

Experimental Investigation of Fixed Tube Sheet Shell and Tube Heat Exchanger

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Abstract - Shell and Tube Heat Exchanger in which it is Fixed Tube-sheet and Counter Flow Type Heat Exchanger. Here, Shell side fluid is cold water and tube side fluid is hot water. Cold water is cold fluid and hot water is hot fluid. I do Thermal Designing STHX due to the problem of Less Heat Transfer rate and Cost is very high and also will do analysis of corrugated tube and compare with existing plain tube. I will make prototype experiment model of shell and tube heat exchanger in which plain and corrugated tube is use one after one and take reading for thermal analysis calculation. Here shell is made by still and tube is made by aluminium. After doing experiment work I will get different comparative result for both plain tube and corrugated tube. Here we show that use of corrugated tube effectiveness increase and pressure drop decrease. So the pumping cost decrease and heat transfer rate increase. Shell and Tube Heat Exchangers are used as process heat exchangers in the petroleum-refining and chemical industries. It is used as steam generator, condensers, boiler feed water heater, and oil coolers in power plant.

Key Words: Heat transfer, Effectiveness, corrugated tube, Plain Tube

1. INTRODUCTION

A shell and tube heat exchanger is a important of heat exchanger device. It is the most useful type of heat exchanger in oil refineries and other large chemical processes and is best use for higher-pressure instruments and area to volume ratio higher than other heat exchanger. As their names explain, this type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. One fluid flow through the tubes, and another fluid runs over the tubes (through the shell) 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: plain, longitudinally finned, micro fin etc. Shell and tube heat exchanger is type of heat exchanger an according to design and construction form TEMA standard.

1.1 Benefit of Shell and Tube Heat Exchanger

Shell and tube heat exchanger is used in power companies, chemical, petrochemical & oil-refining.

- It can be planed for almost any moral obligation to work with a very wide range of pressure & temperatures.
- It can be construct by using many materials like Mild steel, Stainless steel etc
- Many suppliers are available.

1.2 Scope of Shell and Tube Heat Exchanger

- (1) Temperature Range
Maximum 500oC or even 600oC, minimum -100oC
- (2) High Pressure
Shell 300 bar, Tube 1400 bar

1.3 Construction and Working of Shell and Tube Heat Exchanger

A shell and tube heat exchanger is a rank of heat exchanger designs. It is the most ordinary type of heat exchanger used in oil refineries and other large chemical processes, and is retinue for higher-pressure applications. As its name implies, this type of heat exchanger to be made up of a shell (a large pressure vessel) with a bundle of tubes interior it. Shell and tube heat exchangers are designed by the Tabular Exchanger Manufactures Association (TEMA) Standard. In a single pass shell and tube heat exchanger; the fluid enter in one end of tube and out at the other end of tube.

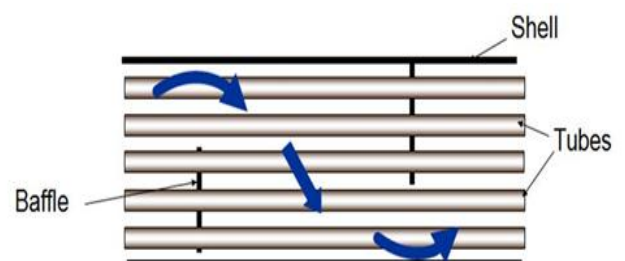


Fig-1.1: Construction of shell & tube heat exchanger

One fluid flow in tube and other fluid flow over the tube called shell. The set of tubes is called a tube bundle. Tube bundle consist of various types of tube like plain, finned etc.

1.4 Components of Shell and Tube Heat Exchanger

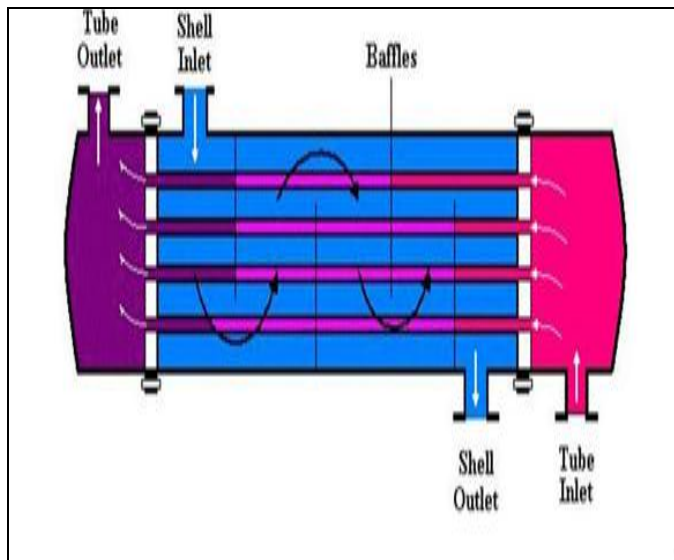


Fig-2: Parts of shell and tube heat exchanger

- (1) Shell
- (2) Shell Cover
- (3) Tubes
- (4) Tube Sheet
- (5) Baffles
- (6) Nozzle
- (7) Tie Rod

2. PROJECT WORK OUT

Here I describe the research objective and problem definition.

