A Review on Shell and Tube Heat Exchanger (STHX) using various Design arrangement of Baffle

Dhavalkumar A. Maheshwari[1]

[1] Assistant Professor, Department of Mechanical Engineering, VIEAT, Kim, Gujarat, India

ABSTRACT

This paper provides a review about major work done on different designs of baffle as well as its arrangement as like segmental baffle, helical baffle, plate baffle etc to improve overall performance of shell and tube heat exchanger. Major factors which affect performance of shell and tube heat exchanger are shown in this paper and also comparisons between different baffle design arrangements are shown. Now a day's mostly research done on helical baffle arrangement which gives better performance compared to segmental baffle and researcher gives some more design arrangement of baffles like trefoil-hole baffles, plate baffles, ladder-type fold baffle etc which gives better overall performance of shell and tube heat exchanger. In most cases, discontinuous, folded, sextant helical baffles, 40° baffle inclination angle as well as low baffle spacing will give the best results when integrated in some combination, whereas continuous helical baffle market as per tles eliminate dead regions. Moreover, sealing strips are more likely to improve the performance of shell and tube heat exchangers with continuous helical baffles.

Keyword: - *Shell and tube heat exchanger, baffle, segmental baffle, helical baffle, Overall performance. etc….*

---

1. INTRODUCTION

Heat Exchanger devices have its application in various fields from petrochemical industries to power plants and everything in between. Some of the other areas where heat transfer must be regulated include heat engines, heat pumps, fuel cells, gas turbines, electronic packaging systems and food processing.

There are three basic modes of heat transfer which include:

1. Thermal Conduction: Conduction is virtually involved in all operations in which heat transfer is taking place. Transfer of heat via conduction occurs through a solid surface that separates fluids having different temperatures. For transferring heat by the process of conduction, heat exchangers are the most common equipment used in process industries.
2. Convection: Convection is the movement of groups of molecules within fluids such as liquids or gases, and within rheids. Convection takes place through advection, diffusion or both.
3. Radiation: Radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium.

There are different types of heat exchanger available in market as per their application such as such as plate fin, shell and tube, double pipe, plate and shell, pillow plate, etc. are a few types of heat exchangers used on an industrial scale. Among which shell and tube heat exchanger (STHX) were used in industries mostly.

Shell and tube heat exchangers mostly used in industries because of they can easily cleaned up, lower cost, more flexible adaptability compared with other heat exchanger.

This paper is focused mainly on the developments made so far with a special type of baffles.

1I. LITERATURE SURVEY

A. Bin Gao, Qincheng Bi & Miao Gui [1]

" Experimental performance comparison for shell side heat transfer for shell and tube heat exchanger with different helical baffles"

In this paper researcher have done experiments and study on effect of baffle overlap proportion on heat transfer performance and shell side flow of the shell and tube heat exchanger with continues helical baffles. Overlap proportion of 10% with shell and tube heat exchanger and different helix angle of 20^o, 30^o, and 40^o were tested. Experimental comparisons were made with data of shell and tube heat exchanger with same helix angle but at different overlap proportion of 50%. Researcher gave result which indicates that both helix angle and overlap proportion have great effect on heat transfer. The overall performance of shell and tube heat exchanger with small overlap proportion is better than large overlap proportion at same Reynolds number or at equal mass flow rate. But shell and tube heat exchanger with large baffle overlap proportion has less irreversibility according to theory of entransy dissipation.

