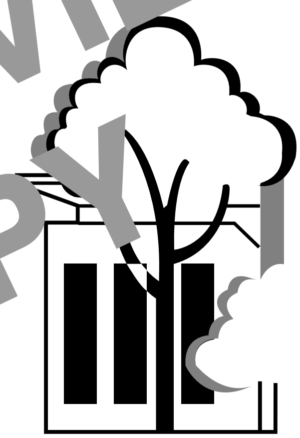
Evaporators and Metering Devices

Table of Contents

EVAPORATORS AND METERING DEVICES

Lesson One

Introduction to Evaporators



TPC Training Systems

43401

Lesson

1 Introduction to Evaporators

TOPICS

The Function of the Evaporator
How the Evaporator Works
Effects of Latent and Sensible Heat
Evaporator Capacity
Temperature Differential
Evaporator Construction
Contact Surface Area
Circulation Velocity
Effects of Water Vapor

OBJECTIVES

After studying this Lesson, you should be able to…

- Explain the function of the evaporator in a refrigeration system.
- List five main factors affecting evaporator capacity, and explain how each can be optimized to gain the greatest possible evaporator capacity.
- Describe the basic evaporator configurations.
- Explain the function of headers and distributors in multiple-circuit evaporators.
- Explain how comfort coolers reduce both air temperature and humidity.

KEY TECHNICAL TERMS

Evaporator 1.01 component that removes heat from the substance to be cooled
Cooling coil 1.01 another term for evaporator
Enthalpy 1.09 total heat content of a substance
Header 1.31 distributes refrigerant among evaporator circuits
Extended-surface evaporator 1.35 finned-tube evaporator
Natural convection 1.39 results from the density difference between warm and cool fluids
Forced circulation 1.40 uses a fan or pump to speed up circulation
Comfort cooler 1.45 air-conditioning system evaporator, reduces humidity as well as temperature

During the refrigeration process, the substance being cooled must not mix with the refrigerant. To keep the refrigerant and the substance being cooled separated, and at the same time permit heat to transfer between them, every refrigeration system uses a kind of heat exchanger called an *evaporator*. The evaporator is also sometimes called the *cooling coil*, the *chilling coil*, or the *freezing coil*.

Although the evaporator itself is a simple device, it is one of the most important components in the refrigeration system. If the evaporator fails, the entire system will fail. In this Lesson, you will learn the principles underlying evaporator performance and the basic types of evaporators commonly used in refrigeration and air conditioning systems.

The Function of the Evaporator

1.01 An *evaporator*—often called a *cooling coil*—is the part of the refrigeration system that removes heat from the substance to be cooled. This substance can be anything—including air—that occupies space and has weight. As you learned when studying the basic refrigeration cycle, an evaporator is able to absorb heat from a surrounding substance because the it is colder than the substance. The evaporator becomes cold and stays cold for the following reasons:

- The evaporator becomes cold because the refrigerant inside the coil is cold.
- The evaporator remains cold because the low temperature of the refrigerant remains unchanged at a given pressure. Any heat it absorbs is converted to latent heat of vaporization as the boiling proceeds.

1.02 Thus the evaporator cools by using the refrigerant's latent heat of vaporization to absorb heat from the substance being cooled. The amount of cooling that takes place in a refrigeration system depends upon the surface area of the evaporator, the heat transfer efficiency, and the temperature difference between the refrigerant and the substance being cooled. The basic method of heat removal is the same, however, whatever the substance being cooled.

1.03 Evaporators get their name from the way the refrigerant behaves while absorbing heat. Liquid refrigerant under high pressure in the receiver enters the metering device, which controls refrigerant flow to the evaporator. The restriction provided by the metering device also works with the compressor to maintain the pressure difference between the high side and the low side of the system. The sudden drop in pressure across the metering device causes the refrigerant to begin to boil. This action, in turn, causes the coil walls to give up heat and become cold. They in turn remove heat from the surrounding material. Thus, heat passes from the warmer substance, through the coil walls, to the refrigerant vapor, which then leaves the evaporator through the suction line and flows to the compressor.

How the Evaporator Works

1.04 A simple evaporator is shown in Fig. 1-1. At Point A on the diagram, the liquid refrigerant enters the metering device. Under proper operating conditions, the refrigerant will be subcooled at this point—that is, cooled below its saturation temperature. Subcooling ensures that the metering valve receives pure liquid refrigerant, with no vapor present to restrict the flow of refrigerant through the valve. You will learn more about how metering devices operate in Lesson Five of this Unit.

