# OVERVIEW OF DESIGN OF SHELL AND TUBE TYPE HEAT EXCHANGER USING DIFFERENT METHODS

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*Abstract:* The present paper gives brief information about concept of  Heat Exchanger design by various methods. Shell and Tube heat exchangers are commonly used as oil coolers, power condensers, pre heaters and steam generators in various industrial application. Currently wide research work is going on in developing compact shell and tube heat exchangers having high Effectiveness. Effectiveness of heat exchangers mainly depends on overall heat transfer coefficient which is function of fluid properties, velocity of flow, surface area, Reynolds number etc. The heat exchanger industries have been striving for improved thermal contact and reduced pumping power in order to improve thermo hydraulic efficiency of heat exchanger. Hence heat exchanger design is a challenging work for engineers working in the field of  Heat transfer. Now a days, Two methods are used for Heat exchanger design purpose, namely Effectiveness-NTU method and LMTD method. In this paper, there is brief review of work carried out by varies researchers in the respective field.

## Introduction:

A heat exchanger is a device that is used to transfer thermal energy (enthalpy) between two or more fluids, between a solid surface and a fluid, or between solid particulates and a fluid, at different temperatures and in thermal contact. A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by a solid wall, so that they never mix, or they may be in direct contact. A Shell and Tube type heat exchangers are commonly used in high pressure applications, oil refineries and large scale chemical processes. They are also widely used in process applications and in the air conditioning and refrigeration industries. These Heat exchangers involves either parallel or counter flow. Also a heat exchanger utilizes the fact that, where ever there is a temperature difference, flow of energy occurs.

In many heat exchangers, the fluids are separated by a heat transfer surface, and ideally they do not mix or leak. Such exchangers are referred to as direct transfer type, or simply recuperators. In contrast, exchangers in which there is intermittent heat exchange between the hot and cold fluids—via thermal energy storage and release through the exchanger surface or matrix are referred to as indirect transfer type, or simply regenerators. Such exchangers usually have fluid leakage from one fluid stream to the other, due to pressure differences and matrix rotation/valve switching.

The basic concept of a heat exchanger is based on the premise that the loss of heat on the high temperature side is exactly the same as the heat gained in the low temperature side after the heat and mass flows through the heat exchanger. Heat exchangers work because heat naturally flows from higher temperature to lower temperatures. Therefore if a hot fluid and a cold fluid are separated by a heat conducting surface heat can be transferred from the hot fluid to the cold fluid. Two fluids of different temperatures are brought

into close contact but are prevented from mixing by a physical barrier. The temperature of the two fluids will tend to equalize. By arranging counter-current flow it is possible for the temperature at the outlet of each fluid to approach the temperature at the inlet of the other.

**Literature Review:**

Various quantitative design aspects, their interaction and interdependence are important to arrive at an optimum heat exchanger design. Most of these considerations are dependent on each other and should be considered simultaneously to arrive iteratively at the optimum exchanger design.

The summery of previous work carried out by various researcher is as given below:

**Arsenyeva Olga, Leonid Tovazhnyansky[1]** has focused the procedure and software for numerical experiment to identify heat exchanger model parameters. It was done by using methodology of comparison between the calculated results and the existing results from computer programs of plate type heat exchanger. Also they compared obtained results with the results obtained by Alfa Laval software.

**Andre L.H. Costa, Eduardo M. Queiroz [2]** has studied about the design optimization of shell-and-tube heat exchangers. They said that the formulated problem consists of the minimization of the thermal surface area for a certain service, involving discrete decision variables. Additional constraints represent geometrical features and velocity conditions which must be complied in order to reach a more realistic solution for the process task. The optimization algorithm is based on a search along the tube count table where the established constraints and the investigated design candidates are employed to eliminate non optimal alternatives, thus reducing the number of rating runs executed. The performance of the algorithm and its individual components are explored through two design examples. The obtained results by them illustrate the capacity of the proposed approach to direct the optimization towards more effective designs, considering important limitations usually ignored in the literature.

**Kapale Uday C., Satish Chand,[5]** has developed a theoretical model for shell-side pressure drop. The model incorporates the effect of pressure drop in inlet and outlet nozzles along with the losses in the segments created by baffles. The results of the model for Reynolds number lying between 103 and 105 match more closely with the experimental results for different configurations of heat exchangers.

**Kara Yusuf Ali, Ozbilen Guraras,[6]** has gives information about Computer codes for design are organized to vary systematically the exchanger parameters such as, shell diameter, baffle spacing, number of tube-side pass to identify configurations that satisfy the specified heat transfer and pressure drops. A computer-based design model was made for preliminary design of shell-and tube heat exchangers with single-phase fluid flow both on shell and tube side and optimum heat transfer surface area required meeting the specified heat transfer duty by calculating minimum or allowable shell-side pressure drop.

