International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

A Study of Enhancement of Heat Transfer using Helical Baffle

Sandesh Bhambal[†*], Paritosh Makasare[†] and Nivedita Uzagare[†]

[†]Mechanical Engineering Department, Marathwada Mitra Mandal's Institute of Technology, SPPU, Pune-47, India

Accepted 01 Oct 2016, Available online 05 Oct 2016, **Special Issue-6 (Oct 2016)**

Abstract

In this Paper heat augmentation techniques with segmented baffle and helical baffle have been studied. This study deals with mainly use of segmented baffles, its disadvantages and how helical baffles prove better as compared to segmented baffle in respect to heat transfer rate. Baffles is one of the important aspect of shell and tube heat exchanger which supports the tubes and changes the direction of the fluid flow..

Keywords: *Heat transfer rate, Helical Baffle, segmented Baffle, Shell and tube Heat Exchanger.*

1. Introduction

Heat transfer enhancement or augmentation techniques refer to the improvement of performance of heat exchangers. Enhancement techniques can be classified as follows:

1. Passive Techniques: No external power is required to enhance the heat transfer for eg treating surfaces, rough surfaces, and external surfaces using inserts.

1. Active Techniques: External power is required to enhance heat transfer, for ex induction pulsating of cam and reciprocating plunger

Compound Techniques: This is a combination of both active and passive method.

More than 35%-40%of heat exchangers that are used in industries are of shell and tube type of heat exchangers. The most commonly used heat exchanger in the process industry is Shell and Tube Heat Exchanger. The reasons for this are several. It provides a comparatively large ratio of heat transfer area to volume and weight. It can be easily constructed in wide range of sizes and capacities. It is strong enough to withstand normal manufacturing stresses, shipping and field erection stresses, and normal operating conditions. Cleaning of shell and tube exchanger is very easy, and those components most subject to failure - gaskets and tubes – can be easily replaced. Shop facilities for the successful design and construction of shell and tube exchangers are available throughout the world. Baffle is an important shell side component of Shell and tube heat exchangers. Besides supporting the tube bundles, the baffles form flow passages for the shell side fluid along with the shell. The most commonly used baffles is the segmental baffle, which forces the fluid in a zigzag manner, thus improving the heat transfer rate but has to compensate for a large pressure drop in the shell side. This type of heat exchanger has been well developed & probably is still the most commonly used type of the shell & tube heat exchanger. The major draw backs of the conventional shell & tube heat exchangers with segmental baffles are three fold. Vineet Kumar, et al., (2014) (i) it causes large side pressure drop. (ii) it causes a dead zone in each component between adjacent segmental baffles, which increases fouling effect. (iii) It causes zig-zag flow pattern which results in high risk vibration failure on tube bundle. To overcome the above mentioned disadvantages of conventional segmented baffle, a number of improved structures were proposed for the purpose of high heat transfer co-efficient, low tube vibration, and low fouling factor.

2. Development in Shell And Tube Heat Exchanger

2.1. Helical Baffle Heat Exchanger

The concept of helical baffle heat exchangers was developed for the first time in Czechoslovakia. The Helical baffle heat exchanger is known as Helix changer, which is a superior shell-and-tube exchanger solution that removes many of the limitations of conventional segmental-baffle exchangers. Helical baffle heat exchangers have shown very effective performance especially for the cases in which the heat transfer coefficient in shell side is controlled or less pressure drop and less fouling are expected. The principle of helixchangers design is fairly easy: circular or elliptical sector-shaped plates are arranged

*Corresponding author: **Sandesh Bhambal**

in a pseudo-helical baffle system. Each baffle occupies one quadrant or one third of the heat exchanger shell cross section area and has an inclination angle to the central axis of the shell, forming a helix flow path for the working fluid. Helical baffle arrangements have less back mixing producing compared with the segmental baffle arrangement in the heat exchanger.

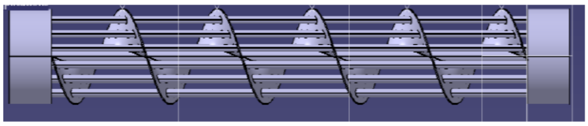

Fig.1 Helixchanger

3. Improvement of Baffle Structure

3.1. Discontinuous Baffle Structure

In the shell and tube heat exchanger with discontinuous helical baffles as shown in Fig. 2 the quadrant or third plates on the shell side can shape a close helical flow pattern, which has higher conversion of pressure drop to heat transfer while an optimal inclination angle is selected. In addition, reducing fouling and flow-induced vibration and increasing the service life of working fluid in the shell side are several benefits from the helix flow manner which can achieve near plug flow conditions. The discontinuous shell and tube heat exchanger have higher heat transfer coefficients under the same shell-side pressure drop. However, certain shortcomings cannot be avoided, for example, under the conditions of identical shell-side mass flow rate and the same baffle pitch, the discontinuous shell and tube heat exchanger usually have relatively lower heat transfer coefficient than the traditional segmented baffle heat exchanger. When the shell-side mass flow rate is small, the percentage of leakage flow of the discontinuous helical baffles may be relatively large in the triangle spaces, which will reduce the shell-side comprehensive heat transfer performance. Furthermore, when the diameter of shell increases in large-scale shell - tube heat exchanger the triangle zone area will become quite large.

