Introduction to Basic Refrigeration and Air Conditioning

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Refrigeration, or cooling process, is the removal of unwanted heat from a selected object, substance, or refrigerated space and its transfer to another object, substance, or space. Removal of heat lowers the temperature and may be accomplished by use of ice, snow, chilled water or mechanical refrigeration.

1. Fundamentals

Heat is a form of energy transferred by virtue of a difference in temperature. Heat exists everywhere to a greater or lesser degree. As a form of energy it can be neither created nor destroyed, although other forms of energy may be converted into heat, and vice versa. It is important to remember that heat energy travels in only one direction; from a warmer to a cooler object, substance, or area. Cold is a relative term referring to the lack of heat in an object, substance, or area. Another definition describes it as the absence of heat, no process yet has been devised of achieving "absolute zero," the state in which all heat has been removed from any object, substance, or area. Theoretically this zero point would be 459.69 below zero on the Fahrenheit thermometer scale, or 273.16 degrees below zero on the Celsius thermometer scale.

Mechanical refrigeration, is the utilization of mechanical components arranged in a "refrigeration system" for transferring heat/refrigeration. Refrigerants, are chemical compounds that are alternately compressed and condensed into a liquid and then permitted to expand into a vapor or gas as they are pumped through the mechanical refrigeration system.

Major components of Refrigeration system

1) Evaporator
2) Compressor
3) Condenser
4) Metering device/Expansion valve

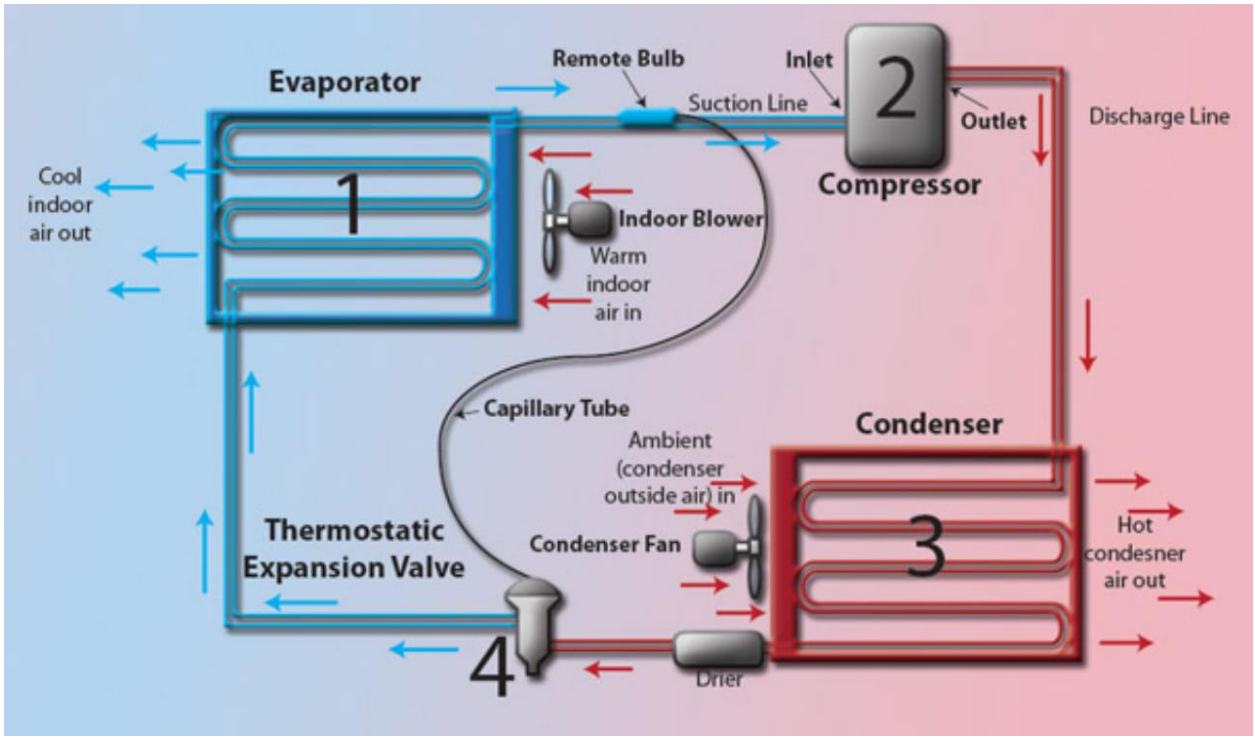

Fig. 1 Schematic of Refrigeration cycle

The refrigeration system requires some major components *i.e.* Evaporator, Compressor, Condenser and Metering devices are connected through the piping (copper/steel) depends upon the refrigerant used in the system. The suction line (Vapor line) connects from the evaporator or cooling coil to the compressor, the hot gas or discharge line connects the compressor to the condenser, and the liquid line is the connecting tubing between the condenser and the metering device. Some systems will have a receiver immediately after the condenser and before the metering device, where the refrigerant is stored until it is needed.