2.1 Objective of Project Work

The main aim of this project is to Experiment Performance for Comparison of Shell and Tube Heat Exchanger with plain tube and corrugated tube for increasing heat transfer rate by increasing heat transfer area, reduce pressure drop and cost reduction. Thermal design calculation of shell and tube heat exchanger is done by TEMA standard

The Objectives of the Study are as follows:-

- Increasing heat transfer rate by increasing heat transfer area.
- Reducing pressure drop at shell side and tube side.
- Reducing cost.

2.2 Problem Definition

The Problems are:

- Heat Transfer Rate is less.
- Effectiveness is less
- Very high cost.
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3. EXPERIMENTAL SET UP

Prototype model of shell and tube heat exchanger is prepared. Here below schematic diagram of experiment layout is provided.

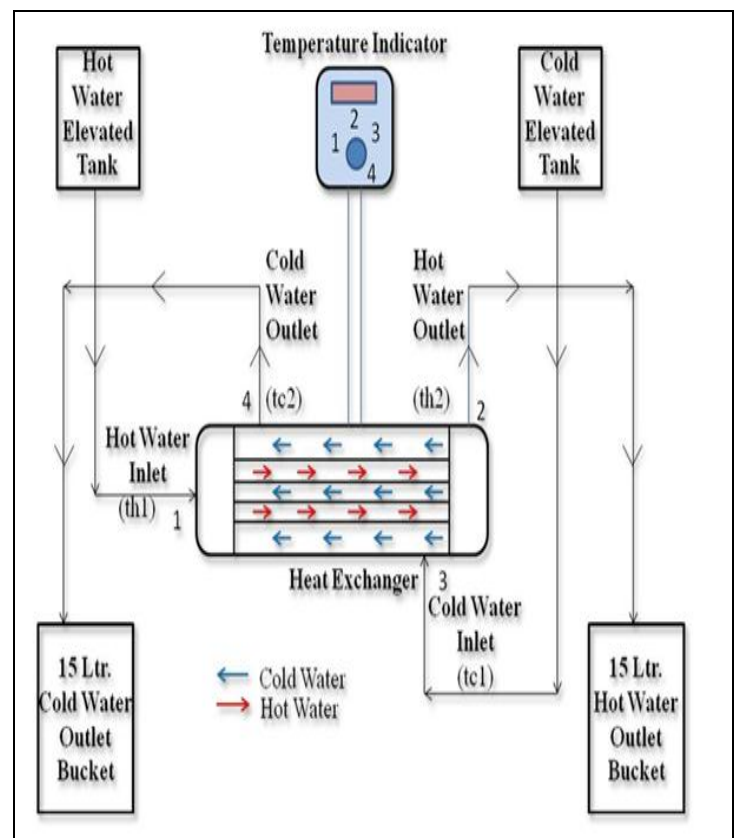


Fig-3: Schematic diagram of experimental layout

Here in this schematic diagram of experiment layout is in which there is one shell and tube heat exchanger is use in which first take plain tube having number of four. Here hot side fluid flow in tube side and cold side fluid flow in shell side. Hot fluid is hot water and cold fluid is cold water. Each having tube side and shell side inlet-outlet is connected and entire both fluid flow in counter flow arrangement for high heat transfer area. Both fluid flows can be indicated by red and blue color. Red for hot tube side fluid and blue for cold shell side fluid. Here in this experiment hot side and cold side tank is put at gravity level so fluid flow at respective inlet of heat exchanger in pipe line. Here two 15 litter capacity pail is taken for outlet fluid of hot side (at 2 point) and cold side (at

4 point) which is filled with outlet hot and cold water in respective bucket. Reading is taken at every 5 min interval and temperature reading is taken and flow measure from 15 litre capacity pail after 5 min. One advantage is that in this model is there is glass wool is provided on shell for to minimize heat loss. And a tape is winding over it. There is sensor with thermo couple (TP 100) is provided at respective inlet- outlet at shell side and tube side and measure common temperature indicator is provide so we take easily reading with accuracy. In this temperature indicator four reading is take first reading is for th1 (hot side inlet temp.) Second is for th2 (hot side outlet) , third is for tc1 (cold side inlet) , fourth is for tc2 (cold side outlet).

