A Practical Attempt to Improve Performance of Heat Exchanger

Kaushik Parmar
UG Student
Department of Mechanical Engineering
VIER, Vadodara

Osama Gora
UG Student
Department of Mechanical Engineering
VIER, Vadodara

Kashyap Desai
UG Student
Department of Mechanical Engineering
VIER, Vadodara

Nirajkumar C Mehta
Assistant Professor
Department of Mechanical Engineering
VIER, Vadodara

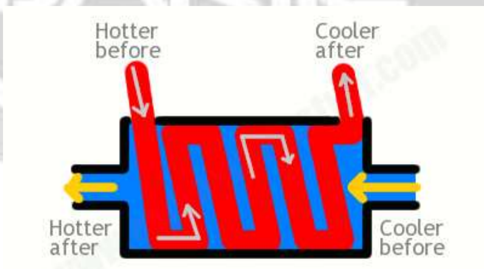
ABSTRACT

Heat Exchanger is a device used intensively for heat transfer form fluid. Thus all various type of heat exchanger .Our concentration is on shell and tube type heat exchanger .We will design the heat exchanger by bell delware method to increase heat transfer by using various material and geometries. Shell-and-tube heat exchangers are widely used in many industrial areas, and more than 35–40% of heat exchangers are of this type due to their robust geometry construction, easy maintenance, and possible upgrades.

Keyword: - *Heat exchanger , shell and tube , design, Fabrication, Performance.*

1. INTRODUCTION

Heat exchangers are devices that provide the transfer of thermal energy between two or more fluids at different temperatures. Shell and tube heat exchangers are the most versatile type of heat exchangers. They are used in the process industries, in conventional and nuclear power stations and they are proposed for many alternative energy applications. The enhancement in heat transfer rate between two or more fluids in heat exchanger is mainly achieved by optimizing the design of heat exchanger and operational parameters.



Optimizing the operational parameters play a key role in the enhancement of heat transfer rate after the design of heat exchanger. The transfer of heat to and from process fluids is an essential part of most chemical processes. The most commonly used type of heat-transfer equipment is the ubiquitous shell and tube heat exchanger; the design of which is the main subject of this report. The word “exchanger” really applies to all types of equipment in which heat is exchanged but is often used specifically to denote equipment in which heat is exchanged between two process streams. Exchangers in which a process fluid is heated or cooled by a plant service stream are referred to as heaters and coolers. If the process stream is vaporized the exchanger is called a vaporizer if the stream is essentially completely vaporized; a reboiler if associated with a distillation column; and an evaporator if used to concentrate a solution. The term fired exchanger is used for exchangers heated by combustion gases, such as boilers, other exchangers are referred to as "unfired exchangers".

1.1 Aim and Objectives

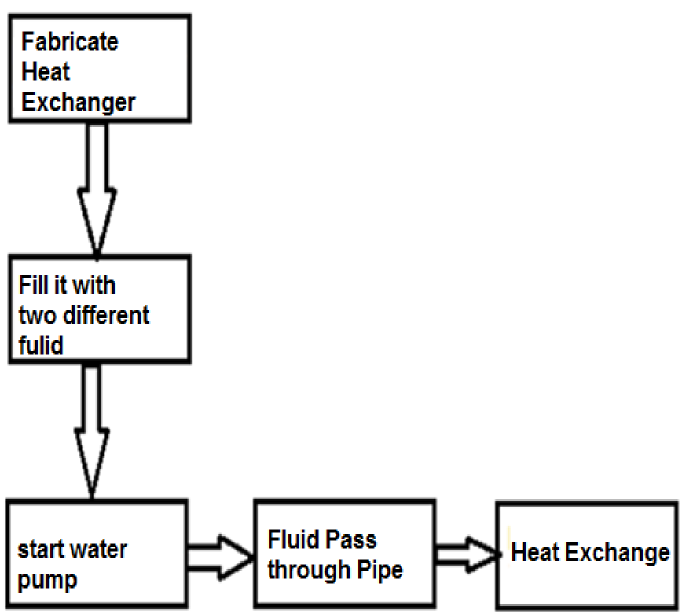
The main objective of this project helps in providing an alternative solution to the existing problem in Hear exchanger with bell Delaware's method, which improve efficiency. The transfer of heat to and from process fluids is an essential part of most of the chemical processes. Therefore, heat exchangers are used extensively and regularly in process and allied industries and are very important during design and operation. The most commonly used type of HE is the shell and tube heat exchanger. In the present study, a comparative analysis of a water to water Shell & Tube HE wherein, hot water flows inside the tubes and cold water inside the shell is made, to study and analyze the heat transfer coefficient and pressure drops for different mass flow rates and inlet and outlet temperatures Bell Delaware methods.

