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A REVIEW ON SHELL AND TUBE HEAT EXCHANGER (STHX) USING VARIOUS ORIENTATION ANGLE OF BAFFLE

Saurabh Sharma[*1] & Ritesh Kumar Dewangan[2]

[*1]M.Tech. Scholar, Department of Mechanical Engineering , Rungta College of Engineering and Technology, Raipur, Chhattisgarh, India -492001

[2]Associate Professor, Department of Mechanical Engineering , Rungta College of Engineering and Technology, Raipur, Chhattisgarh, India -492001

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ABSTRACT

This paper provides a review about major work done on design of Baffle plates and its different orientations 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 orientations are shown. Now a day's most of research done on different orientation angles of baffle which gives improved performance over straight segmented baffle. In most cases, 40° baffle inclination angle as well as low baffle spacing will give the best results. Moreover, sealing strips are more likely to improve the performance of shell and tube heat exchangers with segmented baffle.

KEYWORDS: Shell and tube heat exchanger, baffle, segmented baffle, baffle orientation, Overall performance.

I. INTRODUCTION

A heat exchanger is a device used to transfer heat between a solid object and a fluid, or between two or more fluids. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural gas processing and sewage treatment.

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. Thermal conduction is the transfer of heat (internal energy) by microscopic collisions of particles and movement of electrons within a body. The microscopically colliding objects, that include molecules, atoms, and electrons, transfer disorganized microscopic kinetic and potential energy, jointly known as internal energy. Conduction takes place in all phases of matter, such as solids, liquids, gases and plasmas.
2. Convection: Convection is the heat transfer due to bulk movement of molecules within fluids such as gases and liquids including molten rock . 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.

II. LITERATURE REVIEW

A. Mohammed Irshad, Mohammed Kaushar, G. Rajmohan ''Design and CFD Analysis of Shell and Tube Heat Exchanger''

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In this paper researcher have done Comparison for several shell- and- tube heat exchangers with segmental baffles. The objective of this project is to design a shell and tube heat exchanger with segmental baffles and to study the flow and temperatures inside the shell and tubes using ANSYS software tool for the different baffles assemblies and orientation also overall heat transfer is calculated for each design. This project totally contains 5 designs for comparison. The process in solving simulation consists of modeling and meshing the basic geometry of shell and tube heat exchanger using CFD package ANSYS 14.5.In simulation it is shown how the temperature, pressure, velocity varies in shell due to different baffles orientation. Researcher gave result which indicates that the heat exchanger without any short-circuited flow has the higher heat transfer coefficient than the heat exchanger with leakage. It is found that for 0.5 kg/s mass flow rate there is no much effect on outlet temperature of the tube even though the baffle inclination is increased from 0° to 40°. However the shell-side pressure difference is decreased with increase in baffle inclination angle i.e., as the inclination angle is increased from 0° to 40°. The pressure difference is decreased by 6%, for the heat exchanger with 20° baffle inclination angle and by 19.57% for the heat exchanger with 40° baffle inclination angle with 36% baffle cut. It can be concluded that shell and tube heat exchanger with 40°inclination angle and 25% baffle cut results in better performance compared to 0°, 20° and 30° inclination angle

B. Sayali R.Bhandurge, Prof. A.M.Wankhade, Prof. P.K.Jadhao, Nikhil P.Talwekar ''Analysis and Experimentation of Shell and Tube Heat Exchanger with Different Orientation of Baffles''

In this paper, researcher have done Experimentation along with CFD analysis on single pass, counter flow shell and tube heat exchanger containing Baffles at 0°,15°,30°,45° orientation. To study the heat transfer rate and pressure drop of shell side fluid and compare the result with Bell-Delaware method, Experimental setup is validated with help of Dittus- Boelter correlation. Nusselt number obtains from Experimental set up of 0° orientation and Dittus- Boelter correlation are within 5.72%. Experimental result of 0° orientation is also compare with CFD results in which Nusselt number are found to be within 12.50% and pressure drop is found within 5.55%.Results obtain from CFD analysis is also compare with Bell Delaware method and Nu in case of CFD is 3.35% of Bell-Delaware. Pressure drop Results in case of CFD is Found within 14.99%.CFD analysis at 15°,30° & 45° baffle orientation is also done and results are validate with help of Belle Delaware method.

The overall conclusions are as follows, heat transfer coefficient and heat transfer rate is increased by 10% to 17% when baffle angle inclination changes from 0° to 45°,whereas pressure drop is decreased by 5% to 13.44% with change in baffle inclination from 0° to 45° which helps in reducing the pumping cost of shell and tube heat exchanger. From this experimental, CFD and Bell Delaware analysis it is found that as baffle angle changes from 0 to 45 degree, Nusselt no. increases that is indirectly heat transfer rate is increase and pressure drop is reduces. Due to change in baffle inclination angle more turbulence will be created across the shell side, because of this heat transfer coefficient is increases which results in increase of Nusselt number and hence the heat transfer rate will increase. By varying the baffle inclination with fixed baffle spacing and the baffle cut values of 25% for 4.84 kg/sec shell side flow rates, the experimental results for 0° baffle inclination are compared with CFD simulation result and then compare with Bell-Delaware result, it is observed that experimentation and CFD result for 0° baffle inclination are in good agreement with Bell –Delaware results. The simulation results for 15°, 30°,45° baffle inclination compared with result from Bell-Delaware method. For properly spaced baffles, it is observed that the CFD simulation results are in good agreement with the Bell-Delaware results. The results are also sensitive to baffle cut selection, for this counter flow shell and tube heat exchanger with 10 baffles and baffle inclination of 45° gives slightly better result.