**Leong K. C., Toh K. C. [7]** have discussed through this paper a user friendly computer software developed for the thermal and hydraulic design of shell and tube heat exchangers based on the open literature Delaware method. The authors have decided to use Borland's latest programming environment. Its interactive graphics feature allows the selection of heat exchanger configurations and change of design conditions.

**Lona L.M.F., Fernandes F.A.N [8]** has presented a didactical software developed for the design of shell and tube heat exchanger and heat exchangers networks, this last one using Pinch analysis. The software called heat exchanger simulator (HES), was developed to be used in the undergraduate classes of Chemical Engineering. The shell and tube heat exchanger is equipment largely used at

chemical industries. The most known methods used for its design are the methods of Kern, Bell-Delaware and Tinker, for what a lot of equations are necessary. In this way, the calculation without using any computer aid takes a lot of time.

**Mane Vikas, Prof.J.S.Bagi,[9]** has describes how improvement in quality dimensions of Heat Exchangers takes place by using design software. The importance of Quality product and role of software to achieve better quality is explained here briefly. Heat exchanger design software provides detailed information for heat exchanger, including dimensions, weight.

**Su Thet Mon Than, Khin Aung Lin[11]** have discussed how to design heat exchanger especially for shell and tube heat exchanger. In design calculation, the Mat LAB and AutoCAD software were used. They focused on to present design calculations rather than to deal with the details of individual problems and special cases. In case study graphs of number of tubes Vs heat transfer coefficient, Tube length Vs Reynolds number were studied.

**Thome John R. [12]** has discussed the detailed procedure for heat exchanger design. In this book basic equations for heat exchanger designs are given. Also equations for overall heat transfer coefficient, equations for mean temperature difference are explained. Various graphs of Logarithmic Mean Temperature Difference (LMTD) for different shell passes are shown.

**Stephenraj.V, M.K.Sathishkumar [14]** discussed in the respective paper that  a heat exchanger transfers heat from one fluid to another which are at different temperatures. Heat exchangers are devices built for efficient heat transfer from one fluid to another and are widely used in engineering processes. The heat transfer efficiency depends on both design of heat exchanger and property of working fluid. In this project, the heat transfer efficiency is improved by implementing the full baffle design and travel tube design and analyzing it through CFD flow simulation to find the approximate heat transfer rates. From the simulation results the optimum baffle design and travel tube design for maximum heat transfer rate is identified. Also that project deals with find the suitable fluid for maximum heat transfer rate.

**Syed Yousufuddin [15]** carried out the study of the configuration of a shell-and tube heat exchanger to improve the purpose of heat transfer enhancement by considering the baffle spacing and baffle cut. The investigation in this paper was carried by manual calculations, and that performed for a single shell and two tubes passes heat exchanger, with variable number of baffles spacing and 25% baffle cut. General design considerations and design procedure that follows TEMA standard are also considered in this paper. Also, commercial HTRI Exchanger Suite software was also used for design drawing purposes.

**Remark on literature review:**

The above literature review gives the following research issues:

1. Majority of researches are based on design of plate type heat exchangers. Also the manual calculation for H.E. design  is a very difficult task and required more and more repeated iterations.

2. Many of the researchers have Mat LAB and AutoCAD based software provide the 2D drawing for the shell and tube heat exchangers. These outputs cannot be used for further activity such as Computer Integrated Manufacturing, CFD analysis, etc.

3.Researches based on for design and drafting of some heat exchangers, which gives only line diagram of the heat exchangers and does not give clear idea of detail drawing of heat exchanger.

4. There is no work reported based on software which provides the graphical representation of the effect of various parameters on the thermal performance of the heat exchanger such as number of baffles, tube diameters, mass flow rate, pressure drop etc.

**Conclusion and Future Scope:**

The heat exchanger design calculations are required with assumed data. Iterative procedure is used to correct the assumed data to optimum solution. But it requires lot of calculation work which is time consuming. Same time the drafting of heat exchanger drawing is another complicated task. The computer software will play important role to eliminate the problem of iterative calculations and 3D modeling of heat exchangers.

Many of the Mechanical industries have gone through the significant changes in last decade. Now revolution in industrial sector "Industry 4.0" wants the cloud base operating system.  Competition has increased dramatically. Customers focus on product quality, product delivery time and cost of product. Because of these, a company has to develop design and 3D modeling software to meet the requirement of the customers, Hence, to meet the requirement of automation in the field of heat exchanger design, the future scope is to  "Develop  a software to  design a Heat exchanger using LMTD and NTU method and it's 3D modeling". Design of heat exchanger by using software will save more time and better comparative results also.

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