Commercial and Industrial Refrigeration Systems

Commercial and industrial refrigeration systems and comfort cooling systems both remove heat. Refrigeration systems remove heat for industrial processes and food preservation, while air conditioning systems remove heat for human comfort.

The main difference between commercial and industrial refrigeration systems and comfort cooling systems is that refrigeration systems tend to operate at lower temperatures.

Most commercial refrigeration involves the refrigeration or freezing of food and perishable commodities using refrigerated warehouses, walk-in coolers, and display cases.

Refrigeration of food products starts with the harvest and takes place along the distribution chain from processing plant, to warehouse, to retail establishments, and finally to the home.

Cold storage is used to preserve perishable food. The storage conditions are determined by the type of food and the length of time it is to be kept in storage.

Foods placed in cold storage can be held in the above freezing chilled temperature range where fruits, vegetables, and flowers may continue to grow shoots or ripen.

Correct airflow must be maintained in cold storage areas. Too much airflow may dehydrate produce.

The other cold storage temperature range is below freezing where products such as ice cream and other frozen foods are kept.

Cold storage plants or warehouses can be dedicated to chilled or frozen storage, or may have sections dedicated to both storage temperatures.

Fruits and vegetables are the main foods stored in chill rooms, where medium-range temperatures above the freezing point (32°F to 60°F) are used to maintain the quality of the produce.

Frozen foods are typically maintained at temperatures ranging from 10°F to −10°F, with rooms used to store ice cream commonly kept at −20°F.

Foods being frozen go through a three-step process, starting with the lowering of the sensible temperature. The second step is the removal of the latent heat of fusion, turning water in the product to ice crystals.

Once the latent heat of fusion is removed, further sensible heat is removed until the product has reached the desired frozen storage temperature.

Several methods are used for freezing foods. Air blast freezing uses cold air circulated around the product. It is often used to freeze inconsistent or irregular-shaped objects.

With contact freezing, packaged or unpackaged foods are pressed between cold metal plates.
Belt freezers are generally used for unpackaged products.

Cryogenics is a method used to freeze products at very low temperatures (below −250°F) using cryogenic fluids such as carbon dioxide, nitrogen, and helium.

Freeze-drying, also known as lyophilization, uses a vacuum to remove moisture from the product, resulting in lighter weight and a product that does not require refrigeration for long-term preservation.

Refrigerated and frozen foods are transported throughout the distribution chain in refrigerated ships, trucks, and railcars.

Refrigerated commodities are carried on container ships in insulated steel containers, each with its own electrically powered refrigeration unit.

Generators provide power for the refrigeration unit when the container is being transported and is not connected to the ship’s electrical power.

Microprocessor controls maintain precise temperatures within the container so the commodity does not spoil on an extended ocean voyage.

Many containers maintain a controlled atmosphere (CA) in which oxygen, nitrogen, and carbon dioxide levels inside the container are controlled to minimize ripening.

At some point in the delivery chain, perishable products will be transported in a refrigerated truck or trailer.

Perishables transported long distances are often carried in insulated trailers cooled with a self-contained refrigeration unit mounted on the front of the trailer.

The compressors used in trailer-mounted refrigeration units are open drive semi-hermetic compressors driven by a small diesel engine.

Self-contained trucks with a refrigerated box are often used to carry smaller loads for local delivery.

Local delivery trucks are often cooled by a self-contained refrigeration unit mounted on the front of the cargo area just above the driver’s cab.

Direct-drive units that have a compressor driven by the truck’s engine are used in trucks of lower capacity to make local deliveries.

Commodities can be transported in refrigerated railcars. As an alternative, flatbed rail cars can be used to transport the same refrigerated containers carried aboard ships.

The operation and components used to cool or freeze foods are basically the same as those used in comfort cooling systems.
To cool chill rooms or walk-in coolers, an air-or water-cooled condensing unit is connected to an evaporator unit called the unit cooler. The installation closely resembles a split-system air conditioning system.