Main Objectives are:

- Design the heat exchanger on bell Delaware's method.
- set position for various components
- Set dimensions for various components
- Calculate the Heat Transfer

1.2 Working Principle

A shell and tube heat exchanger is a class of heat exchanger designs. It is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications. As its name implies, this type of heat exchanger consists of a with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes to transfer heat between the two fluids. The set of tubes is called a tube bundle, and may be composed of several types of tubes. Two fluids, of different starting temperatures, flow through the heat exchanger. One flows through the tubes and the other flows outside the tubes but inside the shell . Heat is transferred from one fluid to the other through the tube walls, either from tube side to shell side or vice versa. The fluids can be either liquids or gases on either the shell or the tube side. In order to transfer heat efficiently, a large heat transfer area should be used, leading to the use of many tubes. In this way, waste heat can be put to use. This is an efficient way to conserve energy.



Heat exchangers with only one phase on each side can be called one-phase or single-phase heat exchangers. As we start pump water with start flowing through shell and another fluid which need to be cooled flow in to pipe, as a result heat transfer with each other.

2. LITERATURE REVIEW BASED ON RESEARCH PAPER

1. Ahmerrais khan and sarfaraz khan focus on the various researches on Computational Fluid Dynamics (CFD) analysis in the field of heat exchanger. It has been found that CFD has been employed for the various areas of study in various types of heat exchanges Different turbulence models available in general purpose commercial CFD tools i.e. standard, realizable and RNG k −ε RSM, and SST k −ε in conjunction with velocity-pressure coupling schemes such as SIMPLE, SIMPLEC, PISO and etc. have been adopted to carry out the simulations. The quality of the solutions obtained from these simulations are largely within the acceptable range proving that CFD is an effective tool for predicting the behavior and performance of a wide variety of heat exchangers.

2. Philippe Wildi-Tremblay in his paper explains the procedure for minimizing the cost of a shell-and-tube heat exchanger based on genetic algorithms (GA). The global cost includes the operating cost (pumping power) and the initial cost expressed
3. in terms of annuities. He took some geometrical parameters of the shell-and-tube heat exchanger as the design variables and the genetic algorithm is applied to solve the associated optimization problem. It is shown that for the case that the heat duty is given, not only can the optimization design increase the heat exchanger effectiveness significantly, but also decrease the pumping power dramatically.

4. SiminWangJianWenYanzhong Li in his paper shows that 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 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 performance of the improved heat exchanger is intensified, which is an obvious benefit to the optimizing of heat exchanger design for energy conservation.

5. A.Pignotti in his paper established relationship between the effectiveness of two heat exchanger configurations which differ from each other in the inversion of either one of two fluids. This paper provides the way by which if the effectiveness of one combination is known in terms of heat capacity rate ratio and NTUs then the effectiveness of the other combination can be readily known.