Fig. 1-1. Simple evaporator

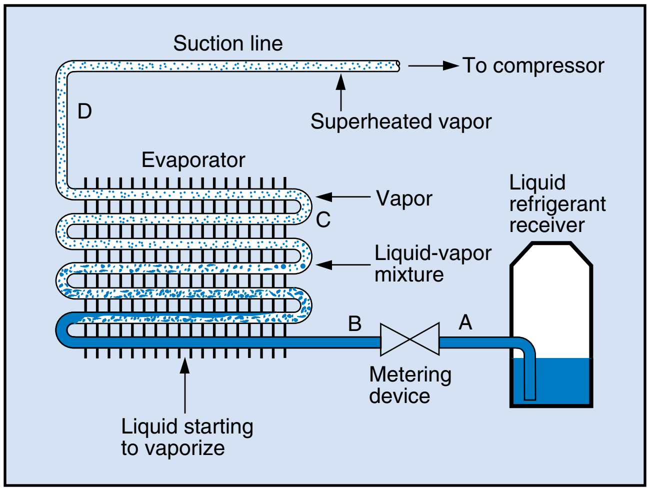
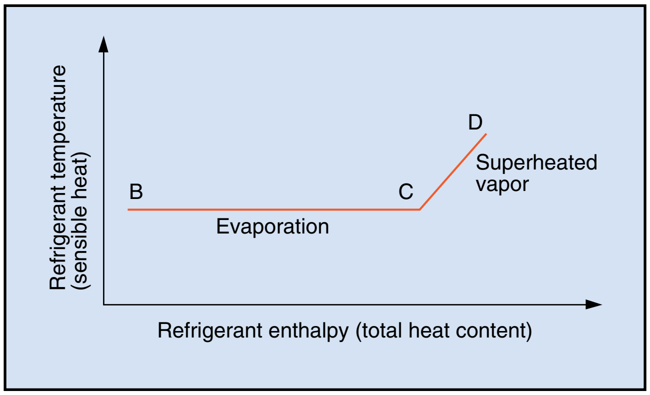


Fig. 1-2. Evaporator effect on refrigerant temperature and enthalpy



1.05 The liquid refrigerant enters the evaporator at Point B. The pressure of the liquid now drops to the pressure in the evaporator, causing the refrigerant's saturation temperature to drop also. Some of the liquid absorbs heat and flashes to vapor, cooling the remaining liquid to the new saturation temperature. Thus, at Point B, the evaporator contains low-pressure liquid refrigerant, plus a small amount of vapor.

1.06 The walls of the evaporator coil are designed to allow efficient heat transfer from the substance to be cooled to the refrigerant within the coil. You will learn the factors that influence this heat transfer efficiency later in this Lesson. To understand how the basic evaporator works, assume that efficient heat transfer occurs from the air or liquid being cooled to the refrigerant in the evaporator coil.

1.07 As the liquid refrigerant passes through the evaporator coil, it continually absorbs heat through the coil walls from the substance being cooled. As it does so, it continues to boil. Finally, at Point C in Fig. 1-1, all the liquid refrigerant has vaporized and only vapor remains in the evaporator coil. The liquid refrigerant's ability to convert absorbed heat to latent heat is now used up.

1.08 The refrigerant vapor within the evaporator coil, however, is still colder than the substance being cooled. Therefore the refrigerant vapor continues to absorb heat. Because no further evaporation can occur, this heat absorption causes an increase in the temperature of the vapor. The vapor temperature continues to rise until the vapor leaves the evaporator through the suction line (Point D in Fig. 1-1). At this point, the temperature of the vapor is above saturation temperature—the vapor is now superheated.

Effects of Latent and Sensible Heat

1.09 Figure 1-2 shows what happens to the refrigerant within the evaporator. It plots refrigerant temperature against refrigerant enthalpy. (Recall that *enthalpy* is the total heat content of a substance.) Points B, C, and D in Fig. 1-2 correspond to Points B, C, and D in Fig. 1-1.

1.10 The temperature is constant from Point B to Point C on the curve, although the enthalpy of the refrigerant increases steadily. This part of the curve corresponds to the evaporation of the liquid refrigerant. It reflects the effects of the latent heat absorbed by the evaporating liquid, with no change in temperature.

1.11 Both the temperature and the heat content of the refrigerant increase from Point C to Point D. At Point C, all the refrigerant liquid has evaporated. Thus, the portion of the curve from Point C to Point D reflects the increase in sensible heat of the refrigerant vapor.

1.12 The heat absorbed by the refrigerant while it is evaporating accounts for most of the cooling accomplished by the evaporator. In other words, the cooling is due to the vaporization of the refrigerant, rather than to an increase in the refrigerant's sensible heat.

Evaporator Capacity

1.13 The capacity of an evaporator equals the amount of heat it can absorb over a given period of time. But the actual rate of heat transfer from the substance being cooled to the refrigerant in the evaporator coil (evaporator capacity) is often less than this amount.

1.14 Some of the factors affecting the capacity of an evaporator are:

- the **difference in temperature** between the refrigerant within the evaporator coil and the substance being cooled

- the **thickness and thermal conductivity** of the materials used in the construction of the evaporator coil
- the **contact surface area** available between the surface of the evaporator coil and the substance being cooled
- the **velocity** of the refrigerant in the coil and the velocity of the substance being cooled
- the **cleanliness** of the evaporator.

1.15 Of these five factors, the last—the cleanliness of the evaporator—is the one over which the technician can exercise the most control. Specific maintenance procedures for the various types of industrial and commercial evaporators are given in Lesson Four of this Unit.