Refrigeration equipment manufacturers classify equipment according to its cooling class, which is based on the evaporator operating temperature.

Supermarkets have cooling requirements that cover nearly all the evaporator operating temperatures. Systems operating at higher temperatures are more energy-efficient than systems operating at lower temperatures.

The same types of compressors used for comfort cooling systems are also used in refrigeration systems. Single compressors are used in about one-half of all refrigeration systems. They have the advantage of being able to supply multiple evaporators at a relatively low cost.

The use of multiple compressors connected in parallel allows greater system capacities and the ability to meet varying load conditions.

Connecting two or three smaller compressors in parallel normally results in a higher Btu-per-horsepower capacity than when one larger compressor is used.

Parallel compressors of different sizes can be staged to obtain more steps of capacity than the same number of equally sized compressors.

There are several guidelines that should be observed when installing parallel compressors. For example, never combine equipment designed to cool non-frozen foods with equipment designed to cool frozen foods.

A satellite compressor is a separate compressor that uses the same source of refrigerant as that used by a related group of parallel compressors.

The satellite compressor functions as an independent compressor connected to a cooling area that requires a lower temperature than is being maintained by the related parallel compressors.

Two-stage compressors are often used in ultra low-temperature systems to pump very low-pressure suction line vapor up to the required condensing pressures and temperatures.

The use of two-stage compressors also results in a lower compression ratio than a single-stage compressor. See the text for the formula for calculating compression ratio.

High temperatures developed between the compression stages can be eliminated by de-superheating the gas in the inter-stage piping.

Most refrigeration systems use air-cooled condensers, which are often installed in a remote location from the compressor.
Condensers used in refrigeration systems are rated by their total heat rejection (THR) value, which is the total heat removed from the refrigerant as it passes through the condenser.

The rating of an air-cooled condenser is based on the temperature difference (TD) between the dry-bulb temperature of the air entering the condenser and the saturated condensing temperature.

Condensing temperatures and pressures must be maintained year-round for proper system operation and capacity.

TXVs require a specific pressure drop to operate at their rated capacity based on the refrigerant used. For example, HCFC-22 expansion valves are manufacturer-rated for a 100 psig pressure drop.

Low head pressure during winter operation can be prevented by refrigerant-side control that adjusts the amount of active condensing surface used in the condensing coil.

Another method of refrigerant-side control uses a condenser with two equal parallel sections, each handling 50% of the load during summer operation. Only one half of the condenser used in winter.

Head pressure can also be maintained by varying condenser fan speed by way of an electronic control, or by cycling the condenser fan on and off using a pressure-actuated control.

Piping of hot gas line connections to multiple condensers must be done in such a way as to maintain a nearly equal pressure drop to each condenser.

Subcooling is used in refrigeration systems to reduce the temperature of the refrigerant in the liquid line, with the end result being increased system capacity.

Subcooling can be attained by using separate subcooling coils or by integrating a subcooling section within the condenser’s main coil assembly. Suction-to-liquid heat exchangers can also be used to increase subcooling.

Air-cooled condensers should be installed according to the manufacturer’s instructions and with special attention to coil airflow and service clearances.

Evaporators used to cool the air in refrigeration systems operate by forced convection or natural convection.

Unit coolers used in chill rooms and walk-in coolers use one or more fans to move cooled air and are classified as forced-convection evaporators.

A unit cooler is usually a packaged assembly consisting of the evaporator coil, blower or fan, expansion valve, and defrost mechanism.

Unit coolers used in areas requiring high humidity have large coils operating with small air-to-refrigerant temperature differences of 4°F to 8°F.
Unit coolers used in areas requiring low humidity have small coils operating with large air-to-refrigerant temperature differences of 20°F to 30°F.

Natural-convection evaporators are used in display cases and are classified as frosting, defrosting, and non-frosting. Non-frosting evaporators operate just at or above freezing, while defrosting and frosting evaporators operate below freezing.

