ISSN XXXX XXXX © 2019 IJESC

Research Article Volume 9 Issue No.3

Heat Exchanger Testing Rig

Abdullah Fayyaz Ah[1], Faiz Azeem[2], Khan Mohd Aamir[3], Mohammed Faique[4], Saiyed Muhammed Jawwad[5], Prof. Shaikh Moin[6]
Department of Mechanical Engineering
Jiems, Akkalkuwa, Maharashtra, India

Abstract:
The project is to design and fabricate an Double pipe heat exchange to explain the process of exchange of heat between two fluids in the parallel and counter flow arrangement. This method can be used for extracting heat from steam and exhaust gases with some minor modifications. The heat exchanger are used in the form of heaters, coolers, condensers, reboilers, evaporators, cooling towers in power industry, radiators in the automobile industry and many others. The other aim of this project is to find the friction factor for the flow of fluid in the pipe. A pipe is a closed conduit used for carrying of fluids under pressure. The fluid flowing in a pipe is subjected to resistance due to shear forces between the fluid itself. As some energy possessed by the flowing fluid will be consumed in overcoming this frictional resistance, there will be always some loss of energy in direction of flow. So in order to estimate these losses due to friction, the friction factor is t be determined.

1. INTRODUCTION

Introduction: - The process of heat transfer has been known to mankind since ancient times. A basic example of heat transfer is heating of water in a vessel where through the layers heat is transferred from fire to water. Energy always flow from higher level towards low level. Thermal energy is no exception. This concept evolved into development of heating as well as cooling systems. This system has direct application in areas like refrigerator, preservation of food, recycling of thermal energy etc. *A. Metric using of advertising*: - In any advertising medium we have to analyze some following metric

1.1 HEAT EXCHANGER

As discussed earlier heat exchanger is a process equipment designed for efficient heat transfer between two fluids , a hot fluid and a coolant. The purpose may be either remove heat from the fluid or to add heat to fluid. The heat exchanger are used in the heater, coolers, condensers, evaporators, cooling towers, (in power industry radiators in automobile etc.)

1.2 CLASIFICATON O HEAT EXCHANGERS:-

There are several types of heat exchanger based on:

1. Operating principle
2. Arrangement of flow path
3. Design and certain constructional features.

Based on the nature of heat exchangers process, the heat exchangers are classified as

a. Direct contact
b. Regenerators
c. Remunerators

a) DIRECT CONTACT:
In the direct contact type, heat transfer takes place between two immiscible fluids or gas and liquid coming into direct contact, cooling towers, jet condensers for water vapor are typical example. In this type there is simultaneous transfer of heat and mass.

b) REGENERATOR OR STORAGE TYPE:-
In regenerator hot fluid is passed through a certain medium called matrix. The heat is transferred to solid matrix and gets collected. This heat is then transformed to cold fluid by allowing it to pass over the matrix. The fluid thus flow through the same space but alternately and so do not get mixed together. They are generally used with engines and gas turbines. Other example is regenerators of furnace and air heaters of blast furnace.

c) DIRECT TRANFER H.E. OR RECUPERATOR TYPE:-
Here the fluid simultaneously on the other side of the separating walls, the heat transfer between the fluid streams without mixing or physical contact with each other. They are used when two fluids cannot be allowed to mix. Examples are boilers, superheated, condensers, economizers, air preheaters in steam power plants, automobile radiators, etc.

Based on the direction of flow of fluids, the heat exchanger are classified as:

a. Parallel flow arrangement.
b. Counter flow arrangement.
c. Cross flow arrangement.
d. Mixed flow arrangement

We discussed earlier,

a) Parallel Flow Arrangement:
Here the fluid enters the unit from the same side and flows in the same direction and leaves from same side

b) Counter Flow Arrangement:
Here the two fluids enter from opposite ends, travel in opposite direction and leaves on opposite side.

c) Cross Flow Arrangement:
Here two fluids are directed at right angles to each other. They are employed in the gas heating and cooling applications e.g. Automobile radiators and cooling units of air conducting duct.

d) Mixed Flow Arrangement:
In order to make heat exchanger compact and to reduce the loss of heat several types of arrangement of the fluids in the tube arrangement are given in most of the cases. A mixed type of arrangement with parallel or counter flow is preferred for effective heat exchange, with reference to above heat exchanger wherein, all three (P.C.C.) types of flows are used.

