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Abstract: *In study about shell and tube heat exchanger, know that many warmexchangersis available in market with their specific advantages and application. In shell and tube warm exchanger many methods have to perform it. In this review paper study about the different methods like LMTD and NTU methods and for increasing heat transfer rate and high performance and high correction factor. In this paper study about manual performance and software performance to define heat transfer rate. Both methos are easy but it is time consuming process. When it is done that time, it may be increased heat transfer rate and concert of warm exchangers.*

KEYWORDS*: Shell and tube warm exchanger, tubes, ANSYS, Baffles.*

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I. Introduction

Heat exchanger is mostly used in manufacturing field and process industry for different application. Many warm exchangersare available in market but the selection of warm exchanger is depending on its application, factor affected and area that may be used and available methods and relation with the industry and coast and etc.In the highly competitiveEnvironment, it is necessary that the heat exchanger provides the required heat transfer, takes up less space, weighs, Less, and yet at a competitive price[1].

In chemical industry transfer of warm, one fluid to other fluid is main process. In industry it is main factor that apply the fixed principles so the growth of the product is less. Detects heat exchangers. Wide use in power production, chemical clarifying,electric cooling, air conditioning ionizing, refrigeration andautomatic applications.There are different types of warm exchangers, Various designs, with content and custom made. Meet particular requirements. Heat out the shell and tube, without a doubt, one of the most generally used warm exchangers. Shell and tube warm exchangers are common, used in chemical and processing field[2].

Deviceobtainable in aopenscope of layout as defined byTubular Exchanger Manufacturers Association (TEMA).Application of single-phase shell-and-tube warm exchangers are as big as it is wide chemical, petroleum, power production and processingfield.In short, the shell and tube exchanger are pressure vessel with several tubes inside it. A task when fluid flows through the tubes of the exchanger the other flows out of the tube inside the shell[3].

Warm exchanger is that tool that transfer energy betwixt two or more fluids, between solid surface and fluids and between solid particles and fluids at separate temperature and thermal contact of fluids. In recently some years warm exchanger is need of increasing efficient of exchangers[4].

The shell and tube warm exchanger and weight provide a large ratio of volume and warm transfer area and easy to clean. Shell and tube warm exchanger isgiven us always good flexibility to meet service requirement. It is design for high pressure comparative to the atmosphere and difference between high pressure to the fluid stream[5].

There ismain three terms using for transfer heat 1) Thermal conduction, 2) Convection and 3) Radiation. Heat exchanger classify due to their main basis of work 1)Recuperators and Regenerators, 2) Direct and indirect contact of surface, 3) Based on its Geometry, 4) Warm transfer mechanism- Single and double phase 5) Arrangement of flow.

We can calculate design analysis through Ansys software in warm exchanger for different baffle in exchanger. These baffles are increase the flow of fluid. We can put these baffles at 45 and 90 degrees in shell and tube warm exchanger[6].

Many warmexchangers available in market and especially shell and tube warm exchanger mostly used in industrial field because of low cost, worker can easily clean and more flexibility as compared to other warm exchangers. Shell and tube warm exchanger have been used over 150 years before in industry[7].

Their thermicautomation and production methods are well defined and applied by the new maker. Tube surface limit from level to foreign metals with simple surface characteristics.They can help provide at least expensive mechanical design for flow, fluid and temperature is involved[8].

Shell and tube warm exchangers have a tube bundle, which can be a simple tube, Longitudinal foam tubes, etc. Shell and tube warm exchangers are used for high pressure applications. Shell and tube are the most commonly used in the process of tube warm exchangers is the basic warm exchanger configuration. Industry, petrochemical, central air conditioning systems and power plants. Heat the shell and tube the exchanger gives a relatively large portion of the warm transfer area in terms of volume and weight which easy to produce in a wide range of sizes[9].

Currently it is mostly used baffles are used to improve facilitate of heat exchangers. Used baffles is a new thing in currently. The Baffles let the shell side flow become turbulent even at low Reynolds numbers, and this the shell increases the heat transfer coefficient.