Multiple evaporators are commonly encountered in refrigeration systems. Special attention must be paid to refrigerant piping and expansion valve installation in order to avoid problems.

Eutectic-plate evaporators, often called holding plates, are used in applications where continuous power to operate a compressor is not always available.

A eutectic solution maintains a constant temperature while being frozen or while thawing. Once frozen by the compressor, the holding plate acts like a block of ice to maintain temperature when the compressor cannot run.

Open, self-service display cases operate at medium and low temperatures and are widely used in food stores.

The cooling load experienced by the display case is affected by the environment in which it is installed. The refrigeration load is normally rated based on ambient summer design conditions of 75°F and 55% relative humidity.

Open display cases refrigerate the food using a blanket of cold air. When compared to closed coolers, they require about twice as much refrigeration capacity due to their open construction.

Open display cases can operate above freezing for fresh produce and dairy products, or below freezing for products such as ice cream.

Accessories are added to the basic refrigeration system to improve safety, endurance, efficiency, or servicing.

Filters and filter-driers are used to remove harmful moisture and debris particles from the refrigeration system.

Filters and filter-driers are available both as sealed, throwaway units and with replaceable cores.

A liquid-line sightglass allows for a visual inspection of the state of the refrigerant in the liquid line and may contain a moisture indicator.

A suction line accumulator is a protective device that prevents the compressor from taking in slugs of liquid refrigerant or compressor oil.

Crankcase heaters are installed on compressors. They separate refrigerant from the oil to prevent damage to the compressor when it starts.
Band-type or insertion-type crankcase heaters are commonly used on refrigeration system compressors.

Oil separators trap and hold for return, any oil that has left the compressor. They are usually installed in the hot gas line as close to the compressor discharge as possible.

Oil filters, oil reservoirs, oil differential check valves, and oil level controls are other components used in the system to manage oil levels and oil return to the compressor.

The liquid receiver is a tank or container designed to store excess refrigerant caused by wide load variations.

Various types of manual shutoff and service valves are installed in a refrigeration system to isolate components or to provide service access for evacuation and refrigerant charging.

Relief valves are mechanical safety devices designed to open and relieve excessive refrigerant pressure.

Fusible plugs perform the same function as relief valves by melting when a temperature corresponding to a pre-determined pressure is reached.

Check valves are placed in refrigeration piping circuits to ensure one-way flow of refrigerant or to block the flow of refrigerant from parts of the circuit.

Mufflers, usually installed in the compressor discharge line, dampen compressor pulsations that can generate noise or damage system components.

Vibration isolators or dampers are flexible tubes installed in refrigerant piping to prevent the transmission of damaging vibrations to other components.

For best vibration control, mount isolators in the suction and discharge lines, with one mounted vertically and one mounted horizontally.

Temperature and pressure control devices used in refrigeration systems may be operated manually or they may be automatic.

Crankcase pressure regulating (CPR) valves are installed in the suction line before the compressor.

CPR valves control the maximum pressure at the compressor suction line and provide overload protection for the compressor motor.

Evaporator pressure regulating (EPR) valves are installed in the suction line between the evaporator and compressor.

EPR valves control the evaporator temperature on systems that use multiple evaporators operating at different temperatures, or on systems where the evaporator temperature cannot be allowed to drop below a certain level.
A condenser pressure regulator (head pressure control) is a three-way modulating valve that maintains proper condenser pressure when the ambient or outdoor air temperature is low. Larger systems use two separate valves to accomplish the same thing.

The head pressure control does this by routing refrigerant in such a way as to flood the condenser. This reduces the condensing surface and causes head pressure to increase.

Bypass control valves for air-cooled condensers function as condenser bypass devices on air-cooled condensers with winter start control. They are installed in the bypass line between the compressor discharge and the receiver.

Capacity control, available in many forms, refers to the method used to control a system so that its heat removal ability or capacity matches changing system load conditions. Hot gas bypass and suction modulation are commonly used methods of capacity control.

