A Review on Investigation of Shell and Tube Heat Exchanger For Different Parameter

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Abstract - *A heat exchanger is a device that is used to transfer thermal energy (enthalpy) between two or more fluids, at different temperatures and in thermal contact The tube diameter, tube length, shell types etc. are all standardized and are available only in certain sizes and geometry. And so the design of a shell-and-tube heat exchanger usually involves a trial and error procedure where for a certain combination of the design variables the heat transfer area is calculated and then another combination is tried to check if there is any possibility of reducing the heat transfer area. A primary objective is the estimation of the minimum heat transfer area required for a given heat duty. Some experts studied on the design, performance analysis and simulation studies on heat exchangers. Modeling is a representation of physical or chemical process by a set of mathematical relationships that adequately describe the significant process behavior. These models are often used for Process design, Safety system analysis and Process control. A steady state model for the outlet temperature of both the cold and hot fluid of a shell and tube heat exchanger will be developed and simulated, which will be verified with the experiments conducted. And various models developed according to the change in physical parameters & results are obtained. These models were developed using latest computers tools like ANSYS, Fluent, and MATLAB etc.. The obtained results were also evaluated by comparing the same with the industrial operating exchanger and found satisfactory*

***Key Words*: Shell and Tube Heat Exchanger (STHE), Flow behaviour, Computational Fluid Dynamic (CFD)**

1.INTRODUCTION

Heat exchanger is device use for the transfer of heat between two fluids that are at different temperature with or without contact each other. Heat exchanger has variety of type such as that recuperator, regenerator, tube, plat etc.

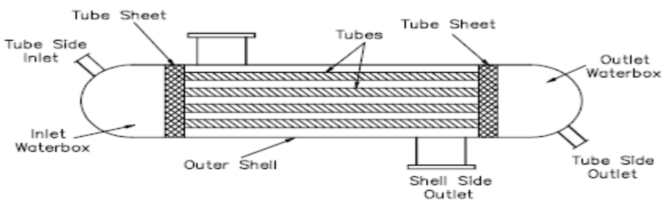

Fig-1: shell and tube heat exchanger [5]

A shell and tube heat exchanger (STHE) is the very common type of heat exchanger. It better type of heat exchanger used in oil corporation and other biggest chemical processes. It is sufficient condition for high pressure and temperature. Their name mentions that type of heat exchanger include shell (large pressure vessel) with bunch of tube inside shell. One fluid flow through tubes and another fluids flow around the tube (through the shell) to transmission heat between fluids. The set of tubes is called tube bundle, and various type of tube: plain, helical, longitudinally, finned. This type of heat exchanger have larger ratio of heat transfer surface area to volume. They are easy to produce in high range of size and flow. Another important part baffle during process and help to prevent vibration. Second it's providing flow path of shell fluid for effective velocity and flow.

2. LITRETURE REVIEW

The main purpose of researches are modified and improve STHE for reducing pressure drop, pumping cost and fouling with maximize heat transfer coefficient, heat transfer rate, performance and effectiveness.

2.1 Design modify with different tube geometry

N.Jamshidi work for intensify the heat transfer rate in STHE experimentally. The heat transmitted coefficient calculated by Wilson plot method. Taguchi method was use for determine the most favourable parameter such as pitch, diameter of tube, mass flow rate of fluid. The best result for heat transfer rate obtained by large coil diameter, coil pitch and suitable condition by nusselt number [11]. S.Rozzi is use STHE in Food Corporation. He is considering convective heat and friction loss in modify helical tube experiment with Newtonian and non Newtonian fluids. The results show that in higher heating than cooling at higher Reynolds number [19]. R.Hosseini conduct experimental work with three tube (smooth, corrugated and with micro fins) compare with theoretical data. The result obtained with Nusselt, Euler, Reynolds and Prandtl number. Here vary the number the performance of STHE changed over three tubes. We show that micro fin give higher performance than other tube at higher product of Reynolds and Prandtl number. Here experimental work result near the theoretical work at higher Reynolds number [15].Vindhya conduct investigation with various flow condition, insulations, turbulence to determine effect of each. She is determine various insulation effect on heat transfer rate. It's conduct thermal analysis with various loads. Find the effectiveness by software and compare with kern method. Insulation is good for increase heat rate at below the critical thickness [20].

