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Experimental Analysis And Setup Of Gravity Assisted Shell And Tube Heat Exchanger

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Abstract— **Heat transfer is one of the most important thing to be considered in thermal industry. There are several type of heat exchangers available for heat transferring purposes. But scientists are involved in finding new methodologies which would further increase the heat transfer rate and the effectiveness of heat transfer by conducting several experiments. Many researchers have found the different methodologies for increasing the heat transfer rate with the application of various research. In this paper we have proposed a new methodology for the heat exchanger in various aspects. In this paper we have proposed a new concept which can be uses in shell and tube heat exchangers. Here we have considered the angle of the heat exchanger to know whether the heat transfer rate increases or decreases with increase in inclination angles of the exchanger. Here we have used the heat exchanger in various angles from 0` to 90` to find at which angle the heat transfer rate is maximum. The experimental analysis shows the heat transfer rate is maximum at 45` and it increases further with increase in the mass flow rate of both the fluids. In this proposal we used water as both hot and cold fluid with varying mass flow rates of the liquids.**

Index Terms— **Heat transfer, shell and tube , overall heat transfer co-efficient, effectiveness.**

I. INTRODUCTION

Heat Exchangers are devices used to enhance or facilitate the flow of heat. Every living thing is equipped in some way or another with heat exchangers. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, and sewage treatment. The most common type of heat exchanger in industrial applications is shell-and-tube heat exchangers. The exchangers exhibit more than 65% of the market share with a variety of design experiences of about 100 years.

A shell and tube heat exchanger is the most common type of heat exchanger in oil re- fineries and other large chemical processes, and is suited for higher-pressure applications. As its name implies, this type of heat exchanger consists of a shell (a large vessel) with a bundle of tubes inside it. One fluid runs through the tubes and the second runs over the tubes (through the shell) to transfer heat between the two fluids. A set of tubes is called a tube bundle which may be composed by several types of tubes. In this heat exchanger both parallel and counter flow can be performed by controlling the valves.

II. CLASSIFICATION OF HEAT EXCHANGER

There are several different styles of heat exchanger equipment in common use. These include:

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· Double pipe heat exchangers
· Hairpin heat exchangers (multitube double pipe heat exchangers)
· Shell and tube heat exchangers
· Plate fin exchangers
· Plate & frame heat exchangers
· Spiral tube heat exchangers
· Spiral plate heat exchangers
· Air-cooled heat exchangers

Other types of heat transfer equipment available are:
· Tank jackets and coils
· Cooling Towers
· Fired heaters & Boilers

By far the most common is the shell and tube design. However, other styles are often suitable or even preferable in specific applications.

III. EXISTING AND PROPOSED SYSTEM

3.1 Existing system

In industries, heat exchangers are used in industrial process to recover heat between two process fluids. Shell-and-tube heat exchangers are the most widely used heat exchangers in process industries because of their relatively simple manufacturing and their adaptability to different operating conditions. But nowadays numbers of industries are searching for effective and less time consuming alternatives of designing of shell-and-tube heat exchangers. As per literature and industrial survey it is observed that there is need of effective design options for STHE. This section explains the details of existing industrial scenario of design of STHE.

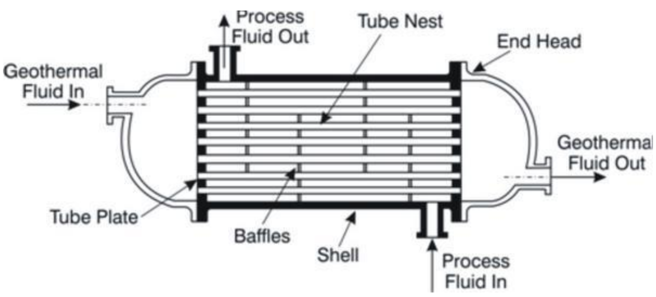

Fig 3.1. Typical shell and tube heat exchanger

3.2 Proposed system

In order to increase the heat transfer rate and effectiveness of the shell and tube heat exchanger we have proposed the concept of placing the heat exchanger at various angles from horizontal to vertical to analyse at which angle the heat transfer rate, overall heat transfer co-efficient and effectiveness.