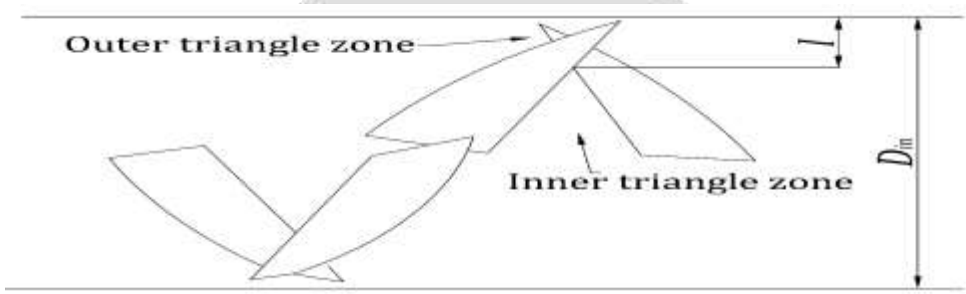

Figure 1. Schematic of axially staggered overlap helical baffles

B. Yonghua You, Yuqi Chen, Mengqian Xie, Xiaobing Luo, Lan Jiao, Suyi Huang [2]

"Numerical simulation and performance improvement for a small size shell-and-tubeheat exchanger with trefoil-hole baffles"

In this paper, researcher have adopted ANSYS FLUENT to conduct a numerical study on thermal augmentations of trefoil-hole baffle arrangement. Design modification made on small size heat exchanger for better overall thermo hydraulic performance. Computational result of following research paper shows that current model, where whole heat exchanger, which including tubes, baffles and fluid on both shell and tube sides, etc., are modeled. They also found that with design modification, pressure loss on shell side decreased at shell side, and thermo-hydraulic performance increased.

C. Jie Yang, Wei Liu [3]

"Numerical investigation on a novel shell-and-tube heat exchanger with plate baffles and experimental validation"

This article present a novel shell and tube heat exchanger with new plate baffles is proposed. They numerically investigated in comparison with a shell and tube heat exchanger with rod baffle. Software FLUENT 6.3 and GAMBIT 2.3 are adopted for modeling and computational calculation They verified modeling approach with experimental data. The shell side result of heat transfer, flow performance and other comprehensive performance are analyzed. The Nusselt number of plate baffle is higher than rod baffle heat exchanger. Overall, the novel plate baffles heat exchanger illustrates evidently higher comprehensive performance than the rod baffles one.

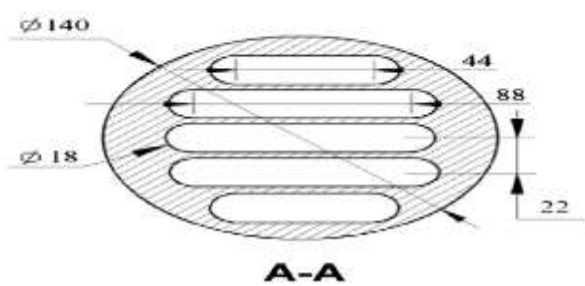

Figure 2. new plate baffle

D. Jian Wen, Huizhu Yang, Simin Wang, Yulan Xue, Xin Tong [4]

"Experimental investigation on performance comparison for shell-and-tube heat exchangers with different baffles"

This article present an improved design structure of ladder type fold baffle is used to block the triangular leakages zone in heat exchanger with helical baffle. Results from numerically showed that distribution of velocity and temperature at shell side improved and axial circular flow is eliminated. They showed by experiments that shell side heat transfer coefficient and overall heat transfer coefficient are improved. The ladder-type fold baffles can effectively improve the heat transfer performance of heat exchangers with helical baffles.

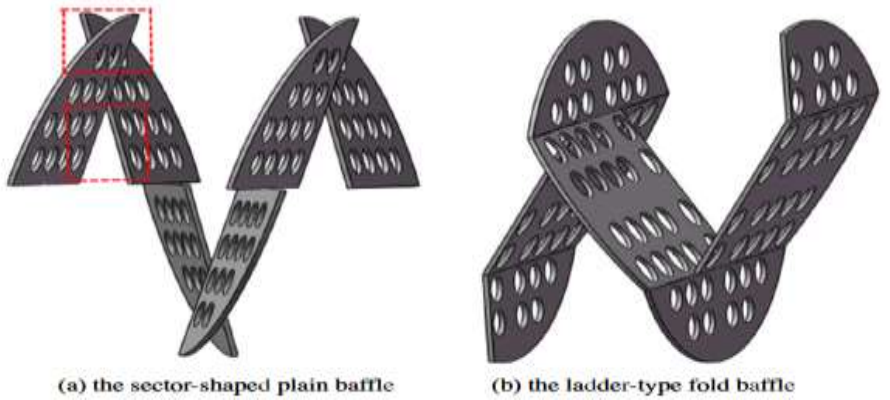

Figure 3. Schematic diagram of the structural characteristics of baffles.