2.2 Design modify with different arrangement of baffle

Bin Gao do same investigation with discontinues helical baffle such as 8º, 12º, 20º, 30º, 40º on energy loss of heat transfer. Here same result as Luhong investigate heat transfer coefficient and pressure drop smaller angle higher than bigger angle. The heat exchangers with helical angle are better in with lower limit of Reynolds number. Here we show the 40º helical baffle are better performance with different five angles. Here also related investigate entropy generation and irreversibility with second law of thermal [4]. Wen Quan Tao experiment conduct with muddle over lapped helical baffle. Here he take 5 different set take as 20º, 30º, 40º, 50º. Here we show the 40º helix baffle give best performance [21]. Luhong Zhang investigates related to baffle angle effects shell side heat transfer coefficient and pressure drop. His conduct pilot experiment with one normal baffle and three helical baffle (helical angle of baffle 7º, 13º and 25º). Apart from small helical angle (here 7º, the shell side coefficients per unit pressure drop for other baffle arrangement space require more than simple baffle. The heat transfer coefficient decrease with increase angle at same condition in shown below chart 1[8]

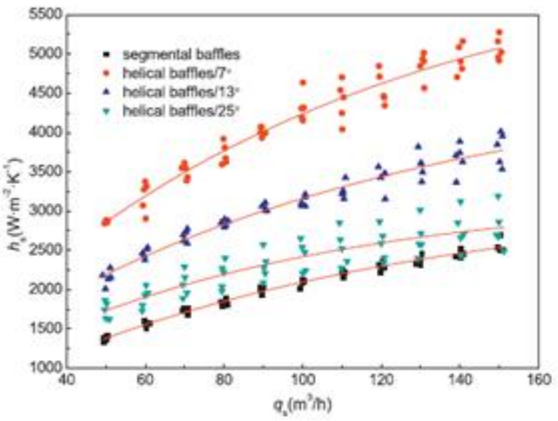

Chart-1: Heat transfer coefficient with volume rate for different baffle helix angle. [8]

2.3 Reduce the leakage flow

Jian investigate how to reduce leakage flow and increase the effectiveness of STHE. The modified conformation of ladder type baffle was expected to block triangular leakage area. Here result show that improve the shell heat transfer coefficient, overall heat transfer coefficient, thermal performance factor but pressure drop also increase so the pump power also increase. Here only use two helical baffles for increase heat transfer with easily location and installation [7]. Simin Wang is describing the gap and shell side. He is blocked the gap by the sealer which effectively decrease short circuit flow in the shell side. The heat transfer coefficient increased so heat transfer increase with pressure drop increase but the pressure drop effect neglected over the heat transfer. The energy analysis by irreversibility second law of thermal analysis useful determines energy conversion. The sealers are cheap, safe and long time operation [18].

2.4 Comparisons between fluids

Digvendra singh find that new heat exchanger methanol is batter cooling than water. He also determine the location of nozzle for optimize condition [6] Vinay carry out experimental stand on concentration of water based Al2O3 as nano fluid effect on shell and tube side characteristics. In the experiment various concentration of Al2O3 with different flow rate. Overall heat transfer coefficient increase with increase of nano particle. The optimize condition with concentration of nano particle with different mass flow rate [1].

2.5 Solution with different Software and Method

Priyanka M Javhar made excel programme developed for easily calculated and instant result for changing different objective characteristics. She is focus on main parameter such as baffle spacing and tube metallurgy and their effects on heat transfer rate. She designs of STHE with kern method. The result determine for optimize result require less baffle space, more passes and metallurgy with preferable pressure drop for less cost [13]. B.Parikshit was determining pressure drop on shell side use of Finite Element Method. He was take various baffle cut and tube arrangement with different angle. Here found that minimum baffle cut was higher performance than other and tube at 60º was higher performance than other. The advantage of this method to determine the pressure drop at any point was not possible in experimental [5]. Shweta find the pressure drop with experiment and compare with Bell, Kern and Bell Delaware method. The result show the bell Delaware method was close to experiment and realistic. The result compare based on heat transfer coefficient and pressure drop with mass flow rate [17]. Sandeep describe the shell and tube heat exchanger which liquid-liquid type of heat exchanger with help of HTRI software. The method is use for optimize design of heat exchanger at less cost [16]. T Kandasan experiment was stand on different cold fluid at different mass flow rate. The outlet condition for made programme and simulate with mat lab [10]. B Chandra sekhar was use the C programme for thermal analysis of STHE [3].

