

Importance of Shell & Tube Heat Exchangers In candy plants

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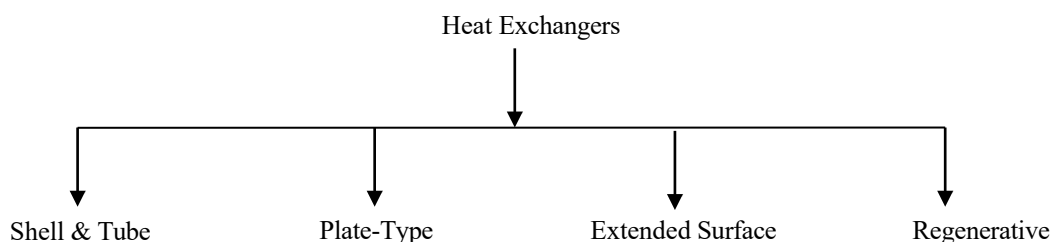
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Abstract: Shell and Tube heat exchanger (HX) plays important role in candy plant. It transfers heat between two or more fluids. It is generally made of bundle of round tubes which are mounted in a cylindrical shell. And tubes are parallel to shell. We are covering several points such as why Shell and Tube heat exchangers are using in candy plants? Because there are many different types of Heat Exchangers are available in market. What are the major advantages that Shell and Tube heat exchangers are providing and others are not. What are limitations of other Heat Exchangers? And what are the main reasons behind use of Shell and Tube heat exchangers in candy plants?

Keywords: Shell & Tube Heat Exchanger; Reasons; Importance; Candy Plants; Operating Temperature.

I. Introduction

Over the past few decades, there has been an incline in the demand of ice-cream at rate of 15-20% year-on-year (Indian Journal of Economics and Development, June 2019, Vol 7 (6)). Hence ice candy plants demand is also increasing. Thus, candy manufacturers are also developing new, innovative and more efficient candy plants. Some of them are using chiller type candy plants. Which reduces the requirement of refrigerant as volume of coil is reduced. It also increases the cooling rate of ice candy. In chiller type candy plants, Shell and Tube heat exchanger is used as chiller, which removes heat from brine using refrigerant. So basically heat is flowing from brine to refrigerant. But why they are using Shell and Tube heat exchanger as chiller, instead of using any other Heat Exchanger? Different types of Heat Exchangers are shown below,



II. Shell & tube Heat Exchanger

It is generally made up of round tubes and mounted in cylindrical shell. In candy plant shell and tube heat exchanger is transferring heat from brine to refrigerant (generally R-404A is more preferable). Two fluids are flowing in this heat exchanger one fluid (Refrigerant) is flowing in round tubes and another fluid (Brine) is flowing in the shell. Simple construction is shown in Figure-1 and Figure-2 shows internal structure of shell & tube heat exchanger.



Figure: 1

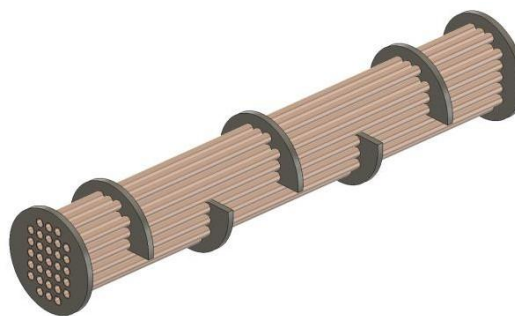


Figure: 2

In this paper after knowing the advantages of shell & tube heat exchanger, there are reasons due to which it is more preferable in industrial application.

Advantages

- They are designed to be as flexible as possible. By changing the materials of tubes, shell and headers, they can be used in many different applications.
- Shell & tube heat exchangers have high heat transfer efficiency.
- Since they are easy to dismantle, cleaning and repairing becomes easy.
- Shell & tube heat exchangers are affordable compared to plate type heat exchanger.
- These exchangers can be used, where operating pressure is high.
- In this exchanger locating tube leaks becomes easy since pressure test is relatively simple.

III. Reasons

There are several reasons, due to which shell & tube heat exchanger is selected as chiller in candy plants. They are listed below,

1. Operating Pressure & Temperature
2. Cost
3. Fouling and Cleanability
4. Fluid Leakage & Contamination

5. Fluids & Material Compatibility

6. Fluid Type

1. Operating Pressure & Temperature

Shell & tube heat exchangers are most versatile in nature and offer broad range of operating pressure and temperature for medium to high heat duties. Heat exchangers must withstand stresses, which are produced by temperature and pressure. Stress mainly depends on inlet and out let temperature. In candy plants mean operating temperature of refrigerant is around -30 °C and for brine is around -25 °C. Operating pressure for refrigerant is 15 psig. Due to low temperature plate heat exchanger is not preferable because there are chances for freezing of water on the outer surface of exchanger, from surrounding. It may damage the heat exchanger. Hence, shell & tube heat exchanger is more preferable.

2. Cost

It is one of the most important factors for selecting heat exchanger. And cost per unit of heat transfer surface area for shell & tube heat exchanger is less compared to gasketed plate heat exchanger.

3. Fouling and Cleanability

Fouling and cleanability is among the most important for liquid-liquid or phase-change heat exchanger and in candy plants refrigerant is changing its phase. And periodic cleaning and replacement of components are needed due to heavily fouling fluid. In candy plant brine is responsible for scaling. And shell and tube heat exchanger is easy to dismantle.

4. Fluid Leakage & Contamination

Where absolutely no contamination is allowed shell and tube heat exchanger is used. And in candy plant brine is not allowed to contaminate refrigerant. If brine contaminate refrigerant then it may cause system failure or may damage the compressor. Gasketed plate heat exchangers have more probability of leakage than shell and tube heat exchanger.

5. Fluids & Material Compatibility

Materials selection and compatibility between exchanger materials and fluid is really important. Shell and tube heat exchangers can be designed using different materials according to working fluids. To attain high heat transfer copper tubes are used in candy plant, copper has high thermal conductivity (385 W/m*K). If fluid is compatible and want to make light heat exchanger aluminum is selected.

6. Fluid Type

In liquid to gas heat exchanger, heat transfer coefficient from gas side to liquid side is 1/10 to 1/100. In candy plant refrigerant is changing phase in shell and tube heat exchanger due to evaporation of refrigerant. And heat transfer co-efficient varies from low values for gas to high values for liquid flow.

IV. Conclusion

Shell and tube heat exchanger is very important part of candy plant. It is economical, easy to dismantle and easy to clean, is highly flexible and also have high heat transfer efficiency. They offer broad range of operating pressure and temperature, its cost per unit of heat transfer surface area for shell & tube heat exchanger is less compared to other exchanger, shell and tube heat exchanger can be designed using different materials which make it more compatible

and also wide range of refrigerant and brine can be used according to selected materials. From the given reasons shell and tube heat exchangers are using in candy plant.

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