

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016

Process and Mechanical Design of Shell and Tube Heat Exchanger

M.Ganesh Karthikayan¹, P.Prem Ananth², R.Vijay³, K.S.Logeshan⁴, Yacoob Mohammed Ashraf Ali⁵

Assistant Professor, Department of Mechanical Engineering, TRP Engineering College, Tiruchirapalli, India¹

UG Scholars, Department of Mechanical Engineering, TRP Engineering College, Tiruchirapalli, India^{2,3,4,5}

ABSTRACT: In the first part of this Analysis a simplified approach to design a Shell & Tube Heat Exchanger [STHE] for a process industry application is presented. The design of STHE includes thermal design and mechanical design. The thermal design of STHE involves evaluation of required effective surface area (i.e. number of tubes) and finding out log mean temperature difference [LMTD]. Whereas, the mechanical design includes the design of main shell under Internal & external pressure, tube design, baffles design gasket, etc. The design was carried out by referring ASME and TEMA standards, available at the company. In the second part of this analysis detail view of design optimization is presented and the solid modeling is been done, Simulation is done by the ANSYS

I. INTRODUCTION

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. The set of tubes is called a tube bundle, and may be composed of several types of tubes: plain, longitudinally finned, etc.

II. LITERATURE REVIEW

Rajiv mukherjee: explains the basics of exchanger thermal design, covering such topics as: STHE components; classification of STHEs according to construction and according to service; data needed for thermal design; tube side design; shell side design, including tube layout, baffling, and shell side pressure drop; and mean temperature difference. The basic equations for tube side and shell side heat transfer and pressure drop. Correlations for optimal condition are also focused and explained with some tabulated data. This paper gives overall idea to design optimal shell and tube heat exchanger. The optimized thermal design can be done by sophisticated computer software however a good understanding of the underlying principles of exchanger designs needed to use this software effectively. Studied that, increased fluid velocities result in larger heat transfer coefficients and, consequently, less heat-transfer area and exchanger cost for given rate of heat transfer. On the other hand, the increased fluid velocities cause an increase in pressure drop and greater pumping power cost. The optimum economic design occurs at the condition where the total cost is a minimum. The basic problem, therefore, is to minimize the sum of the variable annual costs for the exchanger and its operation. The main objective of this paper is to reduce the operating cost of shell and tube heat exchanger.

Yusuf Ali Kara, Ozbilen Guraras: Prepared a vcomputer based design model for preliminary design of shell and tube heat exchangers with single phase fluid flow both on shell and tube side. The program determines the overall dimensions of the shell, the tube bundle, and optimum heat transfer surface area required to meet the specified heat transfer duty by calculating minimum or allowable shell side pressure drop. He concluded that circulating cold fluid in shell-side has some advantages on hot fluid as shell stream since the former causes lower shell-side pressure drop and requires smaller heat transfer area than the latter and thus it is better to put the stream with lower mass flow rate on the shell side because of the baffled space.

M.Serna and A.Jimenez: They have presented acompact formulation to relate the shell-side pressuredrop with the exchanger area and the film coefficient based on the full Bell–Delaware method. In addition to the derivation of the

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016

shell side compact expression, they have developed a compact pressure drop equation for the tube-side stream, which accounts for both straight pressure drops and return losses. They have shown how the compact formulations can be used within an efficient design algorithm.

III. HEAT EXCHANGER DESIGN

The main heat exchanger called rich/lean amine interchanger.

It requires:

Good heat recovery □ the thermal length of heat exchanger is a key feature.

To minimize the fouling tendencies: high pressure drop (above 70 kPa) to keep shear stress high (50Pa)

TUBESHEET

The tubes are fixed with tube sheet that form the barrier between the tube and shell fluids. The tubes can be fixed with the tube sheet using ferrule and a soft metal packing ring.

The tubes are attached to tube sheet with two or more grooves in the tube sheet wall by "tube rolling" .

The tube metal is forced to move into the grooves forming an excellent tight seal. This is the most common type of fixing arrangement in large industrial exchangers.

The tube sheet thickness should be greater than the tube outside diameter to make a good seal. The recommended standards (IS:4503 or TEMA) should be followed to select the minimum tube sheet thickness.

BAFFLES

Baffles are used to increase the fluid velocity by diverting the flow across the tube bundle to obtain higher transfer coefficient.

The distance between adjacent baffles is called baffle-spacing. The baffle spacing of 0.2 to 1 times of the inside shell diameter is commonly used.

Baffles are held in position by means of baffle spacers. Closer baffle spacing gives greater transfer coefficient by inducing higher turbulence.

The pressure drop is more with closer baffle spacing.

The various types of baffles are shown in. In case of cut-segmental baffle, a segment (called baffle cut) is removed to form the baffle expressed as a percentage of the baffle diameter. Baffle cuts from 15 to 45% are normally used. A baffle cut of 20 to 25% provide a good heat-transfer with the reasonable pressure drop.

The % cut for segmental baffle refers to the cut away height from its diameter. also shows two other types of baffles.

▶ **Increase heat transfer coefficient**

▶ Tube Side

- Increase number of tubes
- Decrease tube outside diameter

▶ Shell Side

- Decrease the baffle spacing
- Decrease baffle cut

▶ **Increase surface area**

Increase tube length

Increase shell diameter

Employ multiple shells in series or parallel

▶ **Increase LMTD correction factor and heat exchanger effectiveness**

Use counterflow configuration

Use multiple shell configuration

▶ **Tube side**

Decrease number of tube passes

Increase tube diameter

Decrease tube length and increase shell diameter and

number of tubes

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 8, May 2016

- ▶ **Shell side**
 - Increase the baffle cut
 - Increase the baffle spacing
 - Increase tube pitch
 - Use double or triple segmental baffles

IV. CONCLUSION

- ▶ The design of STHE i.e, thermal and mechanical design was carried at using TEMA/ASME standards both manually and software.
- ▶ It is found at design of STHE obtained by both approaches is very easy, simple, advance and less time consuming as comparing to existing method used in different Indian industries.

REFERENCES

- 1.Sharvan H.Gawande etc. all "Design and Development of Shell & Tube Heat exchanger for Beverage"-2012
2. ASME Section VIII Division I "Rules for construction of Pressure Vessels"-2007
- 3.clark,DR; Schmidt J.R "Parallel Flow Heat Exchanger"-19sreejithk; basil varghese; Deepak das; "Design & cost optimization of plate heat exchaners"-2014
- 4., kai-shini;"Liquid flow distribution in compact parallel flow heat exchanger"-2011