2.6 Flow visualization software

Mohamad describing the use of computational method for improving operation and their outlet for research in industry for reduction cost. The use three meshing method (coarse, medium, fine) for analyse of STHE. In a turbulence model various profile as temperature, velocity and pressure are visualized with different condition [9]. Prasanna j CFD analyses carry out with varies baffle space; vary the baffle cut in a various flow condition. In a small number of baffle visualization not well due to limitation of software. The use kern and bell method to predict the same characteristics for a validation. Here we show that baffle spacing was not improving result compare with baffle cut [12]. Rajagapal use the CFX for analysis of helical baffle STHE at different helix angle. Here we show that maximum baffle helix angle 20º. When we increase baffle angle is not well for tube support. Here we show that our time and cost is reduce with use of CFX software [14]. Avnish CFD analysis carried out with two baffle cut values, baffle spacing to shell diameter ratio effect on heat exchanger with various flow rates. The simulation results are validating by kern and bell Delaware method. The shell side of heat exchanger is sufficient data for flow and temperature field [2].

3. CONCLUSIONS

In general, the researchers give different methods and strategies for thermal designing of shell and tube heat exchanger and develop CFD models for entire heat exchanger. Many of the researchers also done work for that model for to obtaining good required result. They have carried out on CFD analysis for entire whole heat exchanger by applying inlet and outlet condition with help of technical specification. Then finally result is obtain and show with comparison about analysis result and theoretical result for different parameters.

Researchers outlined a systematic approach to designing and evaluating a thermal design of shell and tube heat exchanger calculation with help of specification and correlations. Some researchers have developed a mathematical model and do analysis for understanding the effect of inlet - outlet condition and other specification results.But most of the researchers have been research on entire heat exchanger and some desire quantity. All are focus on the entire heat exchanger and do further design analysis by software but no one has focus on different detail tube geometry pattern and data with comparison which is useful for to get comparatively result and differentiate between them with help of analysis software. For to obtain good performance of heat exchanger. We can see that, all the researchers have been use and develop the different thermal design correlation for to obtain result for each parameter and also done case study for parts; no one has focus on of different tube pattern geometry for to obtaining comparatively result for heat transfer rate , heat transfer area, efficiency, effectiveness, pressure drop and cost. As per review of research papers, we can see that no one has focus on different tube pattern geometry like triangular tube pattern, rotated square tube pattern , rotated triangular tube pattern , square tube pattern .this four tube pattern geometry have different advantage and disadvantage. After study of many research papers, it should be prove that modify design of entire heat exchanger get different result which is also used for our main aim for to increase heat transfer rate by increasing area.

