Design and Fabrication of Shell and Tube Heat Exchanger

Subhansu Sharma[1] Sidharth Kumar[2] Sanjay Mishra[3] Subhash Mohan[4] Kuldeep Nerawat[5]
[1,2,3,4]Student [5]Assistant Professor
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]Galgotias University. Gr Noida, India

Abstract— In present day shell and tube heat exchanger is the most common type heat exchanger widely use in oil refinery and other large chemical process, because it suits high pressure application. The process in solving simulation consists of modeling and meshing the basic geometry of shell and tube heat exchanger using CFD package ANSYS 13.0. The objective of the project is design of shell and tube heat exchanger with helical baffle and study the flow and temperature field inside the shell using ANSYS software tools. The heat exchanger contains 7 tubes and 600 mm length shell diameter 90 mm. The helix angle of helical baffle will be varied from 00 to 200. In simulation will show how the pressure vary in shell due to different helix angle and flow rate. The flow pattern in the shell side of the heat exchanger with continuous helical baffles was forced to be rotational and helical due to the geometry of the continuous helical baffles, which results in a significant increase in heat transfer coefficient per unit pressure drop in the heat exchanger.

Keywords: Shell and Tube Heat Exchanger

I. INTRODUCTION

Heat exchangers are one of the mostly used equipment in the process industries. Heat exchangers are used to transfer heat between two process streams. One can realize their usage that any process which involve cooling, heating, condensation, boiling or evaporation will require a heat exchanger for these purposes. Process fluids, usually are heated or cooled before the process or undergo a phase change. Different heat exchangers are named according to their application. For example, heat exchangers being used to condense are known as condensers, similarly heat exchanger for boiling purposes are called boilers. Performance and efficiency of heat exchangers are measured through the amount of heat transfer using least area of heat transfer and pressure drop. A better presentation of its efficiency is done by calculating over all heat transfer coefficient. Pressure drop and area required for a certain amount of heat transfer, provides an insight about the capital cost and power requirements (Running cost) of a heat exchanger. Usually, there is lots of literature and theories to design a heat exchanger according to the requirements.

II. LITERATURE REVIEW

Vindhya Vasiny Prasad Dubey, Raj Rajat Verma: This paper is concerned with the study of shell & tube type heat exchangers along with its applications and also refers to several scholars who have given the contribution in this regard. Moreover the constructional details, design methods and the reasons for the wide acceptance of shell and tube type heat exchangers has been described in details inside the paper.M. M. El-Fawal, A. A. Fahmy and B. M.Taher:- In this paper a computer program for economical design of shell and tube heat exchanger using specified pressure drop is established to minimize the cost of the equipment. The design procedure depends on using the acceptable pressure drops in order to minimize the thermal surface area for a certain service, involving discrete decision variables. Also the proposed method takes into account several geometric and operational constraints typically recommended by design codes, and provides global optimum solutions as opposed to local optimum solutions that are typically obtained with many other optimization methods. M.Serna and A.Jimenez:-They have presented a compact formulation to relate the shell-side pressure drop with the exchanger area and the film coefficient based on the full Bell–Delaware method. In addition to the derivation of the shell side compact expression, they have developed a compact pressure drop equation for the tube-side stream, which accounts for both straight pressure drops and return losses. They have shown how the compact formulations can be used within an efficient design algorithm. They have found a satisfactory performance of the proposed algorithms over the entire geometry range of single phase, shell and tube heat exchangers.