Capacity can be controlled by maintaining the suction pressure above a certain setpoint by bypassing hot gas into the low side of the system at a controlled rate using special valves. This method is used where short cycling of the compressor is not satisfactory.

On close-connected systems using a single evaporator, the hot gas is bypassed into the evaporator immediately after the expansion valve.

Special tee fittings are available that introduce the hot gas between the expansion valve and the refrigerant distributor assembly.

On systems where the condenser and evaporator are a distance apart, or multiple evaporators are used, the hot gas can be introduced into the suction line upstream of the compressor.

Suction modulation is a form of capacity control that uses a microprocessor-controlled valve to carefully control the flow of refrigerant through the suction line.

During the compressor off-cycle, it is advantageous to prevent refrigerant from migrating to the compressor where it can condense in the crankcase and cause problems during the next startup.

Pump-down controls allow the compressor to pump the refrigerant into the condenser coil and receiver where it is stored during the off-cycle. This keeps liquid refrigerant out of the system’s low side and compressor crankcase. Evaporators used in low-temperature applications will build up frost that must be removed periodically to maintain system efficiency.

The simplest defrost method is to manually turn the refrigeration unit off to allow time for the frost to melt.

Timed defrost uses a timer to shut the unit off to allow frost to melt.

Electric defrost is used when off-cycle or timed defrost is inadequate to clear the frost. Electric heaters, either resistive or infrared, heat the coil to clear the frost.
Sophisticated electromechanical or electronic timers used with temperature sensors initiate and terminate electric defrost.

Hot-gas defrost uses valves to direct hot discharge gas to the evaporator, where it heats the coil and melts the frost.

The latent heat defrost method, in its simplest form, uses three evaporators that are defrosted in rotation. The evaporator being defrosted acts as a condenser for the other two coils, which continue to refrigerate.

If allowed by codes, ammonia-based refrigeration systems offer an alternative to HFC- and HCFC-based systems.

Ammonia, a refrigerant composed of nitrogen and hydrogen, has excellent heat transfer qualities and is commonly used in industrial refrigeration systems.

Ammonia can be used in a conventional mechanical refrigeration system or it can be used in a non-mechanical system in an absorption cycle.

Mechanical ammonia systems can be single- or multi-stage (compound) systems. Compound systems used when very low temperatures are required.

Ammonia liquid re-circulation systems are liquid overfeed systems in which ammonia is supplied from a low-pressure receiver to the system evaporators.

Reciprocating, rotary vane, and screw compressors are commonly used in ammonia systems.

Water-cooled condensers are typically used with ammonia systems. Air-cooled condensers are seldom used with ammonia. Receivers fed by the condenser should always be mounted below the condenser.

Several types of evaporators can be used in ammonia systems, but fan coil, direct-expansion types are limited to systems with suction temperatures above 0°F.

Because ammonia has a harsh effect on the human respiratory system and is dangerous to human health, every effort must be made to prevent its release into the atmosphere.

A secondary coolant is any cooling liquid that is used as a heat transfer fluid. Any system that uses a secondary coolant is called a secondary coolant system.

Water is commonly used as the heat transfer medium at temperatures above freezing; brine is typically used at temperatures below freezing.

Alcohol, glycol and other fluids may be mixed with water for special applications. Measures to prevent or minimize corrosion must be taken when using these different fluids.

Commercial and Industrial Refrigeration Systems
Cold storage is used to preserve perishable food in its fresh, wholesome state for extended periods. This is done by controlling the food’s temperature and humidity during storage. Cold storage conditions are determined by the type of food being stored. They are also determined by the length of time the food is to be held in storage.

Prolonged storage of food requires that the food be frozen, allowing the storage time to be lengthened from days or weeks to months. Freezer rooms held at temperatures below freezing are used to store frozen foods. Temperatures are typically maintained at levels ranging between 10°F and –10°F. Rooms used to store ice cream are often maintained at a temperature of –20°F. Frozen foods can deteriorate during the period between production and consumption. The most important factors contributing to the deterioration of frozen foods are the storage temperature and storage time. The amount of protection provided by the package containing the frozen food is also important. Some of the bacteria in frozen foods may be killed during freezing and frozen storage, but all the bacteria are never completely destroyed. When defrosting, foods are still subject to bacterial decomposition.