II. LITERATURE REVIEW

Consider design of shell and tube heat exchanger such as log mean temperature difference (LMTD) and effectiveness number of transfer unit (NTU) both are methods to analysis of performance, efficiency of the shell and tube heat exchanger. If we not able to select proper method to suitable for our application that's why author saying number of transfer unit (NTU) method is good for the more heat transfer by it[10].

For the used of shell and tube heat exchanger author saying that it is most used in industrial and domestic filed and it is most versatile type of heat exchanger for that's why shell and tube heat exchanger is most used in different applications. It has great pressure and pressure drop can vary with wide range of it. Shell and tube heat exchanger is easy to repair and easy to clean and easy to maintain for long time[11].

Author focus on design of shell and tube heat exchanger and thermal analysis and multiple shell and tube heat exchanger.Author study about linear static- steady thermal analysis of heat exchanger using computational fluid dynamic approach and used HYPERMESH software to perform analysis of shell and tube heat exchanger[12].The research is proven that the spiral tube heat exchanger's effectiveness is more than the normal parallel flow heat exchanger. In this parallel flow is increased about 10% and tube is bend with helix angle of 30 degree[13].

Author tries to design a heat exchanger thermal procedure to give use information about the shell and tube heat exchanger and calculation about pressure drop in heat exchangers. And Log Mean Temperature Difference (LMTD) calculation, correction factor and overall efficiency[14]. In currently analysis of pressure vessel of heat exchanger is using different software like ANSYS, Creo, CAD/CAM etc. but author analysis done by the finite element simulation and analysis of pressure vessel with different joint[15].

MATLAB gives us intensive parametric study about the shell and tube heat exchangers with its effect of shell side heat transfer coefficient and pressure drop and prove that it was rise in tube thickness and rise in length of heat exchanger[16]. Some research about designing two tube shell and tube heat exchanger as per ASME section VIII division 1. TEMA codes and IS 4503:1967. Its main objective is to calculate parameters like thickness and ASME is also make pressure vessel and boilers[17].

Currently we can predict the performance of shell and tube heat exchanger through solving simulation of modeling and meshing the geometry of heat exchanger using computational fluid dynamics by ANSYS 13. And considering baffles in the software[18].The study about multiple tube type heat exchanger in the series are handle the temperature across in the chemical industry. Different temperature is connected through tube within allowable limit[19].

III. Working of Shell and Tube Heat Exchanger

Shell and tube warm exchanger is used two working fluids in thermal contact using outer cylindrically shell. These two fluids path is built thermally conductive metals too easy to transfer heat. The tube is brought with fluid inlet to outlet, in that interval shell pass fluid over the tubes. These tubes are called as tube bundle. The simple figure shown that is shell and tube warm exchanger.

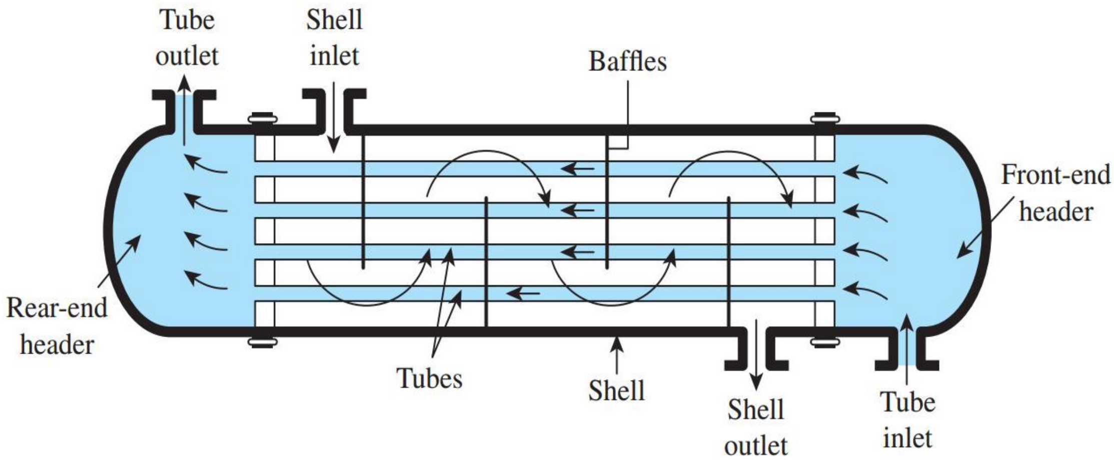

Figure 1. Simple shell and tube warm exchanger[20]