6. V.K. Patel and R.V. Rao explores the use of a non-traditional optimization technique; called particle swarm optimization (PSO), for design optimization of shell-and-tube heat exchangers from economic view point. Minimization of total annual cost is considered as an objective function. Three design variables such as shell internal diameter, outer tube diameter and baffle spacing are considered for optimization. Two tube layouts viz. triangle and Square are also considered for optimization. Four different case studies are presented to demonstrate the effectiveness and accuracy of proposed algorithm. The results of optimization using PSO technique are compared with those obtained by using genetic algorithm (GA).

7. W.J.Marner, A.E.Bergles and J.M. Chenoweth studied the tubular enhanced surfaces used in shell-and-tube heat exchangers. As an initial step, the subject is limited to single-phase pressure drop and heat transfer; however, both tube side and shell side flows are taken into consideration. A comprehensive list of commercial augmented tubes which may be considered for use in shell-and-tube exchangers is given, along with a survey of the performance data which are available in the literature. They discussed the standardized data format which uses the inside and outside envelope diameters as the basis for presenting the various geometrical, flow, and heat transfer parameters for all tubular enhanced surfaces.

8. G.N. Xie, Q.W. Wang , M. Zeng, L.Q. Luo carried out an experimental system for investigation on performance of shell-and-tube heat exchangers, and limited experimental data is obtained. The ANN is applied to predict temperature differences and heat transfer rate for heat exchangers. BP algorithm is used

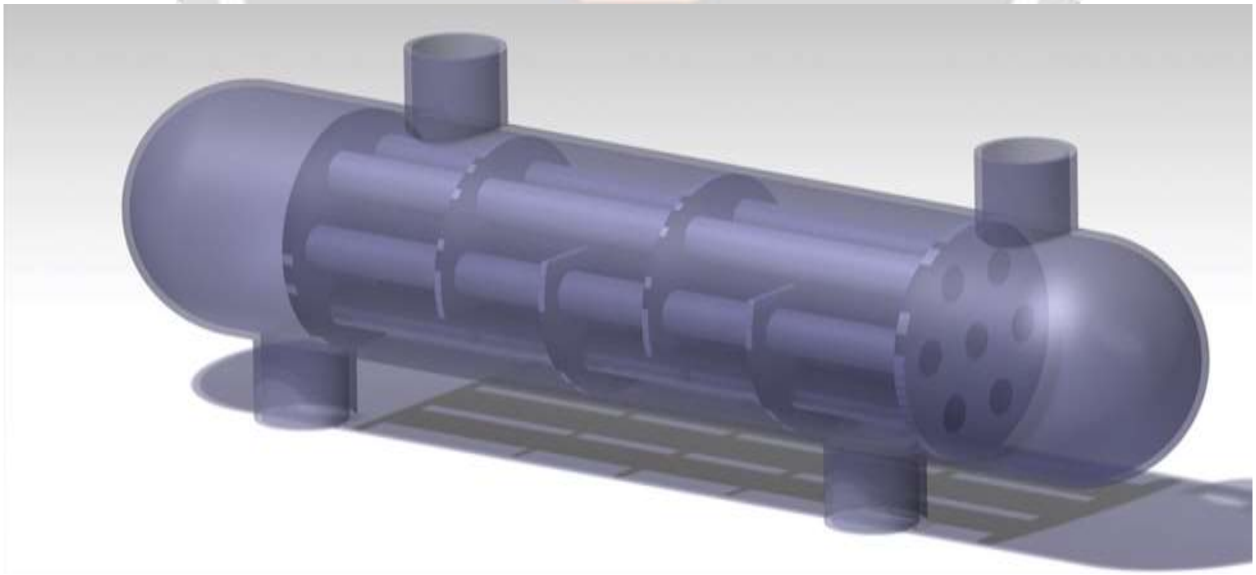
to train and test the network. It is shown that the predicted results are close to experimental data by ANN approach.