Temperature Differential

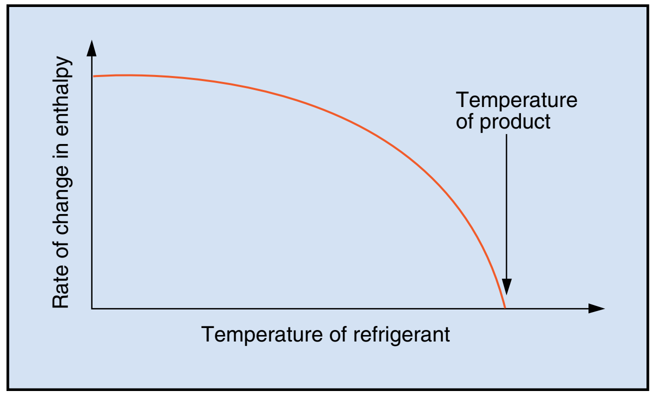
1.16 You learned earlier in this course that heat always flows from a substance at a higher temperature to one at a lower temperature. You should also recall that heat transfer will occur more rapidly if the difference in temperature between the two substances is large rather than small.

1.17 To reduce the temperature of the substance to be cooled, heat must be removed from that substance and absorbed by the refrigerant. The exact amount of cooling depends upon the system application. The maintenance of a comfortable environment for people or for storage of food products might require relatively little heat removal per unit of volume. Other applications, such as metal treating operations that require temperatures well below freezing, call for the removal of a large amount of heat. The methods by which these various temperatures are achieved are essentially the same.

1.18 The amount of heat gained by the refrigerant in the evaporator equals the heat lost by the substance being cooled. The thermal energy (heat) gain of the refrigerant is accompanied by:

- evaporation of the refrigerant at constant temperature in which the latent heat of vaporization is used to bring about the heat transfer, or

Fig. 1-3. Effect of increasing the temperature of the refrigerant



- a rise in the refrigerant's temperature due to an increase in its sensible heat content, or
- a combination of the two.

1.19 If the heat absorbed by the refrigerant does not cause vaporization, the refrigerant's temperature will rise. As the temperature of the refrigerant increases, the rate of heat transfer between the substance being cooled and the refrigerant decreases. This effect is shown by the curve in Fig. 1-3. Notice that the rate of increase in refrigerant enthalpy drops off sharply with increasing refrigerant temperature. This drop means the rate of heat transfer also decreases.

1.20 The use of the latent heat of vaporization for heat absorption has the advantage that the temperature of the refrigerant remains nearly constant. Therefore, the rate of heat transfer between the substance being cooled and the refrigerant stays relatively high. Remember, however, that while the refrigerant is evaporating, the product is getting colder and the temperature *difference* between the two is no longer as great as it was. Thus, the rate of heat transfer slowly decreases, even though the refrigerant temperature remains constant.

The Programmed Exercises on the next page will tell you how well you understand the material you have just read. Before starting the exercises, remove the Reveal Key from the back of the book. Read the instructions printed on the Reveal Key. Follow these instructions as you work through the Programmed Exercises.

1-1. When liquid refrigerant evaporates in an evaporator coil, it gains ________ heat.	1-1. LATENT Ref: 1.01
1-2. When a liquid's temperature is lower than its saturation temperature, it is said to be ________.	1-2. SUBCOOLED Ref: 1.04
1-3. No further conversion of absorbed heat to latent heat is possible once all liquid refrigerant in the evaporator has ________.	1-3. CHANGED TO VAPOR Ref: 1.07
1-4. A vapor is said to be ________ when its temperature is higher than its saturation temperature.	1-4. SUPERHEATED Ref: 1.08
1-5. As liquid refrigerant vaporizes, its temperature remains constant but its ________ increases.	1-5. ENTHALPY Ref: 1.10, 1.11
1-6. Of the factors affecting evaporator capacity, which is the most easily controlled?	1-6. EVAPORATOR CLEANLINESS Ref: 1.15
1-7. Heat transfer occurs rapidly when the temperature difference between two substances is ________.	1-7. LARGE Ref: 1.16
1-8. What happens to the rate of heat transfer with an increase in the refrigerant's sensible heat?	1-8. IT DECREASES Ref: 1.18

Evaporator Construction

1.21 There are two other factors that affect the heat transfer characteristics of an evaporator. They are based on the construction of the particular unit. The first of these factors is the thermal conductivity of the material used in the construction of the evaporator walls.

1.22 Recall that *conduction* is the transfer of heat that occurs by means of direct contact between two materials at different temperatures. The heat transfer depends upon molecular collisions between the materials of the two objects. The speed of heat transfer depends not only on how well the two materials conduct heat, but also on how much direct contact there is between the two materials. Metals—copper, iron, and aluminum, for example—are excellent conductors. For this reason, evaporator coils are almost always metallic. The specific metal used depends not only upon its conductivity, but also upon how the refrigerant affects the material. Corrosion is always an important consideration.

1.23 The thickness of the evaporator coil wall also affects heat transfer. In general, the thicker the wall, the lower the rate of heat transfer. Because the refrigerant is under pressure in most evaporator systems, evaporator walls must be thick enough to withstand the effects of that pressure. However, because evaporators are usually made from highly conductive materials, coil wall thickness has only a slight effect on total heat transfer efficiency.

Contact Surface Area

1.24 An important factor affecting evaporator capacity is the amount of surface area making contact between the walls of the evaporator coil and the substance being cooled. The amount of contact, in turn, depends upon the physical size and shape of the evaporator coil.

1.25 Evaporators are often classified by their construction. Three widely used types of evaporator coils are examples of the common ways of increasing the contact surface area:

- bare-tube coils
- finned-tube coils
- plate evaporators.

Other special-purpose evaporators are described in later Lessons in this Unit.