III. EXPERIMENTAL SET UP

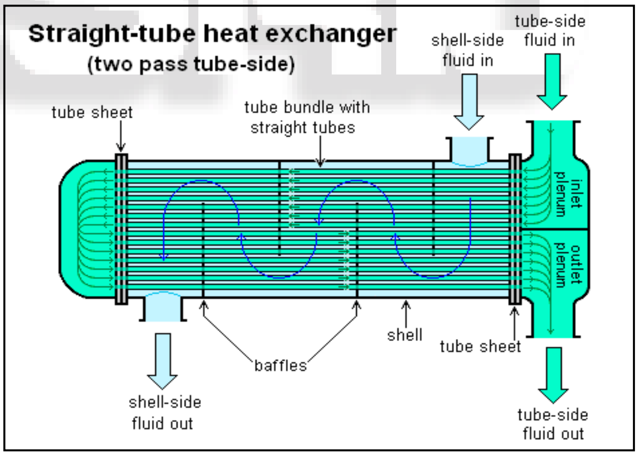

Fig. 1: straight tube heat exchanger (two pass tube)

IV. WORKING PRINCIPLE:

Two fluids, of different starting temperatures, flow through the heat exchanger. One flows through the tubes (the tube side) and the other flows outside the tubes but inside the shell (the shell side). 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 (liquid or gas) on each side can be called one-phase or single-phase heat exchangers. Two-phase heat exchangers can be used to heat a liquid to boil it into a gas (vapor), sometimes called boilers, or to cool the vapors and condense it into a liquid (called condensers), with the phase change usually occurring on the shell side. Boilers in steam engine locomotives are typically large, usually cylindrically-shaped shell-and-tube heat exchangers. In large power plants with steam-driven turbines, shell-and-tube surface condensers are used to condense the exhaust steam exiting the turbine into condensate water which is recycled back to be turned into steam in the steam generator.

V. INNOVATION

1) Using baffles spacing

These baffles are also used to increase the turbulence of the shell fluid. The tubes open to some large flow areas called header at both ends of the shell. These types of heat exchanger can accommodate a wide range of operating pressures and temperatures. They are easier to manufacture and are available at low costs. Both the tube and shell fluids are pumped into the heat exchanger and therefore heat transfer is by forced convection. Since the heat transfer coefficient is high with the liquid flow, there is no need to use fins. They can also be classified into parallel and counter flow types. Baffle spacing is the centerline to centerline between two adjacent baffle

1/5 of shell diameter thus, as baffle spacingis reduce, pressure drop increases at much faster rate than does the heat transfer coefficient.

A cfd simulation can be done for optimization of baffle spacing

VI. ADVANTAGES

– Size - STHEs are capable of providing a larger surface area for heat transfer to take place while having a shorter length overall due to presence of multiple tubes.
– Heat duty - STHEs can handle higher temperatures and pressures and hence higher heat duty. This is because besides providing a higher overall heat transfer coefficient, additions can also be made to negate thermal expansion effects and the thickness can also be varied (more in the next point)
– Versatility - from the design point of view, STHEs are the most versatile of all heat exchangers. Being tubular in shape, heads / closures of required shape and thickness can be used. The number of tubes and tube pitch can be selected according to operating conditions. Expansion bellows can be used to negate thermal expansion effects, baffles if different cuts and spacings can be used to influence the overall heat transfer coefficients and there's even something called a floating head which can be added to negate thermal expansion of the tubes. The number of passes on shell side and tube side can be altered as well.

VII. DEMERITS

1) Size - yes. This can also be a disadvantage as at lower heat duty, there are more compact heat exchangers such as plate type exchanger. Also, the absence of hairpin bends causes STHEs to take up more space than double pipe heat exchangers in some cases.
2) Maintenance - cleaning of tubes is difficult and fouling is always an issue when overall heat transfer coefficient is addressed. This requires periodic cleaning of the shell as well as the tubes. Cleaning tubes may be more difficult if the pitch is triangular.

VIII. APPLICATIONS

1) Power Generation
2) HVAC
3) Marine Applications
4) Pulp and Paper
5) Refrigeration
6) Pharmaceuticals
7) Air Processing and Compressor Cooling

IX. RESULT & DISCUSSION

In this paper, study of shell and tube heat exchanger has been done.how by using baffle spacing we can exchange heat flawlessly. we got to know about their advantages and disadvantages about its technology. How it is used to exchange heat. About its application. Where they are used and applied. What is the basic purpose of using shell and tube heat exchanger as a heat exchanger purpose?

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