In a simple refrigeration cycle, two different pressures exist in the system - the evaporating or low pressure in the "low side", and the condensing, or high pressure, in the "high side". These pressure areas are separated by two dividing points, one is the metering device (Expansion valve) where the refrigerant flow is controlled, and the other is condensing units. (Compressor, condenser *etc*.). The metering device is a point where we will start the trip through the cycle. This may be a thermal expansion valve, a capillary tube, or any other device to control the flow of refrigerant into the evaporator. The expanding refrigerant evaporates (changes state) as it goes through the evaporator, where it absorbs heat from the

substance or refrigerated space and cooling will be produced. After evaporation low pressure low temperature gas sucked by the compressor and the cycle will continue. The low-pressure, low-temperature vapor is drawn into the compressor where it is compressed into a high-temperature, high-pressure vapor. The compressor discharges it to the condenser, so that it can give up the heat that it picked up in the evaporator. The refrigerant vapor is at a higher temperature than the air passing across the condenser (air-cooled type); or water passing through the condenser (water-cooled type); therefore heat is transferred from the warmer refrigerant vapor to the cooler air or water. Heat is removed from the vapor, a change of state takes place and the vapor is condensed again in to a liquid state with high-pressure and high-temperature.

In the refrigeration system the refrigerant is sucked and pumped by the compressor in the closed system. If the system was not closed, it would be using up the refrigerant by dissipating it into the surrounding media; but it is closed, the same refrigerant is used again and again. There are many different types of the compressors are used in the refrigeration systems such as Reciprocating, screw, scroll and centrifugal. But the function is same in all the cases. That means compressing the low pressure and low temperature vapor in to a high pressure and high-temperature gas is done by the compressor. The same can be said of the condenser and evaporator. Bare pipes, Plate type, finned type and fin and tube type condensers and evaporators with electrically driven fans to pass the air through them, or with a condenser pump to pump the water through a water-cooled condenser.

In the case of metering devices, Thermostatic expansion valve, automatic expansion valve, capillary tube are used for regulating the liquid refrigerant into the evaporator, depends on the size of equipment, refrigerant used, and its application *etc*.

The mechanical refrigeration system described above is essentially the same whether the system is a domestic refrigerator, a low-temperature freezer, comfort air conditioning system, industrial chiller, or commercial cooling equipment. Refrigerants will be different in various applications. But the principle of operation and the refrigeration cycle remains the same.

2. Air conditioning

Air-conditioning is that process used to create and maintain certain temperature,

relative humidity and air purity conditions in indoor spaces. This process is typically applied to maintain a level of personal comfort.

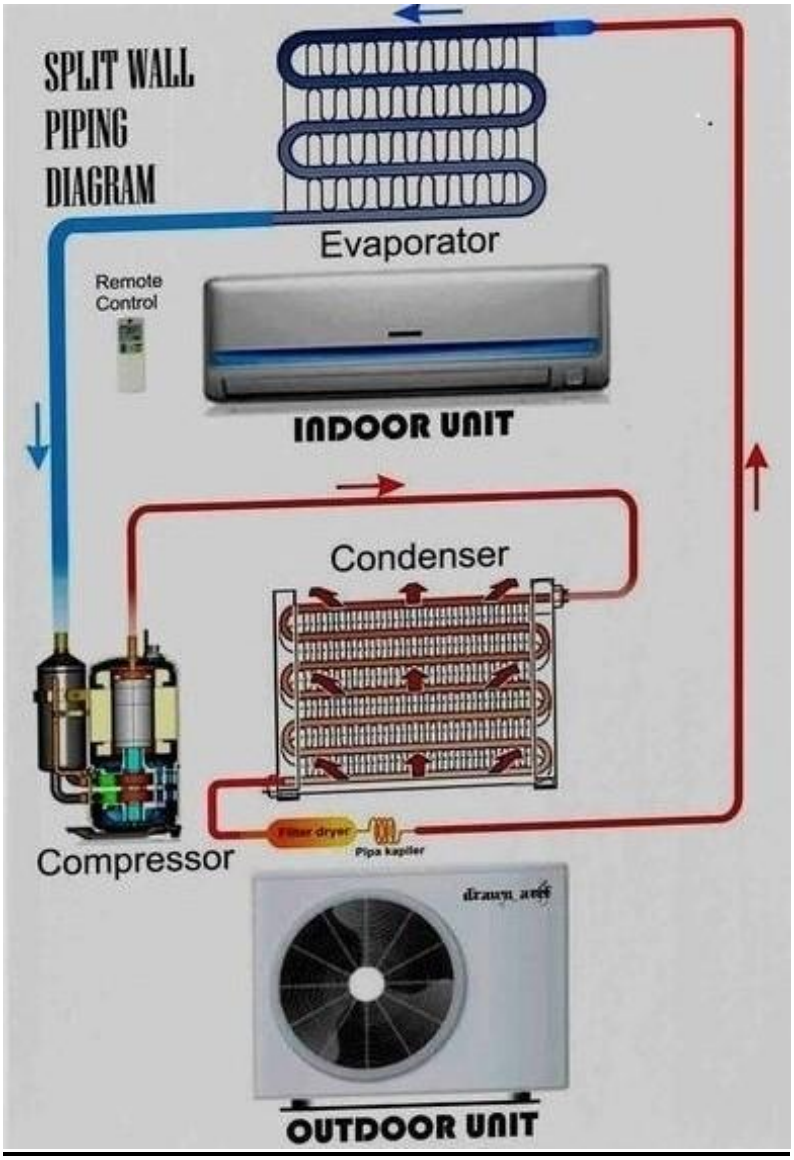

Fig. 2 Simple diagram of air conditioning (split type)