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510 N. Crosslane Rd.
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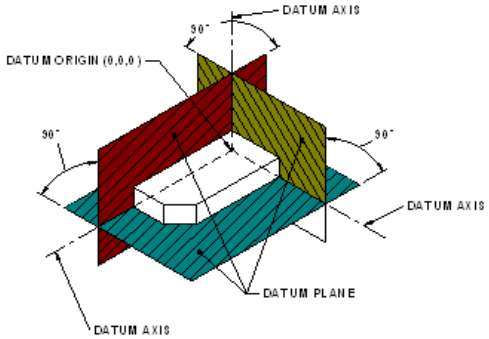

Department of Energy
Fundamentals Handbook

MECHANICAL SCIENCE
Module 2
Heat Exchangers

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REFERENCES

- Babcock & Wilcox, Steam, Its Generations and Use, Babcock & Wilcox Co.
- Cheremisinoff, N. P., Fluid Flow, Pumps, Pipes and Channels, Ann Arbor Science.
- Heat Transfer, Thermodynamics and Fluid Flow Fundamentals, Columbia, MD, General Physics Corporation, Library of Congress Card #A 326517.
- Marley, Cooling Tower Fundamentals and Applications, The Marley Company.

TERMINAL OBJECTIVE

1.0 Without references, **DESCRIBE** the purpose, construction, and principles of operation for each major type of heat exchanger: parallel flow, counter flow, and cross flow.

ENABLING OBJECTIVES

1.1 **STATE** the two types of heat exchanger construction.

1.2 Provided with a drawing of a heat exchanger, **IDENTIFY** the following internal parts:

a. Tubes
b. Tube sheet
c. Shell
d. Baffles

1.3 **DESCRIBE** hot and cold fluid flow in parallel flow, counter flow, and cross flow heat exchangers.

1.4 **DIFFERENTIATE** between the following types of heat exchangers:

a. Single-pass versus multi-pass heat exchangers.
b. Regenerative versus non-regenerative heat exchangers.

1.5 **LIST** at least three applications of heat exchangers.

1.6 **STATE** the purpose of a condenser.

1.7 **DEFINE** the following terms:

a. Hotwell
b. Condensate depression

1.8 **STATE** why condensers in large steam cycles are operated at a vacuum.

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TYPES OF HEAT EXCHANGERS

In almost any nuclear, chemical, or mechanical system, heat must be transferred from one place to another or from one fluid to another. Heat exchangers are used to transfer heat from one fluid to another. A basic understanding of the mechanical components of a heat exchanger is important to understanding how they function and operate.

EO 1.1 STATE the two types of heat exchanger construction.

EO 1.2 Provided with a drawing of a heat exchanger, IDENTIFY the following internal parts:

a. Tubes
b. Tube sheet
c. Shell
d. Baffles

EO 1.3 DESCRIBE hot and cold fluid flow in parallel flow, counter flow, and cross flow heat exchangers.

EO 1.4 DIFFERENTIATE between the following types of heat exchangers:

a. Single-pass versus multi-pass heat exchangers
b. Regenerative versus non-regenerative heat exchangers

Introduction

A heat exchanger is a component that allows the transfer of heat from one fluid (liquid or gas) to another fluid. Reasons for heat transfer include the following:

1. To heat a cooler fluid by means of a hotter fluid
2. To reduce the temperature of a hot fluid by means of a cooler fluid
3. To boil a liquid by means of a hotter fluid
4. To condense a gaseous fluid by means of a cooler fluid
5. To boil a liquid while condensing a hotter gaseous fluid

Regardless of the function the heat exchanger fulfills, in order to transfer heat the fluids involved must be at different temperatures and they must come into thermal contact. Heat can flow only from the hotter to the cooler fluid.

In a heat exchanger there is no direct contact between the two fluids. The heat is transferred from the hot fluid to the metal isolating the two fluids and then to the cooler fluid.

Types of Heat Exchanger Construction

Although heat exchangers come in every shape and size imaginable, the construction of most heat exchangers fall into one of two categories: tube and shell, or plate. As in all mechanical devices, each type has its advantages and disadvantages.

Tube and Shell

The most basic and the most common type of heat exchanger construction is the tube and shell, as shown in Figure 1. This type of heat exchanger consists of a set of *tubes* in a container called a *shell*. The fluid flowing inside the tubes is called the tube side fluid and the fluid flowing on the outside of the tubes is the shell side fluid. At the ends of the tubes, the tube side fluid is separated from the shell side fluid by the tube sheet(s). The tubes are rolled and press-fitted or welded into the tube sheet to provide a leak tight seal. In systems where the two fluids are at vastly different pressures, the higher pressure fluid is typically directed through the tubes and the lower pressure fluid is circulated on the shell side. This is due to economy, because the heat exchanger tubes can be made to withstand higher pressures than the shell of the heat exchanger for a much lower cost. The support plates shown on Figure 1 also act as baffles to direct the flow of fluid within the shell back and forth across the tubes.