REFERENCES

[1]Arunachala U.C, Ambuj B., Eklavyas, Vinay J.R "Performance investigation of shell and tube heat exchanger water based Al2O3 as nano fluid" 4th world conference Applied Science, Engineering Technology October 2015.
[2]Avnish D Jadhav, Tushar A Koli "CFD analysis of shell and tube heat exchanger the effect of baffle cut on pressure drop" International Journal Of Research Aeronautical and Mechanical Engineering. Vol.2 Issue.7, July 2014.pgs:1-7.
[3]B. Chandra, Sekhar D. KrIshnaiah, F. Anand Raju "Thermal analysis of multi tube pass shell and tube heat exchanger. International Journal of Innovative Research in science engineering and technology vol.3, Issue 11, November 2014
[4]Bin Gao, Qincheng Bi, Zesen Nie, Jiangbo Wu "Experimental study of effect of baffle helix angle on shell side performance of shell and tube heat exchanger with discontinue helical baffle" Experimental Thermal and Fluid Science 68(2015) 48-57 Elsevier.
[5]B.Parikshit, K.R Spandana, V. Krishna, T.R.Seetharam, K.N.Seetharamu "A simple method to calculate shell side fluid pressure drop in a shell and tube heat exchanger" International Journal Of Heat and Mass Transfer 84(22015) 700-712 Elesevier.
[6]Digvendra Singh, Narayan Das Pal "Design and performance evaluation of shell and tube heat exchanger using ansys" International Journal Of Scientific Engineering and Applied Science –volume-2 Issue-3 March 2016.
[7]Jian Wen, Huizhu Yang, Simin Wang, Yulan Xue , Xin Tong "Experimental investigation on performance comparison for shell and tube heat exchanger with different baffle" International Journal of Heat and Mass Transfer 84(2015) 990-997.Elsevier.
[8]Luhong Zhang, Youmei Xia, Bin Jiang, Xiaoming Xiao,Xiaoling Yang "Pilot experimental study on shell and tube heat exchanger with small angle helical baffle" Chemical Engineering and Processing 69(2013) 112-118.Elsevier.
[9]Mohammad Reza Saffarian, Tooraj Yousefi, Mostafa Keshavarze Moraveji "Numerical analysis of shell and tube heat exchanger with simple baffle by cfd" Indian J.Sci. Res. 7(1):1334-1345, 2014
[10]M.Thirumarimurgan, T.kannadasan, E.Ramasamy "Performance analysis of shell and tube heat exchanger using miscible system" American Journal of Applied Science 5(5);548-552,2008.
[11]N.Jamshidi,M.Farhadi,D.D, Ganji, K. Sedighi "Experiment analysis of heat transfer enhancement in shell and helical tube heat exchanger" Applied Thermal Engineering 51(2013) 644-652.
[12]Prasana. J, H.R. Purushothama, Devaraj K, Murugesham "A numerical analysis of hydrodynamics and heat transfer effect of shell and tube heat exchanger for different baffle space and cut" Prasanna. J. Et al/Mechanica Confab vol.2, No. 4, June-July 2013
[13]Durgesg Bhatt, Priyanka M Javhar "Shell and tube heat exchanger performance analysis" International Journal of Science and Research ISSN(2012) 2319-7064

[14]Rajagapal Thundil Raj, Srikanth Ganne "Shell side numerical analysis of a shell and tube heat exchanger considering the effect of baffle inclination angle of fluid flow" Thermal Science:2012 vol.16 pp.1165-1174.
[15]R.Hosseini, A Hosseini-Ghaffar, M Soltani "Experimental determination of shell side heat transfer coefficient and pressure drop for an oil cooler shell and tube heat exchanger with three different tube bundles" Applied Thermal Engineering 27 (2007) 1001-1008.Elsevier.
[16]Sandeep K. Patel, Alkesh M Mavani "Shell and tube heat exchanger thermal design with optimization of mass flow rate and baffle spacing" International Journal Of Advance Engineering Research and studies E-ISSN 2249-8974
[17]Shweta Y Kulkarni, Jagadish S B, Manjunath M B "Analysis comparing performance of a conventional shell and tube heat exchanger using kern,bell and bell delware method" International Journal of Research in Engineering and Technology. eISSN: 2319-1163/pISSN 2321-7308.
[18]Simin Wang, Jian Wen, Yanzhong Li "An experimental investigation of heat transfer enhancement for a shell and tube heat exchanger" Applied Thermal Engineering 29(2009) 2433-2438
[19]S.Rozzi, R. Massini, G Paciello, G.Pagliarini, S Rainieri, A. Trifiro "Heat treatment of fluid food in shell and tube heat exchanger: comparision between smooth and helically corrugated wall tubes" Journal of Food Engineering 79(2007) 249-254.
[20]Vindhya, Raj, Piyush, A.K.Srivastava "Performance analysis of shell and tube type heat exchanger under the effect of varid operating condition" IOSR Journal of Mechanical and Civil Engineering Volume 11, Issue 3 Ver.VI (May-Jun. 2014) PP 08-17.
[21]Wen Tao,Jian-Fei Zhang, Bin Li, Wen Jiang Huang, Yong Gang, "Experimental performance comparison of heat exchanger with middle overleaped helical baffle" Chemical Engineering Science 64(2009) 1643-1653.