C. Koorosh Mohammadi , Wolfgang Heidemann & Hans Muller-Steinhagen ''Numerical Investigation of the Effect of Baffle Orientation on Heat Transfer and Pressure Drop in a Shell and Tube Heat Exchanger With Leakage Flows''

In this research paper The commercial CFD code FLUENT is used to investigate the effect of baffle orientation and of viscosity of the working fluid on the heat transfer and pressure drop in a shell-and-tube heat exchanger in the domain of turbulent flow. Two baffle orientations as well as leakage flows are considered. In order to determine the effect of viscosity on heat transfer and pressure drop, simulations are performed for the working fluids air, water, and engine oil by using different flow velocities at the inlet nozzle. Results from numerically showed that by introducing a performance factor, the effects of horizontally and vertically orientated baffles on pressure drop and heat transfer could be compared. The tube-baffle leakage and bypass streams play an important role in the explanation of the performance factor of segmentally baffled shell-and-tube heat

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exchangers. For all shell-side fluids (air, water, engine oil) that have been considered, the vertical baffle orientation seems to be more advantageous than the horizontal orientation and is more noticeable for gases since the dissipation rate in gases is much higher than in liquids.

D. P.S.Gowthaman and S.Sathish ''Analysis of Segmental and Helical Baffle in Shell and tube Heat Exchanger''

Baffle is an shell side Component of shell and tube heat exchanger. The segmental baffle forces the liquid in a Zigzag flow and improving heat transfer and a high pressure drop and increase the fouling resistance and Helical Baffle have a Effective Performance of increasing heat transfer performance. The desirable features of heat exchanger obtain a maximum heat transfer Coefficient and a lower pressure drop. From the Numerical Experimentation result the performance of heat exchanger is increased in Helical Baffle instead of Segmental Baffle. From the Numerical Experimentation Results it is confirmed that the Performance of a Tubular Heat Exchanger can be improved by Helical Baffles instead of Segmental Baffles. Use of Helical Baffles In Heat Exchanger Reduces Shell side Pressure drop, ,pumping cost, weight, fouling etc as compare to Segmental Baffle for a new installation.

E. Neeraj kumar, Dr. Pradeep kumar Jhinge "Effect of Segmental Baffles at Different Orientation on the Performances of Single Pass Shell and Tube Heat Exchanger"

In this work, an attempt has been made to study the effect of increase in Reynolds number at different angular orientation "θ" of the baffles. The range of "θ" vary from 0° to 45° (i.e 0°, 15°, 30° and 45°) and Reynolds number ranges from 500 to 2000 (i.e 500,1000, 1500 and 2000). A prototype model of shell and tube type heat exchanger has been fabricated to carry out the experiments. Water is taken as the working fluid used in both shell and tubes. Based on the experiment result has been observed that the angular orientation of baffles and the Reynolds number effects heat transfer rate and pressure drop in the shell and tube heat exchanger. The heat transfer rate increases up to 30° angular orientation of the baffles and after that there is a drop in heat transfer rate at ϴ (45°). The pressure drop to the shell sides decreases continuously from 0° to 45°which helps in reducing the pumping cost of the shell and tube heat exchanger.

F. A Vindhya Vasiny Prasad Dubey, B Raj Rajat Verma, C Piyush Shanker Verma, D A.K.Srivastava ''Performance Analysis of Shell & Tube Type Heat Exchanger under the Effect of Varied Operating Conditions''

This paper consists of extensive thermal analysis of the effects of severe loading conditions such as various flow condition using different insulations, under various ambient temperature and also they tried to create the turbulence by closing the pump opening and observed its effect on its effectiveness. To serve the purpose a simplified model of shell and tube type heat exchanger has been designed using kern's method then steady state thermal analysis is done on ANSYS 14.0, practical working model of the same has been fabricated using the components of the exact dimensions as derived from the designing. Heat exchanger. The Result of the above experiment show that the insulation is a good tool to increase the rate of heat transfer if used properly well below the level of critical thickness. Amongst the used materials the cotton wool and the tape have given the best values of effectiveness. Moreover the effectiveness of the heat exchanger also depends upon the value of turbulence provided. The ambient conditions for which the heat exchanger was tested do not show any significant effect over the heat exchanger's performance.

G. Simin Wang, Jian Wen, Yanzhong Li ''An experimental investigation of heat transfer enhancement for a shell-and-tube heat exchanger''

In this article for the purpose of heat transfer enhancement, the configuration of a shell-and-tube heat exchanger was improved through the installation of sealers in the shell-side. The gaps between the baffle plates and shell is blocked by the sealers, which effectively decreases the short-circuit flow in the shell-side. The results of heat transfer experiments show that the shell-side heat transfer coefficient of the improved heat exchanger increased by 18.2–25.5%, the overall coefficient of heat transfer increased by 15.6–19.7%, and the exergy efficiency increased by 12.9–14.1%. Pressure losses increased by 44.6–48.8% with the sealer installation, but the increment of required pump power can be neglected compared with the increment of heat flux. The heat transfer

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performance of the improved heat exchanger is intensified, which is an obvious benefit to the optimizing of heat exchanger design for energy conservation

III. CONCLUSION

The current study covers some of the important factors affecting the performance of STHE, and then the analysis of baffles at different orientation angles is done. It was evident from the analysis that providing orientation to the segmented baffles give better results than the baffle having 0° orientation angle due to better heat transfer performance, less fouling and less pressure drop. The effectiveness of the heat exchangers with sealers is higher than that of the heat exchanger having no such arrangement

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