Some cold storage plants and warehouses are used to both process and freeze foods. The process of freezing reduces the temperature of a food product from the ambient level to the storage level and changes most of the water in the product to ice. As shown in Figure 3, the freezing process has three phases. The first phase removes the product’s sensible heat. During the second phase, the product’s latent heat of fusion is removed and the water in the product is changed to ice crystals. In phase three, continued cooling of the product removes the sensible heat below the freezing point and reduces the temperature to the required frozen storage temperature.

Air blast freezing employs cold air circulated around the product at high velocities, maximizing the heat exchange process. The air removes heat from the product via convection and releases it to an air-to-refrigerant heat exchanger coil. One advantage of the blast freezing approach is the ability to freeze objects of inconsistent or irregular size and shape. Evaporator coil air discharge temperatures are typically –20°F to –40°F, but varies depending on the product.

In the refrigeration industry, cryogenics is generally accepted to define the freezing of product using fluid (refrigerant) temperatures below –250°F. The boiling points of common cryogenic fluids, such as carbon dioxide, nitrogen, and helium, which are normally in their gaseous state, are below this temperature. The boiling points of common refrigerants such as HFCs and HCFCs are above this temperature. Liquid nitrogen is most commonly used, while liquid helium provides the lowest temperature.

In refrigeration systems used to cool warehouses, cold storage (chill) rooms, and walk-in coolers, the compressor, condenser, and related components are commonly packaged into an assembly called a condensing unit. In practice, condensing units can be either air cooled or water cooled. They may contain one or more compressors and/or fans (air cooled). Condensing units may be installed in equipment or mechanical rooms, mounted on the roof or other outdoor location, or both. The evaporator, expansion device, and fans are also packaged into an assembly that is installed in the individual chill room or walk-in cooler. This assembly is commonly called a unit cooler. Some large
refrigeration systems may consist of individual components piped together at the job site into a customized system. Self-contained reach-in coolers and display cases have all the system components packaged into a unit that is enclosed in the cabinet. In-depth coverage of systems used in the retail sector can be found in HVAC Level Three, Retail Refrigeration Systems.

Single compressors are found in about half of the refrigeration systems in use. The compressor sizes commonly range between 0.5 and 30 horsepower (hp). A single compressor is often used to cool multiple evaporators in a line of display cases or coolers (Figure 18) or in multi-temperature mobile refrigeration units. One advantage of using a single compressor to supply multiple evaporators is the relatively low cost. Another is that the heat from the equipment can be more easily captured in a heat recovery unit, then used to heat the store or the store’s domestic hot water supply.

The use of multiple compressors connected in parallel allows greater system capacities and the ability to meet varying load conditions more effectively. Connecting two or three smaller compressors in parallel normally results in a higher Btu-per-horsepower capacity than when one larger compressor is used. Compressors in the 5hp, 7.5hp, and 10hp size are typically used for this purpose. Compressors connected in parallel can also provide a system backup in the event that one of the other compressors breaks down.

The compressors may all be the same size, or they can be different sizes. In parallel compressor systems, the compressors can be cycled on and off as needed for capacity control. Compressors may be controlled or staged based on a drop in the system suction pressure. If the compressors are of equal size, one or more mechanical or electronic methods of capacity control can be used to cycle the compressors on and off, while the unit maintains one economical pressure range. Parallel compressors of different sizes can be staged to obtain more steps of capacity than the same number of equally sized compressors. Figure 20 shows an example of capacity control that can be obtained by using three parallel compressors of 5hp, 7.5hp, and 10hp.

Group similar types of equipment that operate at approximately the same suction pressure on the same circuit. For example, group frozen food cases together and ice cream cases together. Never combine medium-temperature or high-temperature equipment designed to cool nonfrozen foods with low-temperature equipment designed to cool frozen foods.