E. J.J. Liu, Z.C. Liu, W. Liu [5]

"3D numerical study on shell side heat transfer and flow characteristics of rod-baffle heat exchangers with spirally corrugated tubes"

This article presents a numerical simulation of the shell side flow in rod-baffle heat exchangers with spirally corrugated tubes (RBHXsSCT). Results are compared
with those in rod-baffle heat exchanger with plain tubes (RBHX). Simulation is conducted to improve the thermo-hydraulic performance in longitudinal flow heat exchangers and to obtain an understanding of the physical behavior of thermal and fluid flow in the RBHXsSCT with Reynolds number ranging from 6000 to 18,000. Simulation results show that the Nusselt number in RBHXSCT with one-start spirally corrugated tubes can be 1.2 times that in RBHX when the Reynolds number is 18,000. The heat transfer quantities in the RBHXsSCT with one-start, two-start, three-start, and four-start spirally corrugated tubes are 104.6%, 105.4%, 106.7%, and 109.6%, respectively, higher than that in RBHX. The pressure drop in RBHX is 1.21, 1.16, 1.12, and 1.08 times that in RBHXsSCT with one-start, two-start, three-start, and four-start spirally corrugated tubes, respectively. The RBHXSCT with one-start spirally corrugated tubes can achieve an efficiency evaluate coefficient of 1.35.

F. Qiuwang Wang, Qiuyang Chen, Guidong Chen, Min Zeng [6]

"Numerical investigation on combined multiple shell-pass shell-and-tube heat exchanger with continuous helical baffles"

In this research paper combined multiple shell pass shell and tube heat exchanger with continuous helical baffle in outer shell pass have been invented to improve overall heat transfer performance and simplify the manufacture process. A combined multiple shell pass shell and tube heat exchanger is compared with conventional shell and tube heat exchanger with segmental baffles by means of CFD method. They showed numerical method which gave under the same mass flow rate and overall heat transfer rate, the average overall pressure drop of combined multiple shell pass shell and tube heat exchanger is lower than conventional shell and tube heat exchanger with segmental baffles. Overall heat transfer rate increased following heat exchanger. The CMSP-STHX might be used to replace the SG-STHX in industrial applications to save energy, reduce cost and prolong the service life.

G. Mehdi Bahiei, Morteza Hangi, Mahdi Saeedan [6]

"A novel application for energy efficiency improvement using nanofluid in shell and tube heat exchanger equipped with helical baffles"

This article present a hydrothermal characteristics of water-Al2O3 nano-fluids are numerically evaluated in shell and tube heat exchanger equipped with helical baffle using two phase mixture. Heat transfer and pressure drop increased by increasing nano-particle concentration and baffle overlapping and also decreasing helix angle. At smaller helix angles, changing the overlapping is more effective on the convective heat transfer coefficient and the pressure drop. The results obtained from single-objective optimization indicate that even when a low pressure drop is significantly important for designer, nano-fluids with high concentrations can be employed. Meanwhile, when both high heat transfer and low pressure drop are important, a small helix angle can be used.

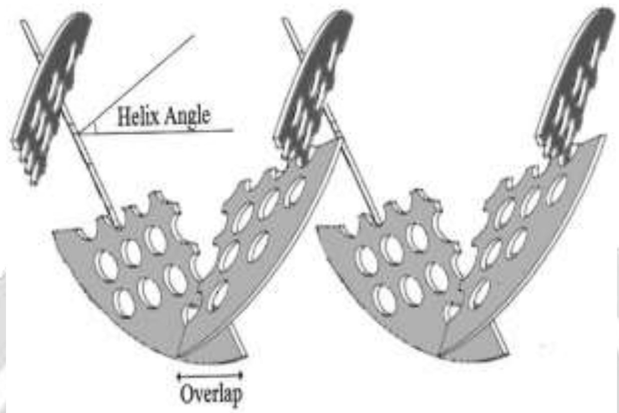

Figure 4. Schematic view of helical baffles.