4. RESULT ANALYSIS

Here we compare the heat transfer rate, shell side pressure drop, effectiveness, Nusselt number, Reynolds number, heat transfer coefficient for shell side and overall heat transfer coefficient between plain tube and corrugated tube.

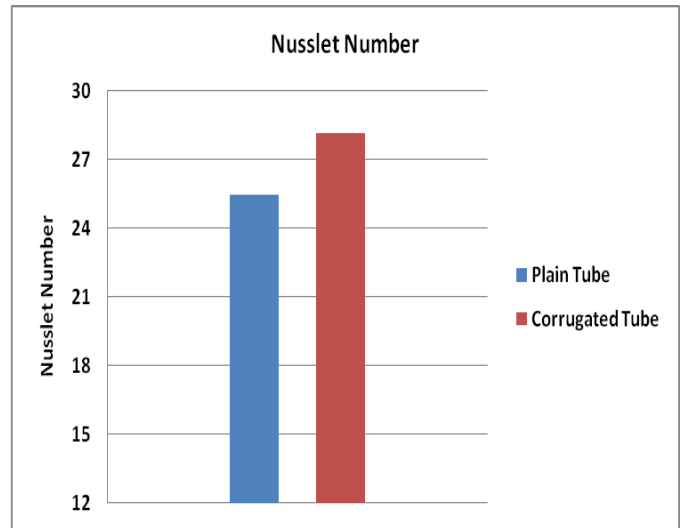


Chart -3: Nusselt number

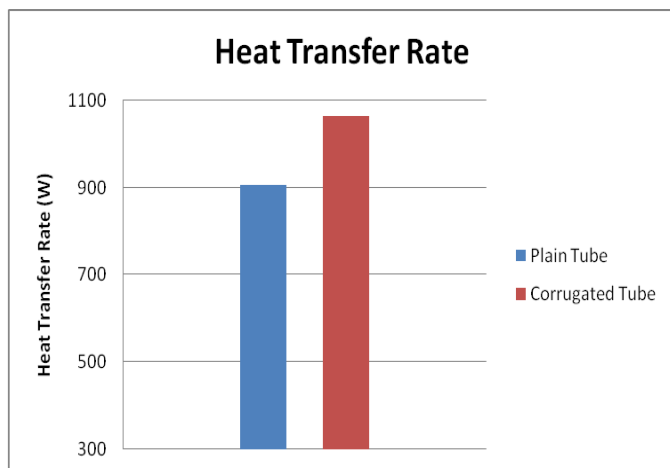


Chart -1: Heat transfer rate

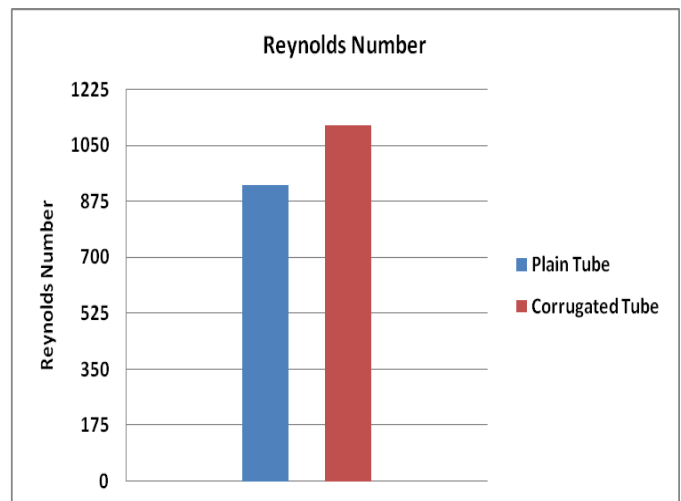


Chart -4: Reynolds number

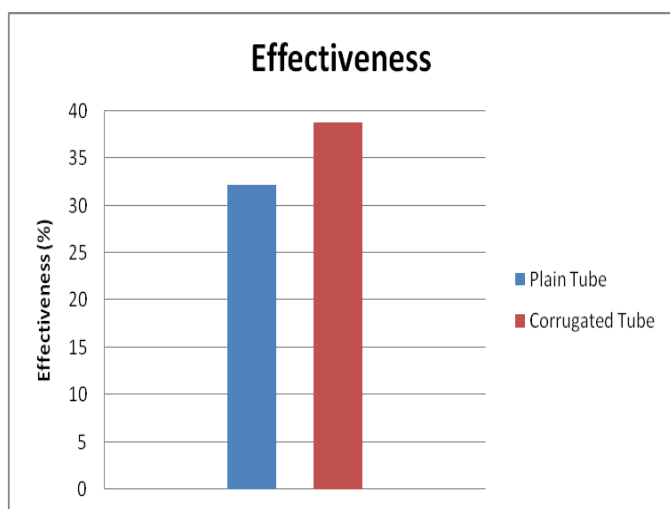


Chart -2: Effectiveness

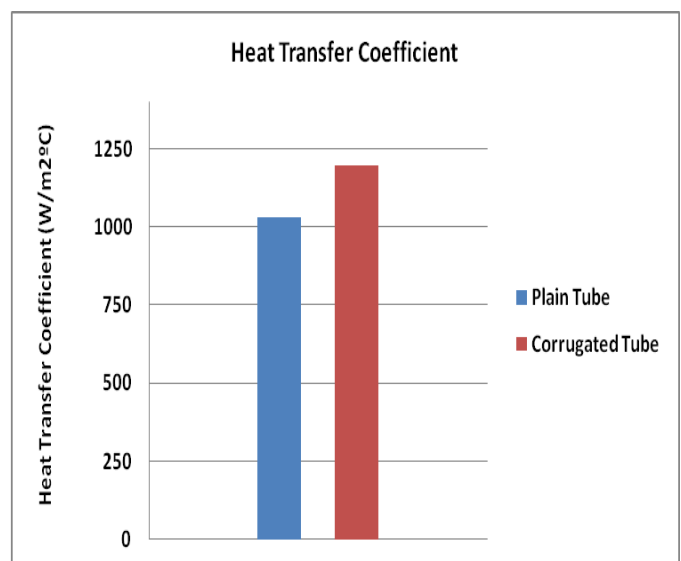


Chart -5: Heat transfer coefficient

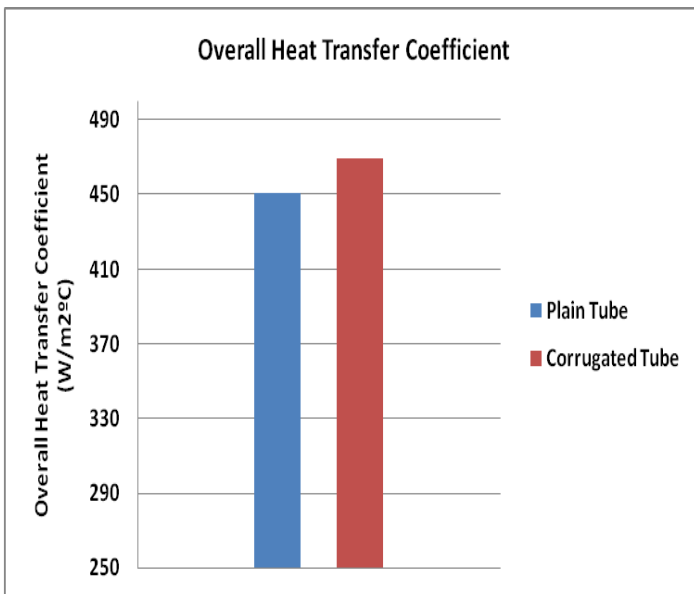


Chart -6: Overall heat transfer coefficient

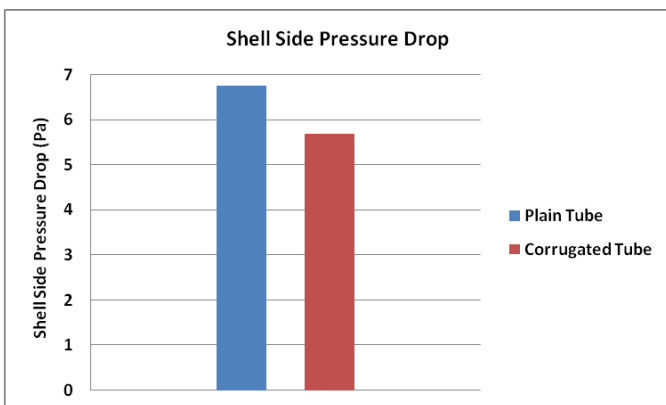


Chart -6: Shell side pressure drop

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5. CONCLUSIONS

From above result analysis I reached following conclusions:

The heat transfer rate for corrugated tube is 17.4% higher than plain tube. The effectiveness for corrugated tube is 20.48% higher than plain tube. So it is useful for industrial purpose. In corrugated tube turbulence created higher than plain tube. So The Reynolds number for corrugated tube is 19.96% higher than plain tube. The Nusselt number for corrugated tube is 10.56% higher than plain tube. Because of Nusselt number increase with Reynolds number. The heat transfer coefficient of shell side for corrugated tube is 16.35% higher than plain tube. The overall heat transfer coefficient of shell side for corrugated tube is 4.1% higher than plain tube. The pressure drop for shell side for corrugated tube is % less than plain tube. So the pumping cost Decrease.