A satellite compressor is a separate compressor that uses the same source of refrigerant as that used by a related group of parallel compressors. However, the satellite compressor functions as an independent compressor connected to a cooling area that requires a lower temperature level than that being maintained by the related parallel compressors. Systems operating at a lower temperature run lower suction pressures and are less efficient. The use of a satellite compressor allows the parallel compressors in the same system to operate at a higher, more efficient suction pressure. The satellite compressor can be a remote unit, or it can be installed on the same rack as a group of parallel compressors. Satellite compressors can be used in both medium- and low-temperature applications. For example, it is common for a low-temperature frozen food cooling system to use a satellite compressor to cool the lower-temperature ice cream freezers.
For a refrigeration system to operate properly, the condensing pressure and temperature must be maintained within certain limits. An increase in condensing temperature causes a loss in capacity. If extreme enough, it may overload the compressor. Low condensing pressures can reduce the flow of refrigerant through conventional expansion valves, resulting in a starved evaporator. Some medium-temperature and low-temperature refrigeration systems use electronically controlled, low-pressure drop expansion valves to ensure that a sufficient supply of refrigerant is fed to the evaporator even when condensing pressures are very low. Conventional thermostatic expansion valves (TXVs) generally require a specific pressure drop to operate at their rated capacity, based on the refrigerant used. For example, HCFC-22 expansion valves are manufacturer-rated at a 100 psig pressure drop. With conventional TXVs, the discharge pressure must be maintained high enough to produce a pressure drop in this range in order to maintain full refrigeration capacity.

Another common method of refrigerant-side control is to use a condenser with two equal parallel sections, each handling 50 percent of the load during normal summer operation. During the winter, only half of the condenser is used. Solenoid or three-way valves are used to shut off one of the condenser sections as well as any pump-down circuits and fans.

Unit coolers used in areas requiring high humidity levels normally have large coils operating with small air-to-refrigerant temperature differences (4°F to 8°F). The rate of airflow across the evaporator coil is high to provide the required refrigeration with the small drop in temperature. When unit coolers are used in areas requiring low humidity, the evaporator coil is small and operates with higher air-to-refrigerant temperature differences (20°F to 30°F). The rate of airflow across the evaporator is low. The evaporator coil(s) in unit coolers that operate at saturated suction temperatures below 30°F must be defrosted periodically. The method used can be air defrost, electric defrost, or hot gas defrost. These defrost methods are described later in this module.

When compared to closed coolers, open, self-service display cases need additional refrigeration capacity because of their higher refrigeration loss. The refrigeration losses in an open display case are great enough that about twice the amount of refrigeration capacity is needed to cool a product than would be needed to cool the same product in a closed case. Warm, moist air from outside the cabinet mixes with the cold, dry air in the case. Customers reaching into the case to remove stored products cause air movement and additional mixing of warm and cold air. This adds a substantial load to the refrigeration cycle because it must cool the additional air and condense the additional moisture. To minimize the mixing of cold and warm air, open display cases should be located away from all externally induced air circulation devices, such as fans, entrance doors, heating duct openings, and air blasts from unit heaters.

The suction line accumulator is a trap that prevents the compressor from taking in slugs of liquid refrigerant or compressor oil. If liquid refrigerant is allowed to enter the compressor, noisy operation, high consumption, and compressor damage may result. Accumulators are installed in the suction line as close to the compressor suction inlet as possible. At this location, any quantities of liquid refrigerant or oil will be trapped temporarily in the accumulator. The trapped refrigerant remains in the accumulator until it is evaporated. Some accumulators have heaters that help to vaporize the refrigerant liquid.
The suction line accumulator is a trap that prevents the compressor from taking in slugs of liquid refrigerant or compressor oil. If liquid refrigerant is allowed to enter the compressor, noisy operation, high consumption, and compressor damage may result. Accumulators are installed in the suction line as close to the compressor suction inlet as possible. At this location, any quantities of liquid refrigerant or oil will be trapped temporarily in the accumulator. The trapped refrigerant remains in the accumulator until it is evaporated. Some accumulators have heaters that help to vaporize the refrigerant liquid.

