Basic Refrigeration Cycle

Mechanical refrigeration is accomplished by a continuously circulating, evaporating and condensing a fixed supply of refrigerant in a closed system. Evaporation occurs at a low temperature and low pressure while condensation occurs at a high temperature and high pressure. Thus, it is possible to transfer heat from an area of low temperature (i.e., refrigerator cabinet) to an area of high temperature (i.e., kitchen).

Beginning the cycle at the evaporator inlet (1) the low pressure liquid expands, absorbs heat and evaporates, changing to a low pressure gas at the evaporator outlet (2).

The compressor (4) pumps this gas from the evaporator through the accumulator (3), increases its pressure, and discharges the high pressure gas to the condenser (5). The accumulator is designed to protect the compressor by preventing slugs of liquid refrigerant from passing directly into the compressor. An accumulator should be included on all systems subjected to varying load conditions or frequent compressor cycling. In the condenser, heat is removed from the gas, which then condenses and becomes a high pressure liquid. In some systems, this high pressure liquid drains from the condenser into a liquid storage or receiver tank (6). On other systems, both the receiver and the liquid line valve (7) are omitted.

A heat exchanger (8) between the liquid line and the suction line is also an optional item, which may or may not be included in a given system design.

Between the condenser and the evaporator an expansion device (10) is located. Immediately preceding this device is a liquid line strainer/drier (9), which prevents plugging of the valve or tube by retaining scale, dirt and moisture. The flow of refrigerant into the evaporator is controlled by the pressure differential across the expansion device or, in the case of a thermal expansion valve, by the degree of superheat of the suction gas. Thus, the thermal expansion valve shown requires a sensor bulb located at the evaporator outlet. In any case, the flow of refrigerant into the evaporator normally increases as the evaporator load increases.

As the high pressure liquid refrigerant enters the evaporator, it is subjected to a much lower pressure due to the suction of the compressor and the pressure drop across the expansion device. Thus, the refrigerant tends to expand and evaporate. In order to evaporate, the liquid must absorb heat from the air passing over the evaporator.

Eventually, the desired air temperature is reached and the thermostat or cold control (11) will break the electrical circuit to the compressor motor and stop the compressor.

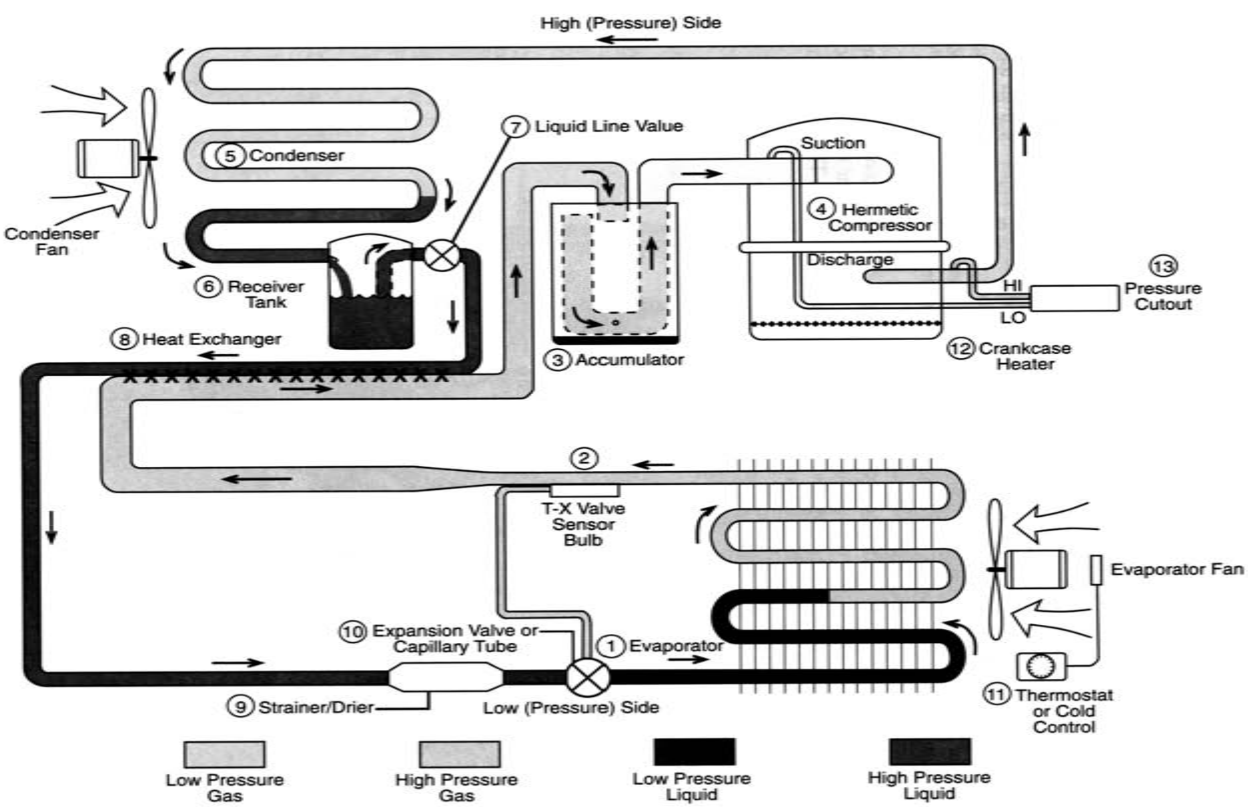
As the temperature of the air through the evaporator rises, the thermostat or cold control remakes the electrical circuit. The compressor starts, and the cycle continues.

