International Journal of Engineering Research and Reviews ISSN 2348-697X (Online)
Vol. 6, Issue 3, pp: (1-3), Month: July - September 2018, Available at: www.researchpublish.com

EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER IN A SHELL AND TUBE HEAT EXCHANGER USING HELICAL BAFFLES

Keval M. Chauhan[1], Vinal G. Virani[2]

[1]Final year Student M-tech, , Thermal science, R K School of Engineering, R K University, Rajkot-360020,
[2]Professor, Mechanical Engineering Department, R K School of Engineering, R K University, Rajkot-360020, Gujarat, India

Abstract: **Experimental analysis of shell and tube heat exchanger (STHE) with helical baffles has been carried out. Also comparative study of STHE with segmental baffles numerically is calculated. The numerical result show that under the same mean bulk temperature, heat transfer co-efficient and mass flow rate of shell and tube heat exchanger with helical baffle is higher than the shell and tube heat exchanger with segmental baffle and pressure drop of shell and tube heat exchanger with helical baffle is lower than the shell and tube heat exchanger with segmental baffle that's result decrease pumping and capital cost. So the STHE with helical baffles might be used to replace the STHE with segmental baffles in industrial application to save energy, reduce cost and prolong service life.**

Keywords: **Heat transfer co-efficient, pressure drop, shell-and- tube heat exchanger, helical baffles, and mass flow rate.**

I. INTRODUCTION

Heat exchangers are important heat and mass exchange equipment in oil refining, chemical engineering, environmental protection, and electric power generation. Along with different types of heat exchangers, shell-and-tube heat exchangers have been commonly used in industries [1]. Chunangad et al. [2] show that more than 35– 40% of heat exchangers are of the shell and tube type, and this is primarily due to the robust construction geometry, easy maintenance and possible upgrades of STHXs. They are widely used as evaporators and condensers. The heat transfer effectiveness of STHX can be improved by using baffles. Segmental baffles are most commonly used in conventional STHX to support tubes and change fluid flow direction. Segmental baffles cause the shell-side fluid to flow in a tortuous, zigzag manner across the tube bundles, which can enhance the heat transfer on the shell side. However, there exist many problems associated with the use of segmental baffles [3] :(1) high pressure drop on the shell side due to the sudden contraction and expansion of the flow in the shell side, and the fluid impinging on the shell walls caused by segmental baffles; (2) low heat transfer efficiency due to the flow stagnation in the so-called "dead zones," Which are located at the corners between baffles and shell wall; (3) low shell-side mass velocity across the tubes due to the leakage between baffles and shell walls caused by inaccuracy in manufacturing tolerance and installation; (4) short operation time due to the vibration caused by shell-side flow normal to tube banks. When the traditional segmental baffles are used in STHXs, higher pumping power is often needed to offset the higher pressure drop under the same heat load. Therefore, it is essential to develop a new type of STHXs using different type of baffles to have higher heat transfer efficiency and lower pressure drop. The concept of STHXs with helical baffles has been discussed by several researchers [4]. The helical baffles in STHXs are shaped approximately as helicoids in order to have the fluid flow in the shell side close to helical flow, which will result in a decrease in pressure drop and an increase in heat transfer in the shell side of the heat exchanger.

BAFFLES

In this work, (1) two different STHXs with Helical baffles were designed and tested, (2) the heat transfer Coefficients per pressure drop of the STHXs with helical baffles were compared with those of the STHXs with segmental baffles, and (3) Suitable helix angle may be selected based upon the desired output and industrial applications.

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

- Hold the tubes in position, both in production and operation.
- Prevent the effects of vibration, which is increased with both fluid velocity and the length of the exchanger.
- Direct shell-side fluid flow along tube field. This increases fluid velocity and the effective heat transfer co-efficient of the exchanger.

II. LITTERATURE REVIEW

The main purpose of this chapter is to provide a literature review of past research effort likes journals and articles related to shell and tube heat exchanger and Moreover, review of other relevant research studies are made to give additional information to understand more on this research.

A) Huadong Li and Volker Kottke (1998)

Huadong Li, Volker Kottke explain in his research work about the local heat transfer coefficient on the outer surface of tubes in shell-and-tube heat exchangers with staggered tube arrangement are visualized and determined from mass transfer measurements. The mass transfer experiments are carried out using a technique based on absorption, chemical and coupled colour reaction. Local mass transfer coefficients are measured for fully developed flow conditions on each tube surface. These coefficients are transformed to heat transfer coefficient by employing the analogy between heat and mass transfer. The averaged heat transfer coefficient and the pressure drop are compared with the predictions from the literature. [3]

B) Reppich and S.Zagermann (1995)

Reppich and S.Zagermann have the developed computer-based design concept assuming from the calculation of optimum tube side and shell side pressure drops allows determining the optimum dimensions of segmental baffled shell-and-tube heat exchangers. As the objective function that is minimized are chosen the total annual costs of the heating or cooling system consisting of the heat exchanger and pumps or compressors. [4]

C) Young-Seok Son, Jee-Young Shin (2001)