Crankcase heaters are installed on most compressors to prevent refrigerant from migrating into the system and mixing with oil when the compressor is off. All heaters evaporate refrigerant from the oil. Heaters are typically fastened to the bottom of the crankcase or inserted directly into the compressor crankcase (immersion type). Band-type heaters that encircle the outside shell of welded hermetic compressors are frequently used. Some of these use PTC (positive temperature coefficient) technology to regulate the output of the heater; as the compressor warms, the heater produces less heat. Band-type heaters are inappropriate for use with semi-hermetic and open drive compressors. Figure 33 shows a variety of clamp-on and insertion type crankcase heaters.

Oil coats the inside of every component through which it passes. It reduces the heat transferability and efficiency of the evaporator and condenser. Oil separators minimize the amount of oil that circulates through a refrigeration system. They also slow down the accumulation of oil in places from which it is difficult to return. The oil separator is one of the primary components of any oil control system. They are typically installed in the hot gas discharge line as close to the compressor as practical. Separators usually have a small sump to collect the trapped oil. A float valve in the sump maintains a seal between the high-pressure and low-pressure sides of the system. As the oil level in the sump rises, the float raises and allows high pressure refrigerant vapor to push the oil back to the low-pressure crankcase of the compressor. When used with a single compressor, the oil separator generally functions without additional system components except for an oil filter, which captures any debris.

Crankcase pressure regulating (CPR) valves are installed in the suction line ahead of the compressor. The valve controls the maximum pressure at the compressor suction line and provides overload protection for the compressor motor. The valve is adjusted for the maximum pressure specified by the manufacturer of the condensing unit when available.

Evaporator pressure regulating (EPR) valves are installed in the suction line between an evaporator and the compressor. They are designed to maintain the desired minimum pressures, and therefore temperatures, within close limits. These valves are used to control the evaporator temperature on systems that use multiple evaporators operating at different temperatures or on systems where the evaporating temperature cannot be allowed to fall below a predetermined level.

The condenser pressure regulator (head pressure control) maintains proper condenser pressures when the ambient temperature of the outdoor air is low. The head pressure control is a three-way modulating valve. It is controlled by the discharge (head) pressure. When the outdoor air temperatures are high enough to cause the compressor discharge pressure to be above the head pressure control valve setpoint, refrigerant flows through the system in the normal manner. It flows from the compressor...
through the condenser and valve ports C and R to the receiver, then through the metering device and into the evaporator.

One approach works well with multiple evaporators, often three or more. This method is sometimes referred to as latent heat defrost. One or more evaporators remain in service, absorbing heat and transferring it to the refrigerant, while one coil is being defrosted. Hot gas is ported to the defrosting coil through a series of solenoid valves. This approach works especially well on large supermarket systems where many evaporators are connected to a compressor rack system. Another approach for small systems is very much like a conventional heat pump; the evaporator becomes the condenser and the condenser becomes the evaporator.

Ammonia liquid recirculation systems are liquid overfeed systems. In this type of system, ammonia is supplied from a low-pressure receiver to the system evaporators. The low-pressure receiver is a vessel that stores liquid ammonia at low pressure and is used to supply the evaporators with liquid ammonia, either by gravity or circulated by a pump. The compressor suction line is connected to the low-pressure receiver, maintaining the pressure and, in turn, the temperature of the liquid refrigerant being recirculated. Large suction line accumulators are often incorporated as well to prevent compressor damage in the event the low pressure receiver overfills with liquid refrigerant. At startup, there is also the potential for liquid carryover into the suction line if the pressure is reduced too quickly and the ammonia liquid boils violently. As a result, the pressure should be reduced slowly in the low-pressure receiver when starting a warm system.