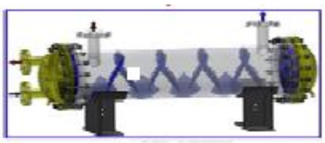

Fig.2 Discontinuous Baffle Heat Exchanger

3. 2. Continuous Helical Baffle

The shell and tube heat exchanger with continuous helical baffles were proposed by Wang and they developed a ‘‘one continuous helical cycle’’ method which could simplify the manufacturing difficulty and reduce the cost significantly. The fluid flow in the shell side of Continuous Helical Baffle is an ideal helix in nature . The advantages of this flow pattern includes all of the good points of discontinuous helical baffles, and even more, excluding the defect ‘‘triangle zones’’ existing in the discontinuous helical baffles. The Continuous Helical Baffle have been considered as the replacement of the segmented baffle heat exchanger due to following attributes

1. Improvement of shell side heat transfer rate.
2. Less pressure drop for a given mass flow rate.
3. Reducing of bypass effects in shell side.
4. Decreasing of fouling in shell side.
5. Prevention of Bundle Vibration.

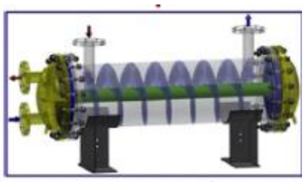

Fig.3 Continuous Helical Baffle Heat Exchanger

4. Configuration and Fabrication

Several helical cycles are linked end to end to form a continuous helicoid, This method overcame the difficulty in manufacturing a whole continuous helicoid at one time and lowered the manufacture cost significantly. One major difficulty related to the manufacturing of continuous helical baffles is the drilling of holes on the baffles. If baffles are drilled the same size holes as the tubes and then later the pitch is varied by stretching the spiral in or out, the tube does not see around hole but rather an elliptic hole. Then it is impossible to pass a round tube through an elliptic hole. Therefore, a die, as shown in Fig.4, is used to hold the helical cycle at the required pitch, and then drill holes on the baffles (B.Peng, 2007).

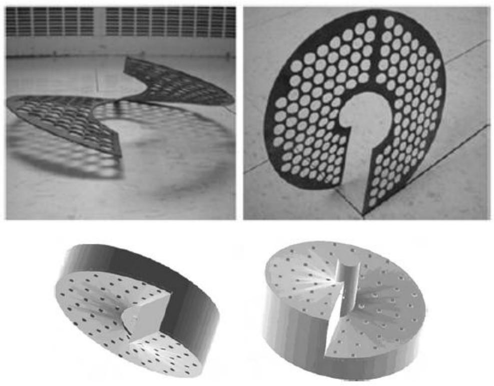

Fig.4 Helical Cycle

An optimally designed helical baffle arrangement depends largely on the heat exchanger operating conditions and can be accomplished by appropriate design of helix angle, baffle overlapping, and tube layout. The cross sectional area of shell side flow channel is determined primarily by the shell inside diameter, tube outside diameter, tube layout and helix angle. A wide range of flow velocities can be achieved by variation of helix angle, analogous to variation of baffle spacing and baffle cut in segmentally baffled heat exchanger (P. S. Gowthaman, 2014).

Important Parameters:

1. Pressure Drop
2. Baffles pitch (Helix angle) angle (φS)
3. Baffle space (Hs)
4. Surface area (A)
5. Heat transfer coeff. (h)

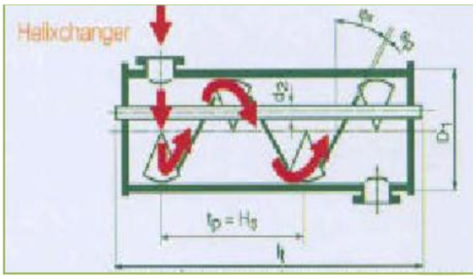

Fig. 5 Helixchanger flow pattern

Advantages of Helixchangers :

1. Thermal & Hydraulic Performance High Thermal Effectiveness
2. Lower Fouling & Cleaning ability
3. Vibration Elimination
4. Cost Saving on Total Life Cycle
5. Improving plant Run
6. High Thermal Effectivness

Conclusions

From the above Study it can be concluded that helical baffles can be replaced instead of other baffles an can be effective in increasing heat transfer rate. The Use of Helical Baffle also reduces shell side pressure drop, pumping cost, size, weight and fouling, also the ratio of heat transfer co-efficient to pressure drop are higher.

References

Sunil S. Shinde, Samir S. Joshi, Dr. S. Pavitran (2012),Performance Improvement in Single phase Tubular Heat Exchanger using continuous Helical Baffles, *IJERA,*2,1141-1149.

S.Shinde, P. V. Hadgekar, Dr. S. P. Pavitran (2012), Comparitive Thermal Analysis of Conventional tubular Heat Exchanger with Helixchanger using Bell-Delaware Method, *IJAEST,* 2,27-38.

Mayank Vishwakarma, K. K. Jain, (2013), Thermal analysis of Helical Baffle Heat Exchanger*, IJSR*, 2(7), 251-254.

Vineet Kumar, Pardeep Kumar, Sunil Nain,(2014) ,Heat Transfer Enhancement in HelixExchanger Using Grooved Tubes at Different Baffle Angles, *International Journal of Emerging Technology and Advanced Engineering* , 4(8),477-484.

P. S. Gowthaman and S. Sathish (2014),Analysis of Segmental and Helical Baffle in Shell and tube Heat Exchanger,*IJCET*,2,625-628.

B. Peng *et. al.*, (2007), An experimental study of shell and Tube heat exchangers with continuous Helical Baffles, *Journal of heat transfer*, 129, 1425-1431.