2. LITERATURE SURVEY

Vindhya Vasiny Prasad Dubey, Raj Rajat Verma:[1]- This paper is worried about the examination of shell and cylinder type heat exchangers alongside its applications and furthermore alludes to a few researchers who have given the commitment in such manner. Additionally the constructional subtleties, structure strategies and the purposes behind the wide acknowledgment of shell and cylinder type heat exchangers has been depicted in subtleties inside the paper.

M. M. El-Fawal, A. A. Fahmy and B. M. Taher:[2]-
In this paper a PC program for efficient structure of shell and cylinder heat exchanger utilizing determined weight drop is set up to limit the expense of the gear. The structure method relies upon utilizing the satisfactory weight drops in request to limit the warm surface zone for a certain administration, including discrete choice factors. Likewise the proposed strategy takes into account a few geometric and operational limitations normally prescribed by plan codes, and gives worldwide ideal arrangements as restricted to nearby ideal arrangements that are ordinarily got with numerous other enhancement techniques.

M.Serna and A.Jimenez:[3]-They have displayed a reduced plan to relate the shell-side weight drop with the exchanger territory and the film coefficient dependent on the full Bell–Delaware technique. Notwithstanding the induction of the shell side reduced articulation, they have built up a reduced weight drop condition for the cylinder side stream, which represents both straight weight drops and return misfortunes. They have demonstrated how the reduced plans can be utilized inside an proficient plan calculation. They have discovered a agreeable execution of the propose.

3. METHODOLOGY

3.1 DESIGN CONSIDERATION:

Designing a heat exchanger following consideration is to be kept in mind
Thermal analysis
Mechanical design
Pressure drop character tics of fluid in two pipes
Design for manufacture
Physical cost and size.

Thermal analysis:
It is governed by the given flow rates and temperature of fluids and determine the heat transfer surface area, which is required to ensure heat transfer at specified rate. Thermal analysis is to be combined with pressure drop character tics and design for manufacture to achieve the required performance of the heat exchanger. The overall heat transfer coefficient can be much improved by making the fluids flow through the heat exchanger but the higher velocity would increase the pumping cost as the pressure drop will be larger. The overall heat transfer coefficient can be kept lower by increasing the surface area of heat exchanger as larger surface area will reduce the pressure drop. However the physical size can not be unnecessarily increased and the cost of the heat exchanger also has to be kept within economic limitations. Proper judgment and consideration of the above factors will result in optimal design.

Mechanical design:
The major consideration behind the mechanical design are as follows:
Operating temperature and pressure
Corrosive characteristics of the fluid
Thermal expansive quality of the liquid and resultant thermal stresses
The relation of the heat exchanger to other equipment.
Design for manufacture
The efficient design for manufacture involves fabrication of heat exchanger at minimum possible cost to yield the required physical character tics and dimensions. For this purpose, proper selection of material and component, their mechanical arrangement and adoption of proper manufacture and assembly procedure are important. It is also important that heat exchanger should meet their safety standards.

3.2 ASPECTS OF EXCHANGER DESIGN:

Design of an equipment is a compromise of various aspects of design factor. The optimum design is a combination of performance of the heat exchanger and the economy of the cost. The factors to be considered in designing a heat exchanger are as follows.
Fluid temperature
Flow rate
Pipe size and layout
Dirt factor and fouling character tics
Mechanical design consideration.

Fluid temperature:
Usually the temperature of the fluid stream at the inlet is specified, otherwise the outlet temperature should be fixed, based on the flow rates and requirements of heat transfer. The ratio rise or drop in fluid temperature to the maximum temperature difference between the two fluids is called as the effectiveness and it indicates the type of the flow path i.e. parallel or counter or cross flow. It is a surface area of the heat exchanger through which energy is transferred from hot fluid to cold fluid. However, while traversing their path through the exchanger, the temperature of two fluids will undergo changes and the Log Mean Temperature Difference is taken into account to compute the surface area required for transfer of the required amount of heat.

Flow rate:
The velocity of the fluid is controlled so as to avoid excessive pressure drop and problems like erosion, noise and vibration. Usually the maximum velocity is kept below 7.5 m/s. the restriction of flow rates governs cross- sectional area of passage for the respective fluid streams.