In addition to the accumulator, a compressor crankcase heater (12) is included on many systems. This heater prevents accumulation of refrigerant in the compressor crankcase during the nonoperating periods and prevents liquid slugging or oil pump-out on startup.

Additional protection to the compressor and system is afforded by a high and low pressure cutout (13). This control is set to stop the compressor in the event that the system pressures rise above or fall below the design operating range.

Other controls not indicated on the basic cycle which may be part of a system include: evaporator pressure regulators, hot gas by-pass regulators, electric solenoid valves, suction pressure regulators, condenser pressure regulators, low side or high side float refrigerant controllers, oil separators, etc.

It is extremely important to analyze completely every system and understand the intended function of each component before attempting to determine the cause of a malfunction or failure.



Typical Refrigeration System Operation

Evaporator Superheat

Check your superheat. After the box temperature has reached or is close to reaching the desired temperature, the evaporator superheat should be checked and adjustments made if necessary. Generally, systems with a design TD of 10°F should have a superheat value of 6° to 10°F for maximum efficiency. For systems operating at higher TDs, the superheat can be adjusted to 12° to 15°F as required.

Note: Minimum compressor suction superheat of 20°F may override these recommendations on some systems with short line runs.

To properly determine the superheat of the evaporator, the following procedure is the method Heatcraft recommends:

Warning: If the condensing unit has no flooded condenser head pressure control, the condensing unit must have the discharge pressure above the equivalent 105°F condensing pressure.

1. Measure the temperature of the suction line at the point the bulb is clamped.

2. Obtain the suction pressure that exists in the suction line at the bulb location by either of the following methods:
   a. A gauge in the external equalized line will indicate the pressure directly and accurately.
   b. A gauge directly in the suction line near the evaporator or directly in the suction header of the evaporator will yield the same reading as 2a above.

3. Convert the pressure obtained in 2a or 2b above to saturated evaporator temperature by using a temperature-pressure chart.

4. Subtract the saturated temperature from the actual suction line temperature. The difference is superheat.

Alternative Superheat Method

The most accurate method of measuring superheat is found by following the previous procedure, temperature/pressure method. However, that method may not always be practical. An alternative method which will yield fairly accurate results is the temperature/temperature method:

1. Measure the temperature of the suction line at the point the bulb is clamped (outlet).

2. Measure the temperature of one of the distributor tubes close to the evaporator coil (inlet).

3. Subtract the inlet temperature from the outlet temperature. The difference is superheat.

This method will yield fairly accurate results as long as the pressure drop through the evaporator coil is low.

General Sequence of Operation

Refrigeration Cycle

1. Power is supplied to the timer at terminals “1” and “N”.

2. The fan delay and the defrost termination thermostat is closed in the fan delay position and open in the defrost termination position. The unit cooler fans run continuously.

3. The defrost heaters are off.

4. The room thermostat closes when the temperature rises above the desired setting.

5. The liquid line solenoid is energized and opens, which allows liquid refrigerant to flow through the unit cooler.

6. The low pressure control closes when the suction pressure rises above the cutin setting of the control.

7. On systems with oil pumps, the oil safety control is closed. If the net oil pressure is less than 9 PSI for more than 120 seconds, the oil safety opens, thus breaking the circuit to the compressor contactor holding coil. The compressor will not operate. This control is reset manually and must be reset before the compressor can be restarted.

8. The compressor contactor closes. The compressor and condenser fan start simultaneously.

9. The room temperature gradually decreases to the desired temperature.

10. Once the desired temperature is reached, the thermostat opens and the liquid line solenoid closes, stopping refrigerant flow through the evaporator.