1.26 The simplest type of evaporator is the *bare-tube coil evaporator*—which can be either a *single-circuit evaporator,* as shown in Fig. 1-4, or a *multiple-circuit evaporator,* as shown in Fig. 1-5. Bare-tube coils are also called *prime-surface evaporators*. Because of its simple construction, the bare-tube coil is easy to clean and defrost. Notice, however, that it offers relatively little surface contact area compared to the other types. The amount of surface area can be increased by simply extending

Fig. 1-4. Bare-tube coil evaporator–single circuit

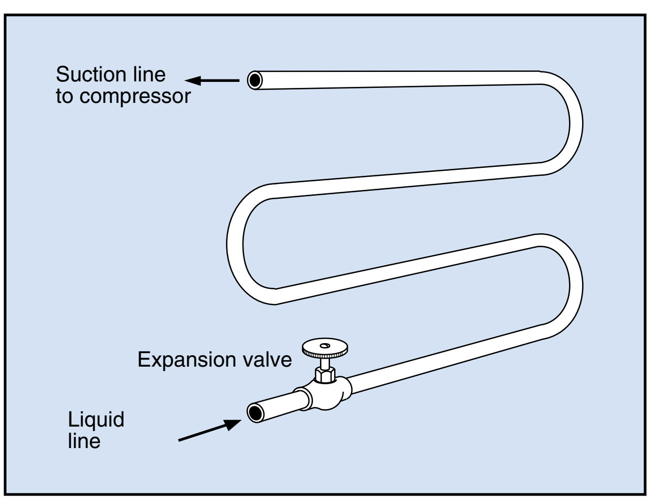


Fig. 1-5. Bare-tube coil evaporator–multiple circuit

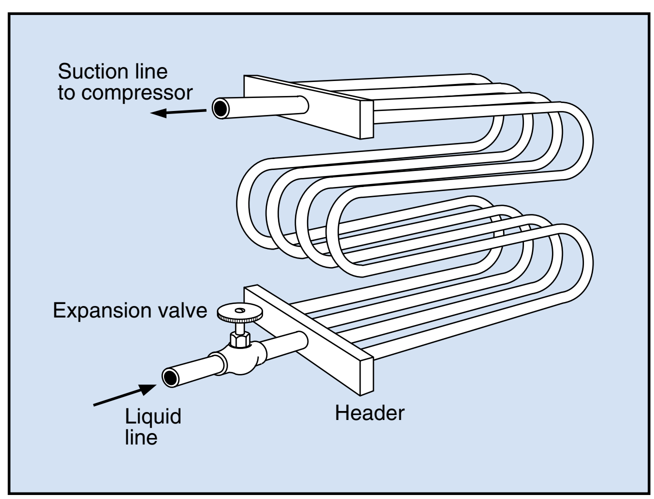
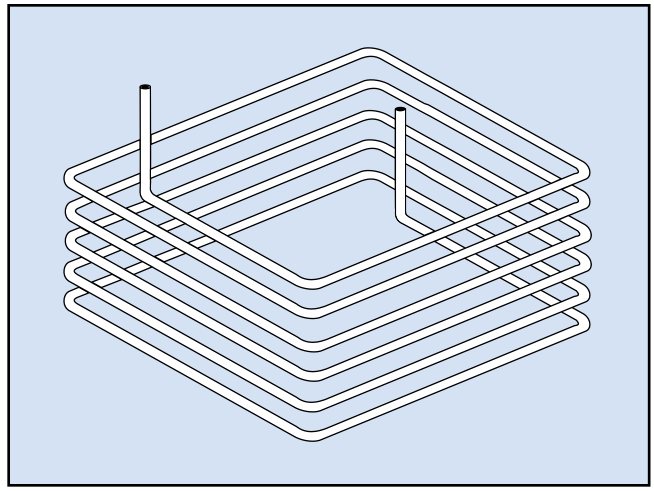


Fig. 1-6. Refrigerant distributor

Fig. 1-8. Special-purpose single-circuit coil



the length of the tube. But there are disadvantages to excessive tube length.

1.27 The effective length of the evaporator tube is limited by the capacity of the inlet metering device or expansion valve. If the tube is too long for the capacity of the inlet device, the liquid refrigerant vaporizes completely early in its progress through the tube, thus leading to excessive superheating at the outlet.

1.28 Long tubes cause a greater pressure drop between the expansion valve at the evaporator inlet and the connection to the suction line. The result of this drop is a reduced suction line pressure. For maximum compressor efficiency, suction pressure should be kept at the highest level possible for the evaporator's pressure-temperature requirements.

1.29 The ratio of tube length to tube diameter can also be critical. If the tube diameter is too large, the refrigerant velocity will be too low and the volume of refrigerant will be too great in relation to the surface area of the tube to allow complete vaporization. This condition, in turn, can allow liquid refrigerant to enter the suction line with possible slugging damage to the compressor. If, on the other hand, the tube diameter is too small, the pressure drop due to friction will be too high and will reduce system efficiency.