H. Jian-Feng Yang, Min Zeng, Qiu-Wang Wang [8]

"Numerical investigation on shell-side performances of combined parallel and serial two shell-pass shell-and-tube heat exchangers with continuous helical baffles"

In this article Combined parallel and serial two shell-pass shell-and-tube heat exchangers whose outer shell pass are set up continuous helical baffles have been proposed to enhance the heat transfer performance. The CPTSP-STHX and CSTSP-STHX are compared with the segmental baffled shell-and-tube heat exchanger by computer simulation. The results of simulation present that, total heat transfer rate Q of the CPTSP-STHX and CSTSP STHX-1 raise nearly 5.1% and 9.5% respectively, and the heat transfer coefficient h of the CPTSP-STHX and CSTSP-STHX-1 enhance nearly 7.6% and 14.8% than that of SG-STHX, while all of them have the same mass flow rate M, the same heat transfer area A, and the same pressure drop Dp. Also under the same mass flow rate M and the same heat transfer area A, the Q and the Dp of the CSTSP-STHX-2 increase nearly by 46.3% and 130.9% than those of the SGSTHX, respectively.

III. CONCLUSION

The current study covers some of the important factors affecting the performance of STHE, and then a comparison of helical baffles with the traditional segmental baffles was made. It was evident from the comparison that helical baffles give better results than the segmental ones due to better heat transfer performance, less fouling and less fluid-induced vibrations. The effectiveness of the heat exchangers with two-layer helical baffles is higher than that of the heat exchanger with single layer helical baffles.

IV. REFERENCES

[1] Bin Gao, Qincheng Bi & Miao Gui (2016): "Experimental performance comparison of shell-side heat transfer for shell-and-tube heat exchangers with different helical baffles", Heat Transfer Engineering, DOI: 10.1080/01457632.2016.1151300

[2] Yonghua You, Yuqi Chen, Mengqian Xie, Xiaobing Luo, Lan Jiao, Suyi Huang; "Numerical simulation and performance improvement for a small size shell-and-tubeheat exchanger with trefoil-holebaffles" 10.1016/j.applthermaleng.2015.06.012 [3] Jie Yang, Wei Liu "Numerical investigation on a novel shell-and-tube heat exchanger with plate baffles and experimental validation" http://dx.doi.org/10.1016/j.enconman.2015.05.066.

[4] Jian Wen, Huizhu Yang, Simin Wang, Yulan Xue, Xin Tong "Experimental investigation on performance comparison for shell-and-tube heat exchangers with different baffles" http://dx.doi.org/10.1016/j.apenergy.2014.11.029
[5] J.J. Liu, Z.C. Liu, W. Liu "3D numerical study on shell side heat transfer and flow characteristics of rod-baffle heat exchangers with spirally corrugated tubes" http://dx.doi.org/10.1016/j.ijthermalsci.2014.10.011
[6] Qiuwang Wang, Qiuyang Chen, Guidong Chen, Min Zeng "Numerical investigation on combined multiple shell-pass shell-and-tube heat exchanger with continuous helical baffles" 0017-9310/$ - see front matter _ 2008 Elsevier Ltd. doi:10.1016/j.ijheatmasstransfer.2008.09.009
[7] Mehdi Bahiei, Morteza Hangi, Mahdi Saeedan "A novel application for energy efficiency improvement using nanofluid in shell and tube heat exchanger equipped with helical baffles" http://dx.doi.org/10.1016/j.energy.2015.10.120
0360-5442/© 2015 Elsevier Ltd.
[8] Jian-Feng Yang, Min Zeng, Qiu-Wang Wang "Numerical investigation on shell-side performances of combined parallel and serial two shell-pass shell-and-tube heat exchangers with continuous helical baffles"

BIOGRAPHIES (Not Essential)

	Mr.Dhavalkumar Maheshwari is presently working as a Assistant Professor in a VIEAT, Kim, Surat, India.