11. Suction pressure decreases and the compressor contactor opens when the pressure drops below the cutout setting on the low pressure control. The compressor and condenser fan stop running.

12. This cycle is repeated as many times as necessary to satisfy the room thermostat.

13. Frost starts to form on the evaporator coil and continues to form until the defrost cycle is initiated.

Defrost Cycle

1. The defrost cycle starts automatically by the timer at predetermined times. Typical settings are two to four defrost cycles per day for freezers. For heavier frost loads additional settings may be required.

2. Switched “2” to “4” opens in the time clock which breaks the circuit to the room thermostat, liquid line solenoid and evaporator fan motors, allowing the compressor to pump down and shut off. Simultaneously switch “1” to “3” closes in the timer allowing current to flow to one side of the defrost heater contactor. When the compressor shuts off, an auxiliary contact will send power to the contactor holding coil; thus, energizing the defrost heaters.

3. The heaters raise the temperature of the coil to 32°F causing the frost to melt off the coil.

4. When the coil warms to 45°F to 55°F, the defrost termination thermostat closes, which allows current to the switching solenoid in the timer allowing the refrigeration cycle to begin again.

5. The evaporator heaters are off. If the termination thermostat fails to close, the fail-safe set on the timer will terminate defrost.

6. The low pressure control closes and the compressor will start.

7. when the coil temperature reaches 23°F to 30°F, the fan delay closes. This allows the current to flow to the fan motors. The fan motors start running.

8. The system will now operate in the refrigeration cycle until another defrost period is initiated by the timer.

NOTES
1. Lockout relays or normally closed switch of auxiliary contact on the compressor contactor may be wired to defrost contactor. Its purpose is to prevent energizing of the defrost heaters until the compressor has pumped down and stopped, thus keeping power demand to a minimum.
2. If the control voltage is to remain energized for any period of time with the compressor disabled, remove the defrost clock pins to prevent the defrost heaters from energizing.
3. A preventative maintenance schedule should be set up as soon as possible after start-up to maintain equipment integrity.

General Guidelines

Application	TD	Coil	Notes
Convenience store	10 to 15°F	Low silhouette	Multiple units for adequate air coverage Up to 18 ft. long = 1 coil Up to 30 ft. long = 2 coils Up to 40 ft. long = 3 coils Estimating guide*: Cooler 100 sq. ft./ton, Freezer 75 sq. ft./ton
Holding warehouse	10 to 15°F	Low silhouettte or heavy duty	Forklift operation Average air changes Product load 10 to 15% of total load Some warehouses (seafood) may require copper fin coils Estimating guide 200 to 300 sq. ft./ton
Product warehouse	7 to 10°F	Low velocity, low silhouette or heavy duty	High seasonal loads Heavy product respiration Additional humidity may be required Estimating guide 150 to 200 sq. ft./ton
Blast cooler/freezer	7 to 10°F	Heavy duty	High air velocity, heavy infiltration Fast defrost (4 to 6 FPI coils) Product spaced to allow air circulation Equipment sized to extract all interior heat Box temp below desired product temperature Multiple units to provide capacity control
Ice cream hardening	10°F	Heavy duty	10 hour pulldown with product 30% frozen and a certain percentage overrun (thickness of ice cream)
Controlled temperature beer warehouse	15 to 20°F	Heavy duty	Floating box temperature (40 to 72°F) contingent on average monthly dewpoint Auxiliary air circulation may be required due to high TD Heavy loading – high infiltration 20 to 30°F pulldown on beer
Candy warehouse	20 to 25°F	Heavy duty	Low relative humidity Auxiliary air circulation and reheat maybe required Vapor barrier essential
Prep room	20°F	Low velocity	Heavy motor and personnel load Estimating guide 150 sq. ft./ton
Floral box	8°F	Low velocity	Light loading conditions Glass walls Estimating guide 100 sq. ft./ton*

* Glass doors assumed on one long wall only.
Note: Estimating guides are ballpark figures only. All attempts should be made to obtain accurate job survey and subsequent refrigeration calculations.

APPLICATION NOTE:
This information is provided for reference only. No guarantees are expressed or implied as to suitability or fitness for use, as all projects are subject to variations. Not for construction. Seek professional advice prior to application or use.

Our daily objective is to meet and greet our customers in a prompt, kind and courteous manner.

Kansas City
1104 Union Ave.
Kansas City, MO
64101

Lenexa
14021 W. 95th St.
Lenexa, KS
66215

Springfield
2215 W. Sunset Ste. A
Springfield, MO
65807

Des Moines
4137 109th St.
Urbandale, IA
50322

Wichita
212 S. Hydraulic
Wichita, KS
67211