In this experimental analysis we have uses water for both hot fluid and cold fluid. By varying the inlet temperature of hot fluid along with the mass flow rate the readings has been observed using suitable equipments`

IV. NOMENCLATURE

A Heat transfer area (m^2)
T_1 inlet temperature of hot fluid (^oC)
T_2 outlet temperature of hot fluid (^oC)
U overall heat transfer coeffiecient ($W/m^{2o}C$)
C_p specific heat capacity (kJ/kg k)
D diameter of the shell (mm)
Di inner diameter of the tube (mm)
Do outer diameter of the tube (mm)
ΔT_m temperature difference (^oC)
Q heat transfer rate (w)
M mass flow rate (kg/s)

The following data are adopted for the design of spiral tube heat exchanger is given below.

Length of the heat exchanger (l) = 1000mm
Outer diameter of copper tube (Do) = 19mm
Tube diameter of copper tub (d_i) = 17mm
Number of tubes (n) = 3
Number of baffles (p) = 6
Shell material = mild steel
Working fluid = water
Tube material = copper

4.1. Experimental set up for shell and tube heat exchanger

It consists of three tubes made up of copper. Each are 1 m long, had 19 mm outer diameter and 17 mm inner diameter. The main components are used for fabrication are thermocouples, measuring instruments, electric heater with control unit. the shell of length 1000 mm and diameter of 762 mm.

Temperature monitor is used to monitor the temperature of fluids in various sections. Electrical heater with control unit is used to increase or decrease the temperature of the fluid passed to the evaporator section. A pump is used to circulate the hot water to heat pipe, and the control valves are used to regularize the flow of fluid to heater or condenser section.

4.2 NTU Method

The number of transfer units (NTU) method is used to calculate the theoretical overall heat transfer coefficient (U) by using effectiveness charts. In addition to the effectiveness, the ratio of C_{min}/C_{max} is needed (C_{min} is the smaller of the two heat capacity rates C_c and C_h and C_{max} is the higher one). From the effectiveness graphs, the intersection point of the ratio C_{min}/C_{max} and effectiveness value gives the NTU value. The effectiveness:

$$\varepsilon = C_h\,(T_{h,} - T_{h,o}) \,/\, C_{min}(T_{h,i} - T_{c,i}) \quad [1]$$

$$\varepsilon = (T_{c,o} - T_{c,i}) \,/\, C_{min}(T_{h,i} - T_{c,i}) \quad [2]$$

Then the theoretical heat transfer coefficient value (U) is calculated by the following equation,

$$NTU = (UA)/C_{min} \quad [3]$$

$$U = ((NTU)_{in})/A \quad [4]$$

4.2.1. Heat lost by hot fluid

$$Q_h = m_h c_{ph}\,(T_{hi} - T_{ho}) \quad [5]$$

4.2.2. Heat gained by cold fluid:

$$Q_c = m_c c_{pc}\,(T_{co} - T_{ci}) \quad [6]$$

4.2.3. Heat capacity ratio:

$$C_r = C_{min}/C_{max} \quad [7]$$

4.3 Assumptions

Assumptions in calculation of overall heat transfer coefficients are,

- The overall coefficient U is constant.
- The specific heats of the hot and cold fluids are constant.
- Heat exchange with the surroundings is negligible.
- The flow is steady.

V. RESULTS AND DISCUSSION

From the observations made it has been found that the overall heat transfer rate at an angle of 45` with mass flow rate of 69 kg/s fives the maximum value.

Effectiveness at 45`= 0.88 (counter flow)

Therefore, it can be said that rather than using the heat exchanger in existing method it is advised to use at an angle of 45`.

VI. CONCLUSION

It is concluded that the heat transfer rate is increased while placing the heat exchanger at 45` with the mass flown rate being fixed at 72 lph. Therefore it can be concluded that the heat exchanger can be used in an inclined angle to get high transfer rate and effectiveness.

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