Pipe size and layout:
Heat transfer is governed by factors like pipe sizes, length, and thickness. The parameter may vary from 6 mm to 50 mm. The heat transfer from pipes of smaller size are difficult to clean. Pipe length is normally kept between 2 m to 7m. A light guage or heavy duty guage pipe is used depending upon the fluid pressure, corrosion and other consideration.

Dirt factor and fouling consideration:
Dirt accumulates in pipe and it adversely affects the heat transfer and changes the pressure drop. Proper allowance will have to be made for this factor, depending upon the nature and quality of the fluid. In case of deposits, larger tubes size may be necessary to facilitate mechanical cleaning. Similarly in case of chemical cleaning is required, the material of heat exchanger needs to be suitably withstand the corrosive effect of chemicals, if any and also of that fluid. Mechanical design consideration. Heat exchangers which are to be operated under low pressure and temperature i.e. up to 15 to 150 oC, do not require any design consideration for thermal stresses. The design consideration however becomes important at high

pressures and temperature as thermal stresses would be significant.

3.3 FOULING OF HEAT EXCHANERS:

Fouling is defined as the deposition of thermally insulating material on the heat transfer surface during the heat transfer process. In heat exchangers scaling and deposition results in a lower overall heat transfer coefficient in operation than that calculated for surface. An allowance is often made for fouling in operation than that calculated for surface. An allowance is often made for fouling in design by assigning fouling factor to which will become coated in use.

The fouling factor is equal to equivalent thermal resistance of the scale. So the fouling factor appears as thermal resistance terms in equation for overall heat transfer as given below:

$$\frac{1}{U_o} = \frac{1}{h_o} + \frac{A_o}{A_i} \times \frac{1}{h_i} + R_o + \frac{A_o}{A_i} \times R_{fi} \times R_{fo}$$

Where

U_o: Overall heat transfer coefficient on outside of tube

h_o & h_i : Heat transfer coefficient on outrer and inner sides of tube

R_{fi} & R_{fo} : Inside and outside fouling resistance

R_w = Tube thermal resistence

A_o & A_i : Outer and inner areas of heat transfer barries for circular tubes

1 = do-1+fi+L+fo+do log do

where,

fi & fo are inside and outsife fouling factors. The magnitude of fouling factor depends upon the nature of scale. If the scale uniform, the resistance is calculated by dividing the scale thickness by the thermal conductivity of scale material.

4. CONCLUSION

we can clearly see that , in both the flows (i.e. parallel flow as well as in counter flow) the temperature of hot water is progressively decreased. Whereas the temperature of cold water is progressively increased. This concludes that, heat is lost by hot water and that heat is gained by cold water. Friction factor in both the pipe is too low. So we can conclude that power loss in the pipes is very much less. From results, we can rightly conclude that the counter flow arrangement is more effective than parallel flow arrangement.

5. REFERENCE

[1].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

[2]. Yusuf Ali Kara, OzbilenGuraras, —A computer program for designing of shell and tube heat exchanger‖, Applied Thermal Engineering 24(2004) 1797-1805

[3].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

[4]. M. M. El-Fawal, A. A. Fahmy and B. M. Taher, "Modelling of Economical Design of Shell and tube heat exchanger Using Specified Pressure Drop", Journal of American Science

[5].JiangfengGuo, Lin Cheng, MingtianXu, "Optimization design of shell and tube heat exchanger by entropy generation minimization and genetic algorithm", Applied Thermal Engineering 29 (2009) 2954–2960.

[6].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.

[7]. Rajeev Mukharji, "Effective design of shell and tube heat exchanger", American Institute of Chemical Engineering, 1988.

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

[10].SepehrSanaye, Hassan Hajabdollahi, "Multi-objective optimization of shell and tube heat exchanger", Applied Thermal Engineering 30 (2010) 1937-1945.

[11]. Taborek, J., Evolution of heat exchanger design techniques, Heat Transfer Eng. 1, No. 1, 15-29 (1979

[12]. M. Thirumarimuegan, —Performance analysis of shell and tube type heat exchanger using Miscible system‖, American journal of applied science, 2008, 5(5): 548-552.al, V