1.30 One way to increase surface contact area is to place a number of single-circuit evaporator coils

Fig. 1-7. Flat single-circuit evaporators

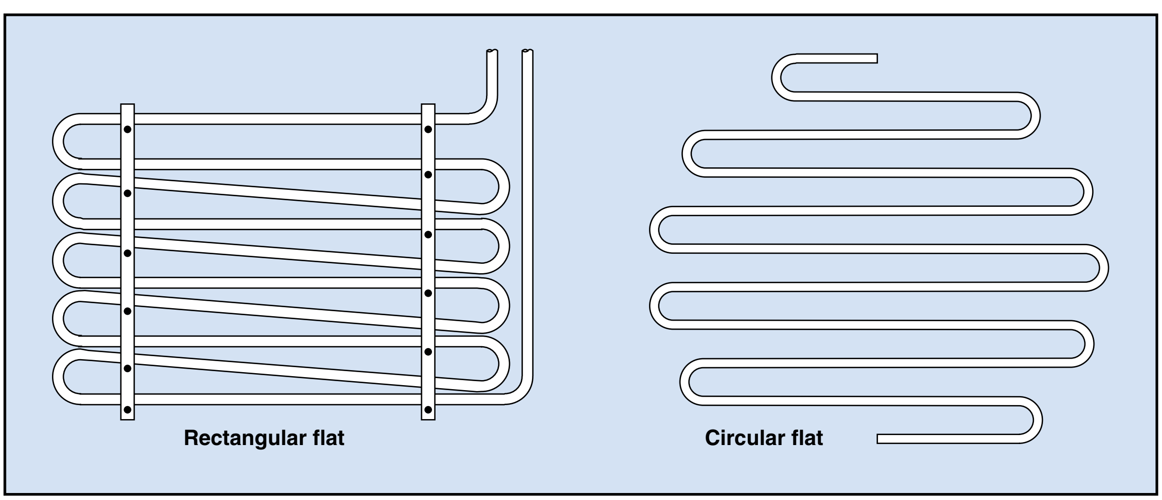


Fig. 1-9. Multiple-circuit coil used as stand

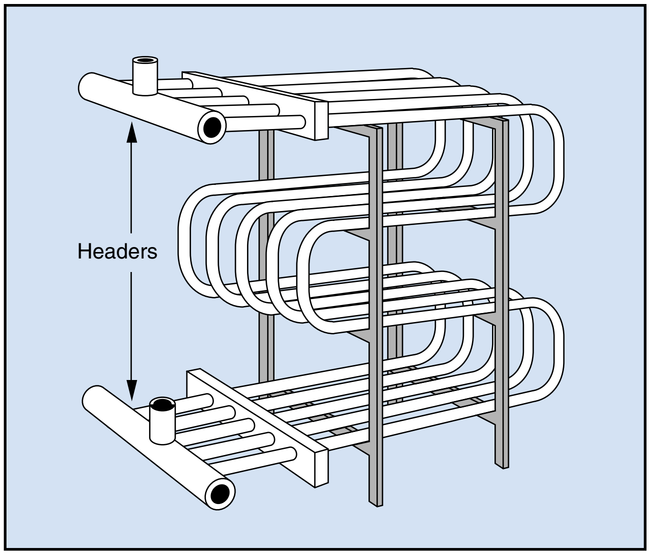
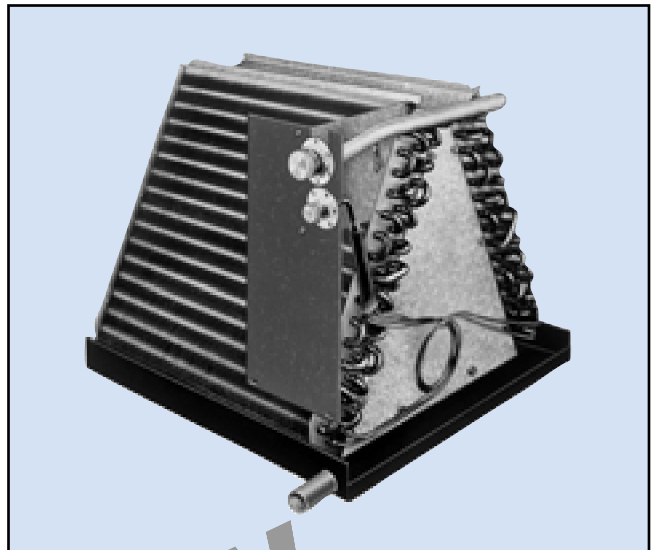


Fig. 1-10. Finned-tube evaporator



in parallel, as shown in Fig. 1-5. This configuration is called a *multiple-circuit evaporator*. It retains the advantages of ease of cleaning and defrosting while offering a larger surface area for heat transfer. This evaporator construction also allows the use of a single suction line to the compressor at the evaporator outlet, and a single expansion valve at the inlet.

1.31 Liquid refrigerant is uniformly distributed from a single expansion valve to the individual coils of a multiple-circuit evaporator by a *header*, as shown in Fig. 1-5, or a *distributor*, as shown in Fig. 1-6. Distributors are usually located as close as possible to the expansion valve. They provide better distribution than plain headers or manifolds, because they feed an equal amount of liquid refrigerant and flash gas from the expansion valve to each circuit. Several types of distributors are available.

1.32 Both single- and multiple-circuit coil evaporators are manufactured in many different shapes to serve a wide variety of applications. Some typical configurations are shown in Fig. 1-7 through 1-9. Figure 1-7 shows two flat single-circuit evaporators: a rectangular flat and a circular flat. Coils such as these often serve as shelving in food storage cases or in similar applications where direct contact cooling is desired.