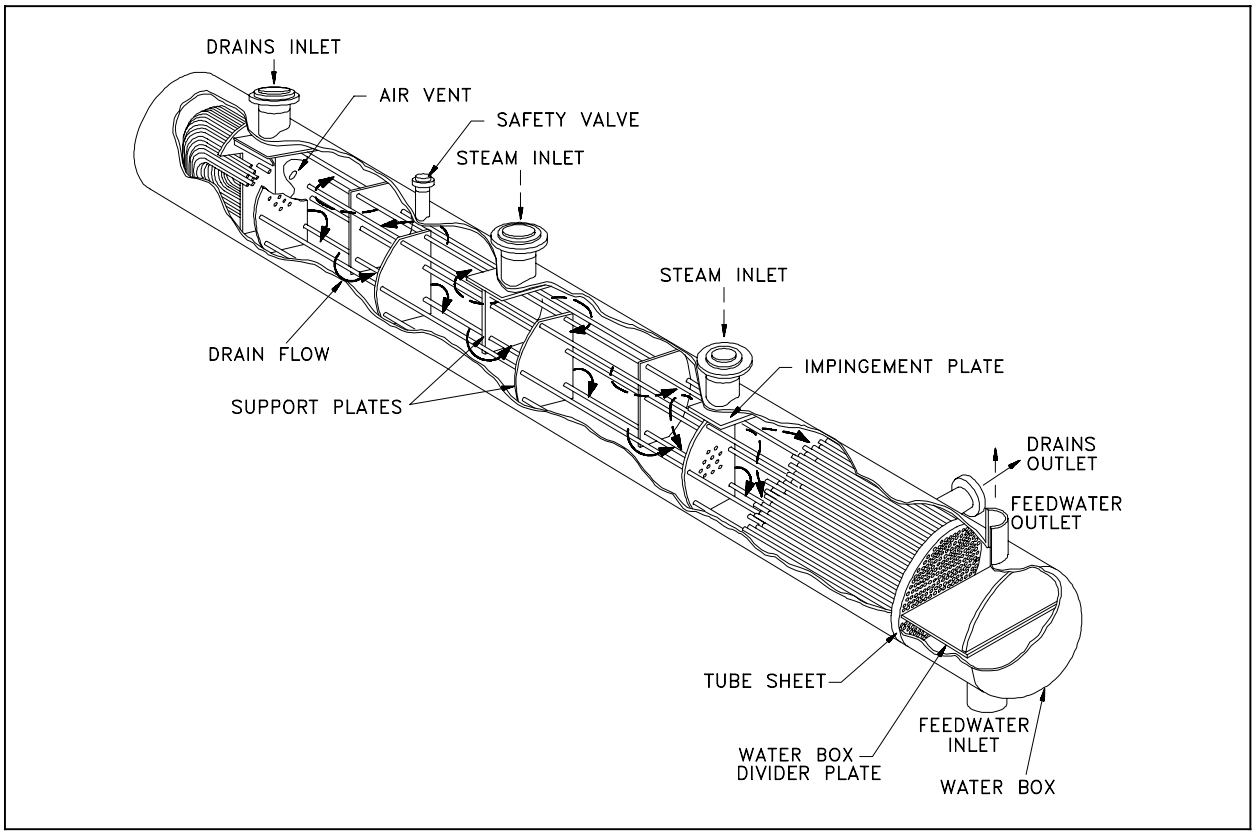
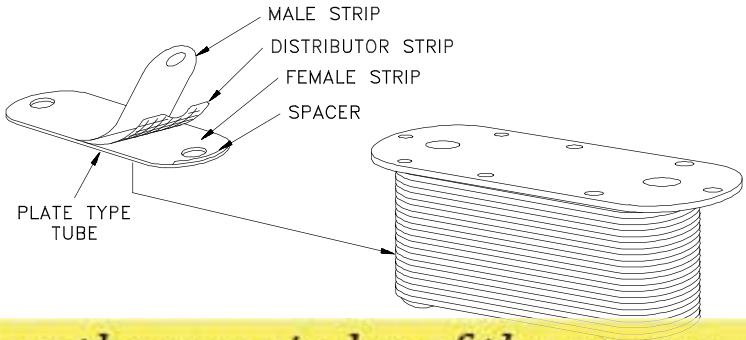


Figure 1 Tube and Shell Heat Exchanger

Plate

A plate type heat exchanger, as illustrated in Figure 2, consists of plates instead of tubes to separate the hot and cold fluids. The hot and cold fluids alternate between each of the plates. Baffles direct the flow of fluid between plates. Because each of the plates has a very large surface area, the plates provide each of the fluids with an extremely large heat transfer area. Therefore a plate type heat exchanger, as compared to a similarly sized tube and shell heat exchanger, is capable of transferring much more heat. This is due to the larger area the plates provide over tubes. Due to the high heat transfer efficiency of the plates, plate type heat exchangers are usually very small when compared to a tube and shell type heat exchanger with the same heat transfer capacity. Plate type heat exchangers are not widely used because of the inability to reliably seal the large gaskets between each of the plates. Because of this problem, plate type heat exchangers have only been used in small, low pressure applications such as on oil coolers for engines. However, new improvements in gasket design and overall heat exchanger design have allowed some large scale applications of the plate type heat exchanger. As older facilities are upgraded or newly designed facilities are built, large plate type heat exchangers are replacing tube and shell heat exchangers and becoming more common.



Types o

Because h e categorized according to categorize them is th ategories are parallel fl

Pa and the shell sic nter the heat ex luids transfer he er. Note that th temperature.