A CRITICAL REVIEW ON DIFFERENT HEAT EXCHANGERS USED FOR HEAT TRANSFER BETWEEN TWO FLUIDS

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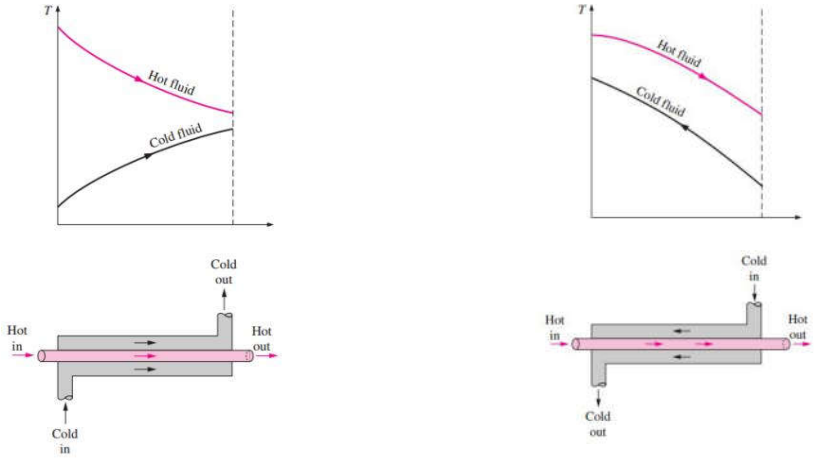
Abstract: *Heat exchangers are those devices which are used to transfer heat from hot fluid to cold fluid which are of either same or different phases. Heat exchangers are used in wide range for different types of industrial and domestic applications. Some of the heat exchangers are mixing type and some are non-mixing type. The difference between the mixing and non-mixing is that in non-mixing type the fluids are separated by metal wall. In non-mixing type as there is used a metal wall to separate the two different fluids, the heat transfer takes place by convection in each fluid and by conduction through the walls, so that in the analysis of heat exchanger, it is necessary to calculate overall heat transfer coefficient U.*

Keywords: *Overall heat transfer coefficient, area density, tube spacing,*

I. Introduction

To achieve a particular engineering objective, it is very important to apply certain principles so that the product development is done economically. This economic is important for the design and selection of good heat transfer equipment. The heat exchangers are manufactured in different types, however the simplest form of the heat exchanger consist of two concentric pipes of different diameters known as double pipe heat exchanger. In this type of heat exchanger, one fluid flows through the small pipe and another fluid flows through the space between both the pipes. The flows of these two different fluids, one is at higher temperature called hot fluid and another is at lower temperature called cold fluid, can be in same or in opposite directions. If the flows are in same direction then the heat exchanger is called as parallel flow heat exchanger and if the flows are in opposite direction then the heat exchanger is called as counter flow heat exchanger.



(a) Parallel flow **(b) Counter flow**

Fig. 1: Double pipe heat exchangers with different flow and their respective temperature profile.

The further development is done in the heat exchangers to facilitate them in different applications as per requirement. These heat exchangers are different from the conventional heat exchangers such that they have large heat transfer surface area per unit volume and are known as compact heat exchangers. For the compact heat exchangers,

II. Followings are some examples of heat exchangers used in different applications:

1. Intercoolers and preheaters;
2. Economisers and superheaters;
3. Condensers and boilers in steam plant;
4. Condensers and evaporators in refrigeration units;
5. Regenerators;
6. Automobile radiators.

III. Different types of heat exchangers used

Following are the different types of heat exchangers used based on the various applications.

1. Shell and tube heat exchanger:

Shell and tube heat exchangers are commonly used in the chemical and process industries. These devices are available in a wide range of configurations as defined by the Tubular Exchanger Manufacturers Association (TEMA). The applications of single-phase shell-and-tube heat exchangers are quite large because these are widely in chemical, petroleum, power generation and process industries. In essence, a shell and tube exchanger is a pressure vessel with many tubes inside of it. One process fluids flows through the tubes of the exchanger while the other flows outside of the tubes within the shell. The tube side and shell side fluids are separated by a tube sheet. In these heat exchangers, one fluid flows through tubes while the other fluid flows in the shell across the tube bundle.