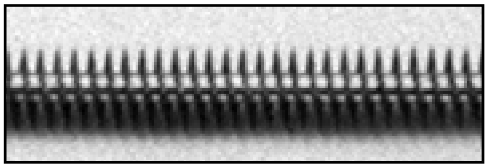
1.33 Another example of a single-circuit coil evaporator is shown in Fig. 1-8. Here the coil is formed into a three-dimensional box-like arrangement. As you can see, coils can be designed to fit a variety of cooling compartment sizes and shapes. In cold-storage plants, coils are often shaped to extend across rooms, and to be suspended from walls and ceilings.

1.34 A multiple-circuit evaporator used as a stand in an ice cream hardening room is shown in Fig. 1-9. Headers provide uniform distribution of the liquid refrigerant.

1.35 The most common method of increasing surface contact area is by adding fins to single- or multiple-circuit coils. These finned evaporators are also called *extended-surface evaporators*. In the *finned-tube evaporator* shown in Fig. 1-10, a multiple-circuit coil is positioned within a framework of metal fins. Because the metal fins are constructed of thin sheets of metal having good thermal conductivity, this arrangement greatly increases the contact surfaces available for heat transfer. The shape, size, or spacing of the fins can be adapted to provide the best rate of heat transfer for a given application. For example, in low-temperature applications, the evaporator designer must consider frost or ice formation in determining fin size and spacing.

1.36 Figure 1-11 on the following page shows a different kind of finned tube in which a thin strip of metal is wound around an individual tube. The edge

Fig. 1-11. Finned tube with spiral fin



of the metal strip is attached to the tube, forming a spiral. This kind of construction also greatly increases the area available for heat transfer. The finned coils can be arranged in rows or banks within a frame.

1.37 Another common evaporator, called a *plate evaporator*, is often used as a wall or shelving in applications with limited space. It is used mainly in contact cooling where the product to be cooled is placed directly on the plate. The frozen food industry, for example, makes extensive use of plate evaporators.

1.38 Some plate evaporators are constructed of two metal sheets with raised edges. When sealed together, the two sheets form a flat compartment. One type of plate evaporator simply circulates the refrigerant throughout the hollow area between the two metal sheets. Another type, shown in Fig. 1-12, contains tubing between the two sheets through which the refrigerant circulates. In this type of evaporator, the plates are usually sealed and held tightly against the tubing by a partial vacuum within the space between the sheets, thus increasing heat transfer.

Circulation Velocity

1.39 Evaporator capacity can also be increased by increasing the velocity of the air or liquid moving across the evaporator coil. When the circulation of the air or liquid being cooled depends entirely upon natural convection, a large amount of surface contact area is required for sufficient heat transfer. In *natural convection*, circulation occurs because of the density difference between warm and cool fluids. Natural convection is a relatively slow process that limits the rate at which an evaporator can absorb heat. Increasing the coil surface contact area is one way to overcome this disadvantage.

1.40 However, a more common and practical method of improving upon natural convection is to add a fan or pump to speed up the circulation of the substance being cooled. This arrangement, called *forced circulation*, allows more heat to be transferred per unit area of evaporator coil in a given length of time. Two typical forced-air evaporators are shown in Fig. 1-13. These units use fans to move the air across the coil. The increased velocity of the air will either increase the amount of cooling or allow a decrease in the size of the evaporator required by the system. (The use of pumps to circulate the liquid being cooled will be covered in Lesson Three.)

1.41 Forced-circulation air-cooling units can be classified into three groups according to the velocity of the air leaving the unit: low velocity, medium velocity, and high velocity.