3. DESCRIPTION

3.1 Components selected for the project has the following specifications

- Shell diameter (ds) 0.2m
- Tube inside diameter (di) 0.016m
- Tube outside diameter (do) 0.01924m
- Pitch (pt) 0.03m
- Length of shell (ls) 0.8m
- Length of tube (lt) 0.825m
- Length of baffle (lb) 0.2m
- Number of baffles (nb) 4
- Number of tubes (nt) 18
- Number of shell passes (ns) 1
- Number of tube passes (nt) 2
- Clearance (c) 0.01076m
- Bundle to shell diametrical clearance (δb) 0.028m
- Shell to baffle diametrical clearance (δsb) 0.0254m
- Tube to baffle diametrical clearance (δtb) 0.0005m
- Mass flow rate 0.035 kg/s
- Shell: Temperature At inlet 30.6
- Shell: Temperature At outlet 33.5
- Tube: Temperature At inlet 54.4
- Tube: Temperature At outlet 34.6Refrigerant used: R-134a

3.2 Design of model



3.3 Experimental Procedure

1.Choose the type of heat exchanger(Co-current or Counter-current) in the experimental section.Enter the left side button to start the concurrent flow and enter right side button to start the countercurrent flow heat exchanger experiment.

2.Enter the tube inlet temperature to any value within the range of 0 to 100°C.

3.Enter the shell inlet temperature to any value within the range of 0 to 100°C.

4.Enter the flow rate of shell and tube should be from (0.00001 to 0.0001 m3/sec)

5.Click the Ok button and clickStart button to start the experiment.

6.Note down the temperature at four axial locations of the the heat exchanger at a time interval of one minute from the table at the bottom of the heat exchangers.

7.Plot the final tube and shell side temperature as a function of axial length of the heat exchanger.

8.Enter the new tube inlet temperature or the new shell inlet temperature.

9.Click the Input button and click Start button to start the experiment.

10.Plot the evoluation of temperature profile at the shell and tube side along the length of the heat exchanger.

11.Click The Start New button to start the experiment again.

12.Calculate the Time Constant

4. CONCLUSIONS

The shell and tube heat exchanger is analyzed using Bell Delaware methods and heat transfer coeffient, Reynold's number, pressure drops are calculated. Also the shell side pressure increase rapidly with increasing flow rate and this increase is again more in Bell Delaware method as compared to others. Since in a baffled heat exchanger, there is a obstruction to flow, drop in the pressure is definitely more when compared to the heat exchanger without baffles.

5. REFERENCES

[1] D. Q. Kern, "Process Heat Transfer", McGraw-Hill Book Company, Int. ed. 1965.

[2] V.K. Patel, R.V. Rao, "Design optimization of shell and tube heat exchanger using particle swarm optimization technique", Applied Thermal Engineering 30 (2010) 1417-1425.

[3] Hari Haran, Ravindra Reddy and Sreehari, "Thermal Analysis of Shell and Tube Heat ExChanger Using C and Ansys" , International Journal of Computer Trends and Technology (IJCTT) – volume 4 Issue 7–July 2013.

[4] A. Pignotti, "Relation Between the Thermal Effectiveness of Overall Parallel and Counter flow Heat Exchanger Geometries", J. Heat Transfer 111(2), 294-299 (May 01, 1989), asme.org.

[5] Indian Standard (IS: 4503-1967): Specification for Shell and Tube Type Heat Exchangers, BIS 2007, New Delhi.

[6] Wolverine Tube Heat Transfer Data Book.

[7] Dutta B.K. "Heat Transfer-Principles and Applications", PHI Pvt. Ltd., New Delhi, 1st ed. 2006. Vindhya Vasiny Prasad Dubey, Raj RajatVerma, PiyushShankerVerma, A. K. Srivastava, "Steady State Thermal.

[8] Analysis of Shell and Tube Type Heat Exchanger To Demonstrate The Heat Transfer Capabilities Of Various Thermal Materials Using Ansys", Global Journals Inc., GJRE Volume 14, Issue 4, ISSN- 09755861.