The working of these warm exchanger is easy one fluid is passed in tube and one fluid passed outer side of the tube. It means cold fluid obtain warm from the hot fluids. The basic fundamental of shell and tube warm exchanger is to pass hot fluid to cold fluid without mixed them so, only warm can be transfer in the heat exchangers. In the fig. we can see that two inlet and two outlet port. When both are starts their respectively inlet to outlet. And tube side pass along with tube bundle. That is safe with tube sheets and exit with tube outlet[21].

Likewise shell side flow starts with inlet and pass over tubes and exit with outlet. Each tube with have turbulator which give us turbulent flow through the tube. Between them provide the baffles, which is used to maximize the thermal mixing between the shell side to the coolant pipes.

The shell side tube is work near the baffled which cause is continuous pass the flow over the bundle. And transfer and exit temperature is quite low. This is may be single phase and double phase. In single phase heat exchanger water enter and water is leave. And in double phase heat exchanger may be phase change through heat transfer. Gas or steam enters in inlet and liquid or water outlet. In this figure multi pass shell and tube heat exchanger seen.

We can calculate their performance and efficiency, correction factor by Logarithmic Mean Temperature Difference (LMTD) and Number of Transfer Units (NTU) methods. We can use any one which requirement we have need in the heat exchanger.

3.1 DESIGN OF HEAT EXCHANGER METHOD

The study of warm transfer design is related to in and exittemperature and coefficient of warm transfer and geometry of warm exchanger.the two main common problem of warm exchanger is rating and sizing. We will discuss with basic principle of warm exchanger here we write enthalpy balance equation.

$$Q_c = \dot{m}_c\left(h_{c2} - h_{c1}\right) \qquad (1)$$

$$Q_h = \dot{m}_h\left(h_{h1} - h_{h2}\right) \qquad (2)$$

For phase change with constant specific heat write in.

$$Q_c = \left(\dot{m}c_p\right)_c\left(T_{c2} - T_{c1}\right) \qquad (3)$$

$$Q_h = \left(\dot{m}c_p\right)_h\left(T_{h2} - T_{h1}\right) \qquad (4)$$

Where $(mc_p)_c$ – thermal capacity of cold fluid
$(mc_p)_h$ – thermal capacity of hot fluid

- **COEFFICIENT OF OVERALL HEAT TRANSFER**

Coefficient of overall warm transfer can be calculated as term of single thermal resistance of the system.

$$\frac{1}{UA} = \frac{1}{(\eta_o hA)_i} + \frac{1}{Sk_w} + \frac{1}{(\eta_o hA)_o} \qquad (5)$$

Where n_o is surface efficiency of inlet and exit surfaces
h is heat transfer coefficient of inlet and exit surfaces
S is shape factor of two fluids

- **LMTD METHOD**

The logarithmic mean temperature difference (LMTD) defined as all basic warm transfer units. It is writ as parallel flow and counter flow arrangement.
The LMTD written as

$$\Delta T_{LMTD} = \frac{\Delta T_2 - \Delta T_1}{\ln \frac{\Delta T_2}{\Delta T_1}} \qquad (6)$$

Were,
$\Delta T1$ and $\Delta T2$ is temperature difference

- **NTU METHOD**

The Number of transfer unit (NTU) method is expand to simplified number of warm transfer problems. It is defined as the ratio of the maximum possible heat transfer rate to the actual heat transfer rate. NTU method depends on the hot fluid and cold fluid has minimum fluids[22].
If the cold fluids have a minimum fluid than it written as

$$\in = \frac{C_{\max}(T_{H,in} - T_{H,out})}{C_{\min}(T_{H,in} - T_{C,in})} \qquad (7)$$

If the hot fluids have minimum fluid than it written as

$$\in = \frac{C_{\max}(T_{C,out} - T_{C,in})}{C_{\min}(T_{H,in} - T_{C,in})} \qquad (8)$$