Fig. 1-12. Plate-type evaporators

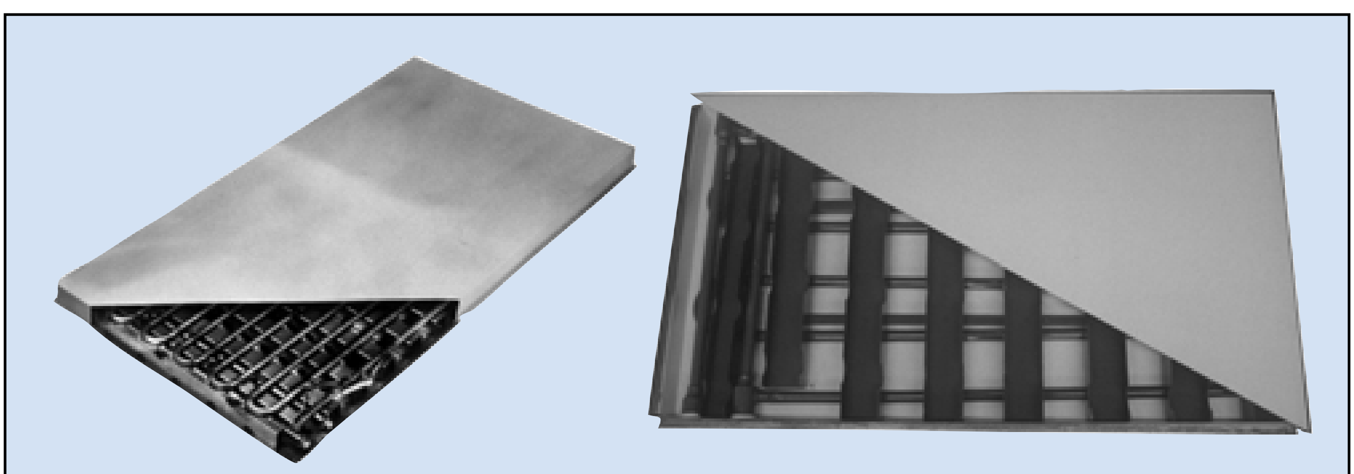
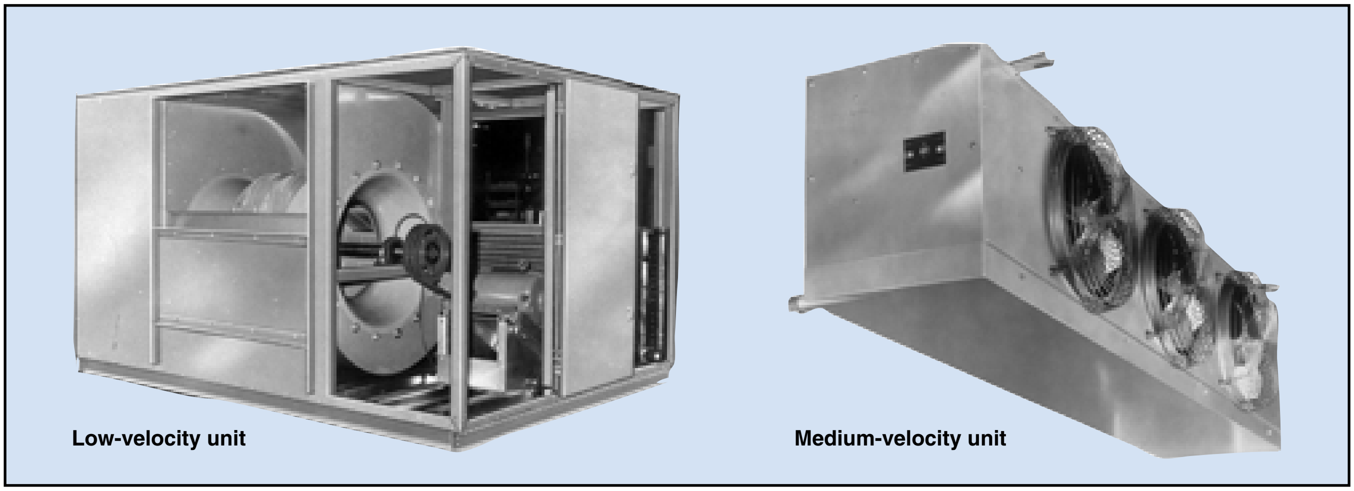


Fig. 1-13. Forced-air evaporators



1.42 *Low-velocity units* have a discharge air rate that does not exceed 500 feet per minute (fpm). These units usually operate in the 200 to 300 fpm range, and are used where low noise and low air flow rates are needed. A specific application is comfort air conditioning. Both centrifugal and propeller fans are used with low-velocity cooling units. An example is shown in Fig. 1-13.

1.43 *Medium-velocity units* have an exit velocity of 500 to 800 fpm. They are frequently used in refrigerators and freezers where drafts and noise are not a problem. Propeller fans are usually the source of air circulation in these units. An example of this kind of unit is also shown in Fig. 1-13.

1.44 *High-velocity units* have a minimum discharge rate of 800 fpm, but are frequently in the range of 1000 to 2000 fpm. They are used principally in blast freezers or special product refrigerators requiring quick reduction of temperature. High-velocity cooling units usually use axial fans as the source of circulation.

Effects of Water Vapor

1.45 The evaporators used in air conditioning systems are frequently called *comfort coolers*, meaning that they reduce both the temperature and humidity of the air to levels of human comfort. Earlier in this course, you learned that ambient air is a mixture of air and water vapor. When this moist air circulates around cold evaporator coils, it is cooled. If it is cooled below its dewpoint temperature, moisture condenses on the evaporator coils. When this happens, the evaporator is absorbing the latent heat of condensation of the water vapor in addition to the sensible heat required to reduce the air temperature.

1.46 If moisture condenses on an evaporator with a surface temperature below 32°F (0°C), frost or ice will form on the surface of the evaporator coils. If allowed to remain or build up, the ice will limit further heat transfer. You will learn about the various methods used to defrost evaporator coils in Lesson Four of this Unit.

1-9. Name the three main types of evaporator coil.	1-9. BARE-TUBE COIL, FINNED-TUBE COIL, PLATE Ref: 1.25
1-10. If an evaporator tube diameter is too large, refrigerant ________ will be too low.	1-10. VELOCITY Ref: 1.29
1-11. How is refrigerant from a single expansion valve distributed to the individual coils of a multiple-circuit evaporator?	1-11. BY USING A HEADER OR DISTRIBUTOR Ref: 1.31
1-12. What is the main advantage of the finned-tube evaporator coil over the bare-tube coil?	1-12. INCREASED CONTACT AREA FOR HEAT TRANSFER Ref: 1.35
1-13. Natural convection in fluids occurs because the ________ of a cool fluid is greater than that of a warm fluid.	1-13. DENSITY Ref: 1.39
1-14. Low-velocity cooling units are used where ________ and ________ must be kept low.	1-14. NOISE and AIR FLOW RATE Ref: 1.42
1-15. Comfort cooling units reduce both the ________ and ________ of the air to levels of human comfort.	1-15. TEMPERATURE and HUMIDITY Ref: 1.45
1-16. To cool air below its dewpoint temperature, an evaporator must absorb both the ________ and the ________ heat of the water vapor.	1-16. SENSIBLE and LATENT Ref: 1.45

Answer the following questions by marking an "X" in the box next to the best answer.