Young-Seok Son, Jee-Young Shin Reported from ansys simulation studies on STHX with helical baffles were using commercially available CFX4.2 codes and concluded that the performance of STHX with helical baffles is grater then conventional STHX. Fluid contacts are flowing rotationally in the shell and hence reduced the stagnation zones in the shell side, so improving heat transfer. [5]

D) E. S. Gaddis and V. Gnielinski (1997)

E. S. Gaddis and V. Gnielinski explain in his research work about the procedure for evaluating the shell side pressure drop in shell-and-tube heat exchangers with segmental baffles. The procedure is based on correlations for calculating the pressure drop in an ideal tube bank was joined with correction factors, which used for find out of leakage and bypass streams, and on equations for calculating the pressure drop with the help of Delaware method. [6]

E) V. Sreedhar, G.Ravi Chandra, T.N.Ravi Kanth (2017)

V. Sreedhar, G.Ravi Chandra, T.N.Ravi Kanth has Conduct experiment and evaluate the performance of shell and tube heat exchangers with two baffles as Segmental and Disc-Doughnut type baffle. We have tested the heat exchanger with two baffles at different hot fluid temperatures and observe its effect on the performance of the heat exchanger with different baffles. By comparing the parameters such as LMTD, effectiveness, and heat transfer coefficient of heat exchangers with Segmental and Disc-Doughnut type baffles and suitable baffles are selected for better heat transfer rate. The results shows that the increase in the LMTD is 19.75%, Effectiveness is 10.8% , NTU is 37.25% using Disc and Doughnut baffle compared to segmental baffle at hot water temperature 38^{o}c.[7]

F) Y. Wang, Z. Liu, S. Huang, W. Liu, and W. Li (2011)

Y. Wang, Z. Liu, S. Huang, W. Liu, and W. Li was Carried out experimental investigations on flower baffled STHX and the original segmental baffle STHX models and reported that the overall performance of the flower baffled heat exchanger model is 20–30% more efficient than that of the segmental baffle heat exchanger under same operating conditions. [8]

G) M. Saeedan and M. Bahiraei (2015)

M. Saeedan and M. Bahiraei worked on 3D simulation for one period of shell side of STHX with helical baffles was implementing for different values of helix angle and overlap. The obtained results demonstrate that decreasing the helix angle and increasing the baffles overlap will raise both convective heat transfer coefficient and pressure drop. [9]

III. CONCLUSION

Shell and tube heat exchanger with helical baffle is investigated with kern method and compare to shell and tube heat exchanger with segmental baffle. The conclusion summarized follows:

Under the same mean bulk temperature, heat transfer co-efficient of shell and tube heat exchanger with helical baffle is higher than the shell and tube heat exchanger with segmental baffle. So, effectiveness also increases. The pressure drop of helical baffle heat exchanger is low than the segmental baffle heat exchanger. There for the giving better performance through helical baffle heat exchanger.

REFERENCES

[1] Gulyani, B. B., “Estimating Number of Shells in Shell and Tube Heat Exchangers: A New Approach Based on Temperature Cross,” ASME J. Heat Transfer, 122, pp. 566–571, 2000.

[2] Master, B. I., Chunangad, K. S., and Pushpanathan, V., “Fouling Mitigation Using Helixchanger Heat Exchangers,” *Proceedings of the ECI Conference* on Heat Exchanger Fouling and Cleaning: Fundamentals and Applications, Santa Fe, NM, May 18–22, pp. 317–322,2003.

[3] Li, H. D., and Kottke, V., “Visualization and Determination of Local Heat Transfer Coefficients in Shell and-Tube Heat Exchangers for Staggered Tube Arrangement by Mass Transfer Measurements,” Exp. Therm. Fluid Sci., 17(3), pp. 210–216,1998.

[4] Reppich, M., and Zagermann, S., “A New Design Method for Segmentally Baffled Heat Exchangers,” Comput. Chem. Eng., 19, pp. 137–142, 1995.

[5] Young-Seok Son, Jee-Young Shin, “Performance of a shell-and-tube heat Exchanger with spiral baffle plates,” KSME International Journal 15 (2001) 1555-1562.

[6] E. S. Gaddis and V. Gnielinski, “Pressure drop on the shell side of shell-and-tube heat exchangers with segmental baffles,” *Chem. Eng. Process. Process Intensif.*, vol. 36, no. 2, pp. 149–159, 1997.

[7] V. Sreedhar, G.Ravi Chandra, T.N.Ravi Kanth, “experimental investigation on shell and tube heat exchanger using segmental and disc-doughnut type baffles. ”International journal of mechanical engineering and technology (ijmet) volume 8, issue 12, December 2017, pp. 975–984, article id: ijmet_08_12_106.

[8] Y. Wang, Z. Liu, S. Huang, W. Liu, and W. Li, “Experimental investigation of shell-and-tube heat exchanger with a new type of baffles,” *Heat Mass Transf. und Stoffuebertragung*, vol. 47, no. 7, pp. 833–839, 2011.

[9] M. Saeedan and M. Bahiraei, “Effects of geometrical parameters on hydrothermal characteristics of shell- and-tube heat exchanger with helical baffles: Numerical investigation, modeling and optimization,” *Chem. Eng. Res. Des.*, vol. 96, pp. 43–53, 2015.