Now we can define heat transfer rate as

$$Q = \in C_{\min}(T_{H,in} - T_{C,in}) \qquad (9)$$

Now it is possible to make NTU equation with another parameter as the number of transfer unit NTU
The value of NTU is

$$NTU = \frac{UA}{C_{\min}} \qquad (10)$$

NTU method for Parallel flow

$$\epsilon = \frac{1-\exp\left[-NTU\left(1+C_r\right)\right]}{1+C_r}$$

$$NTU = \frac{-\ln\left[1-\epsilon\left(1+C_r\right)\right]}{1+C_r} \qquad (11)$$

NTU method for counter flow

$$\epsilon = \frac{1-\exp\left[-NTU\left(1-C_r\right)\right]}{1+C_r\exp\left[-NTU\left(1-C_r\right)\right]}, when\, C_r < 1 \quad (20)$$

and

$$\epsilon = \frac{NTU}{1+NTU}, when\, C_r = 1$$

or

$$NTU = \frac{1}{C_r - 1}\ln\left(\frac{\epsilon - 1}{\epsilon C_r - 1}\right), when C_r < 1 \quad (22)$$

and

$$NTU = \frac{\epsilon}{1-\epsilon}, when\, C_r = 1 \qquad (12)$$

IV. Addition swirl to the shell and tube warm exchanger

There are three methos to transfer a warm in whirl

1) Active method
2) Passive method
3) Compound method

In active method it needs to external power to transfer a heat. And in passive methos its is don't need any external power supply to transfer a heat. And if system need two or more active or passive technique to rise in heat move it is called as compound method[23].

Performance of the heat exchangers can be raised by adding whirl. Twisted-tape is a good path of adding whirl to the fluid flow and two type of whirl flow is mostly used in industrial field: the continuous whirl and break whirl flow devices.

In a continuous whirl flow, its moving is full length of the tube. That time pressure drops and heat transfer coefficient is steady with axial distance.

In breaking whirl flow the moving is produced at the entrance of the tube and break with the flow path. That time pressure drops and heat transfer amount is decrease with the axial distance.

To rise rate of transfer heat it is need to rise the removal heat transfer amount. It is come with forced removal. This can be done by rising the removalamount or rise in surface area.

Some diagrams showing the possible methods to rise in heat transfer rate[24].