1-1. The function of the evaporator in a refrigeration system is to

- ☐ a. meter liquid refrigerant to the system
- ☐ b. protect the compressor
- ☐ c. remove heat from the substance to be cooled
- ☐ d. store liquid refrigerant

1-2. The sudden drop in refrigerant pressure at the metering device causes the

- ☐ a. evaporator walls to become hot
- ☐ b. high- and low-side pressures to equalize
- ☐ c. refrigerant to boil
- ☐ d. refrigerant to release heat

1-3. Refrigerant leaving the evaporator through the suction line leading to the compressor is

- ☐ a. a mixture of liquid and vapor
- ☐ b. at its saturation temperature
- ☐ c. subcooled liquid
- ☐ d. superheated vapor

1-4. In a refrigeration system, the temperature of the substance to be cooled must be

- ☐ a. above freezing
- ☐ b. lower than the evaporator
- ☐ c. the same as the evaporator
- ☐ d. higher than the evaporator

1-5. A bare-tube coil evaporator is also called a(n) ________ evaporator.

- ☐ a. distributed
- ☐ b. extended-surface
- ☐ c. plate
- ☐ d. prime-surface

1-6. What device is commonly used to feed equal amounts of refrigerant to the multiple circuits of an evaporator?

- ☐ a. Accumulator
- ☐ b. Distributor
- ☐ c. Float valve
- ☐ d. Reservoir

1-7. What causes finned-tube coils to have a higher rate of heat transfer than bare-tube coils?

- ☐ a. Greater surface area
- ☐ b. Lower refrigerant velocity
- ☐ c. Multiple metering devices
- ☐ d. Restricted flow channels

1-8. Plate evaporators are used mainly in

- ☐ a. comfort cooling systems
- ☐ b. contact product cooling
- ☐ c. multiple-evaporator systems
- ☐ d. place of manifolds

1-9. Using forced circulation to increase evaporator capacity requires

- ☐ a. adding a fan or pump
- ☐ b. installing a thermostatic expansion valve
- ☐ c. lengthening the coils
- ☐ d. using natural convection

1-10. The temperature at which the water vapor in the air starts to condense on the evaporator coils is called the air's________ temperature.

- ☐ a. condensing
- ☐ b. dewpoint
- ☐ c. saturation
- ☐ d. wet-bulb

SUMMARY

The evaporator is the refrigeration system component that removes heat from the substance being cooled. It is able to absorb heat because it is colder than the substance. It is cold because of the vaporizing refrigerant inside it.

Several factors affect the capacity of an evaporator—difference in temperature between the refrigerant and the cooled substance, thickness and thermal conductivity of its walls, its surface area, the velocity of the refrigerant, and the cleanliness of the evaporator. Most evaporator coils are metallic, because metals are good conductors of heat.

The three widely used types of evaporator coils are bare-tube coils, finned-tube coils, and plate evaporators. Bare-tube coil evaporators can be either single-circuit or multiple-circuit components. They are sometimes called prime-surface evaporators. Although they are easy to clean, they offer relatively little surface contact area.

The finned-tube or extended-surface evaporator has much greater thermal capacity than the bare-tube type because of the increased contact surface available. The plate evaporator is often used as a wall or shelving in locations with limited space.

Circulation of the substance being cooled across the evaporator coil can be by either natural convection or by forced circulation. Forced circulation air cooling units fall into three categories: low-velocity units (discharge rates under 500 fpm), medium-velocity units (discharge rates of 500 to 800 fpm), and high-velocity units (minimum discharge rate of 800 fpm).

The evaporators used in air conditioning systems are often called comfort coolers, because they reduce both the temperature and the humidity of the air to levels of human comfort. If frost or ice forms on the surface of evaporator coils, it will limit heat transfer.

Answers to Self-Check Quiz

1-1. c. Remove heat from the substance to be cooled. Ref: 1.01

1-2. c. Refrigerant to boil. Ref: 1.03

1-3. d. Superheated vapor. Ref: 1.08, Fig. 1-1

1-4. d. Higher than the evaporator. Ref: 1.16

1-5. d. Prime-surface evaporator. Ref: 1.26

1-6. b. Distributor. Ref: 1.31

1-7. a. Greater surface area. Ref: 1.35

1-8. b. Contact product cooling. Ref: 1.37

1-9. a. Adding a fan or pump. Ref: 1.40

1-10. b. Dewpoint. Ref: 1.46

Contributions from the following sources are appreciated:

Figure 1-6. Alco Controls Div., Emerson Electric Company
Figure 1-11. Edwards Engineering Corp.
Figure 1-12. Dole Refrigeration Company
Figure 1-13. Bohn Heat Transfer Div., Gulf and Western Mfg. Company; Halstead & Mitchell Div., Halstead Industries