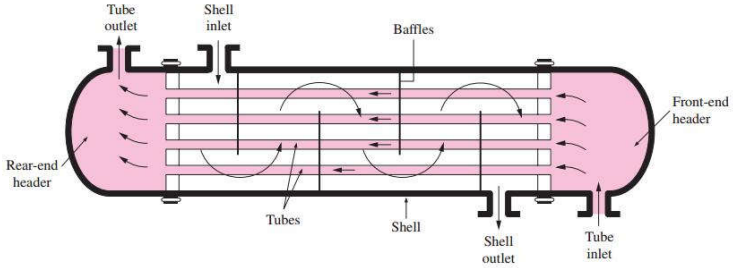


Fig. 2: Shell and tube type of heat exchanger.

The baffles are primarily used in shell-and-tube heat exchangers for supporting the tubes and for inducing cross flow over the tubes, resulting in improved heat transfer performance. To induce turbulence outside the tubes it is customary to employ baffles that cause the liquid to flow through the shell at right angles to axes of the tubes. In these heat exchangers, the shell-side flow is complicated for two reasons, the first is the approximately sinusoidal overall flow pattern as the fluid flows through the tube bundle, and the second is the influence of the various leakages through the clearances required for the construction of the exchangers. The various tube arrangements are as shown in fig. given below.

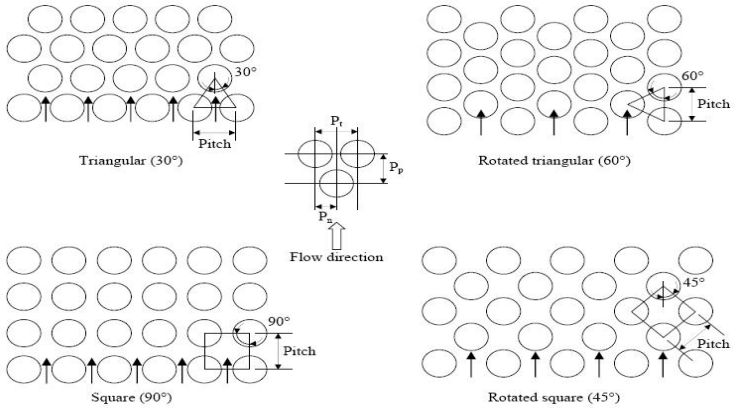
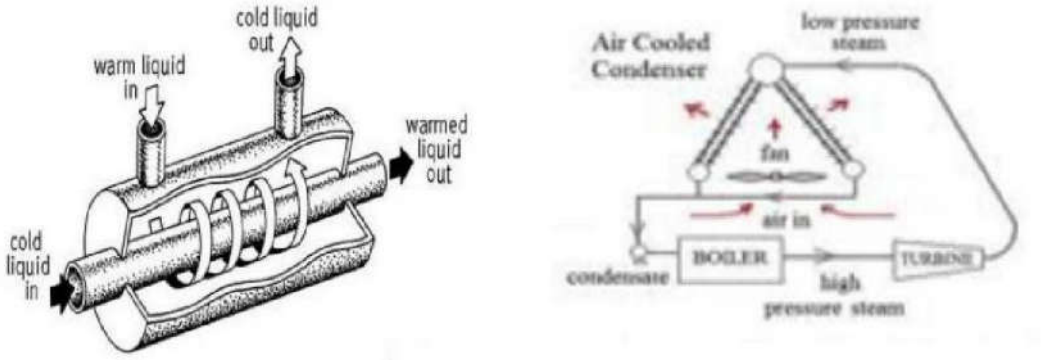


Fig. 3: Various tubes arrangements in shell and tube type of heat exchanger.