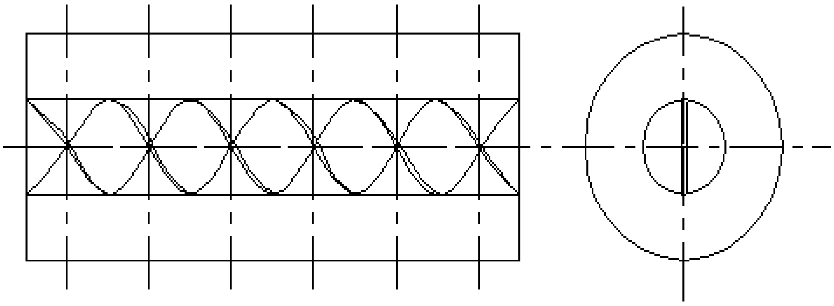

Figure 2. A diagram of Deviant-stripset inside the tube

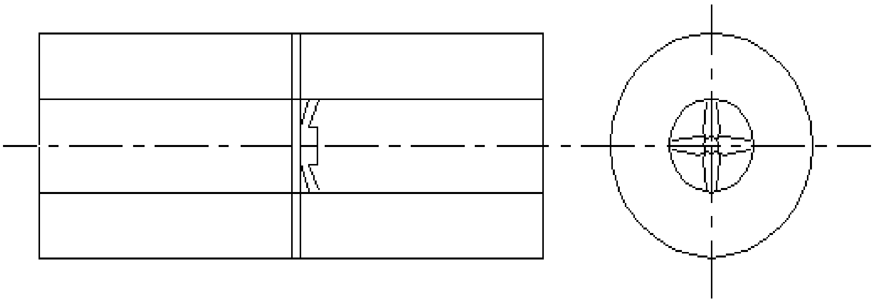

Figure 3. A diagram of screwset inside the tube

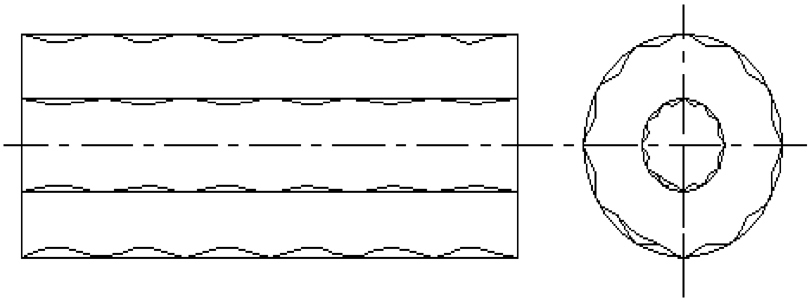

Figure 4. A diagram of shell and tube with curly surface

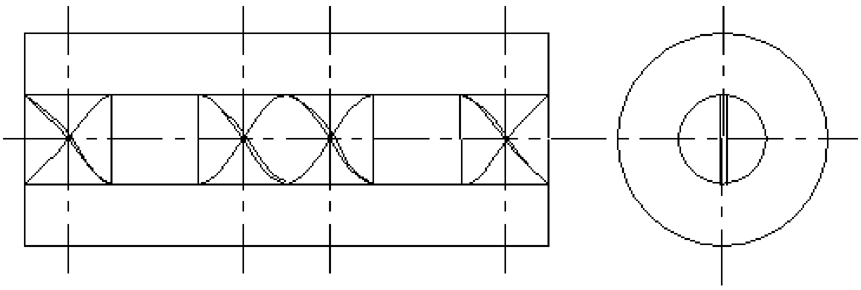

Figure 5. A diagram on somehelix turnset inside the tube

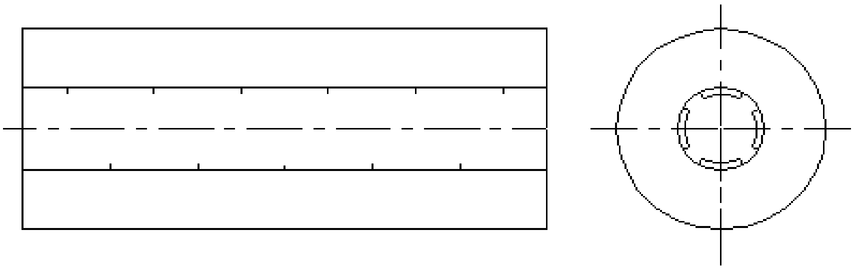

Figure 6. A diagram on ductoutside with barrier to produce a turbulent flow

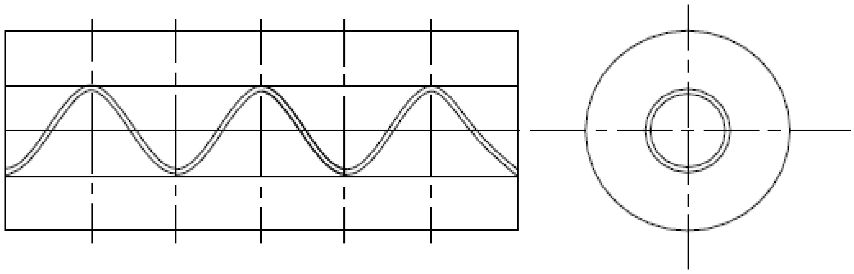

Figure 7. A diagram on coilingset inside the tube[25]

V. Conclusion

In this review paper conclude that the construction of shell and tube warm exchanger may be done by TEMA/ ASME and may be manually by using logarithmic mean temperature difference (LMTD) and Number of transfer unit (NTU) and by software base modeling and simulation by ANSYS, Creo and MATLAB.Each method is simple and basic progress and time consuming as a new warmexchanger. In a tube of the shell and tube warm exchanger is vibrate when HEx is starts it can study about that mid of the tube it is a natural frequency, bundle cross flow and critical velocity are slightly increase and then after decrease to the end of the tube length.

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