2. Condenser:

Condensers are the types of heat exchangers used to condense a substance from its gaseous to its liquid state. In this process, the hot fluid (or gases) gives its latent heat to the cold fluid and comes to the liquid state.

The condensers are used for industrial as well as domestic purpose. They are available for various ranges of size and shape. For example the condensers used in domestic refrigerator and air conditioners are quite small and the condensers used in power plants are of bigger sizes. Use of cooling water or surrounding air as the coolant is common in many condensers. The main use of a condenser is to receive exhausted steam from a steam engine or turbine and condense the steam. Fig. is showing water cooled condenser and air cooled condenser as well.

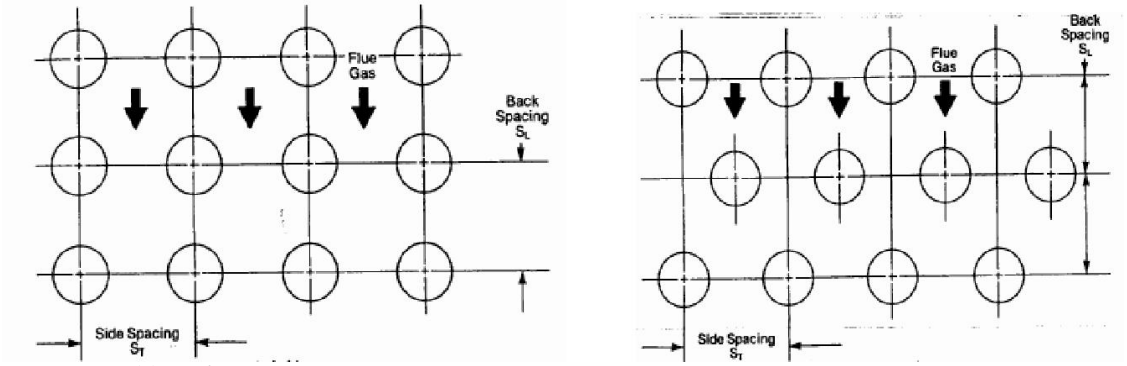


(a) Water cooled condenser **(b) Air cooled condenser**

Fig. 4: Water cooled condenser

3. Economiser and air-preheater:

Economiser is a type of heat exchanger commonly used in a steam power plant particularly to heat the water entering the boiler so that the fuel consumption is reduced. Econimiser can be used anywhere. The economiser not only pre-heats the feed water but also lowers the temperature of the flue gases flowing to the atmosphere. Economisers are basically tubular heat transfer surfaces used to preheat the boiler water before it enters the drum. The term economizer comes from early use of such heat exchangers to reduce operating cost or economize on fuelby recovering extra energy from flue gas. The different tubular arrangement of the economiser is as shown in fig. 5.



(a) In-line arrangement **(b) Staggered arrangement**

Fig. 5: Economiser air-preheater tube arrangement

Air-preheater is the also a type of heat exchanger and used in the steam power plant just like the econimiser. The difference between these two is that the air-preheater is used to preheat the air entering the furnace. The purpose is that the efficiency of the boiler and hence steam power plat increases as the fuel consumption decreases.

4. Radiator:

Radiators are the types of heat exchangers used to transfer thermal energy from one medium to another for the purpose of cooling and heating. The major applications of radiators are inautomobiles, buildings, and electronics.The radiator is always a source of heat to its environment, although this may be for either the purpose of heating this environment, or for cooling the fluid or coolant supplied to it, as for engine cooling. The radiators used in the cars and heavy vehicles are the compact heat exchangers. In compact heat exchangers, the two fluids usually move perpendicular to each other, and such flow configuration is called cross-flow.the cross-flow is said to be unmixed since the plate fins force the fluid to flow through a particular interfinspacing and prevent it from moving in the transverse direction (i.e., parallel to the tubes).