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Review on Simple Vapour Compression Refrigeration System

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Abstract-In present, a vapor compression refrigeration cycle is frequently used. Simple compression refrigeration is similar to reversed Carnot cycle and domestic and industrial refrigerator, air conditioning system, heat pump and water cooler designed base on vapor compression refrigeration cycle. This paper deals about simple vapor compression system, its various components and about the coefficient of performance (COP) of vapor refrigeration system.
Keywords:- Vapour, Refrigeration, Compression, COP.

I. INTRODUCTION

A vapor compression refrigeration system is an improved type of air refrigeration system in which a suitable working substance, termed as refrigerant, is used. It condenses and evaporates at temperatures and pressures closed to the atmospheric conditions. The refrigerants, usually, used for this purpose are ammonia (NH_3), carbon dioxide (CO_2) and sulphur dioxide (SO_2). The refrigerant used, does not leave the system, but is circulated throughout the system alternately condensing and evaporating. In evaporating, the refrigerant absorbs its latent heat from the brine (salt water) which is used for circulating it around the cold chamber. While condensing, it gives out its latent heat to the circulating water of the cooler. The vapor refrigeration system is, therefore a latent heat pump, as it pumps its latent heat from the brine and delivers to the cooler.[1]. The vapor compression refrigeration system is now-a-days used for all purpose refrigeration. It is generally used for all industrial purpose from a domestic refrigerator to a big air conditioning plant.

II. REFRIGERATION

Literal meaning of refrigeration is the production of cold confinement relative to its surroundings. In this, temperature of the space under consideration is maintained at a temperature lower than the surrounding atmosphere. To achieve this, the mechanical device extracts heat from the space that has to be maintained at a lower temperature and rejects it to the surrounding atmosphere that is at a relatively higher temperature. Since the volume of the space which has to be maintained at a lower temperature is always much lower than the environment, the space under consideration experiences relatively higher change in temperature than the environment where it is rejected. The precise meaning of the refrigeration is thus the following: Refrigeration is a process of removal of heat from a space where it is unwanted and transferring the same to the surrounding environment where it makes little or no difference. The term „refrigeration' may be defined as the process of removing heat from a substance under controlled conditions. It also includes the process of reducing and maintaining the temperature of a body below the general temperature of its surroundings. In other words, the refrigeration means a continued extraction of heat from a body whose temperature is already below temperature of its surroundings. In a refrigerator, heat is virtually pumped from a lower temperature to a higher temperature. According to Second Law of Thermodynamics, this process can only be performed with the aid of some external work. It is thus obvious that supply of power is regularly required to drive a refrigerator. Theoretically, a refrigerator is a reversed heat engine or a heat pump which pumps heat from a cold body and delivers it to a hot body. The substance which works in a pump to extract heat from a cold body and to deliver it to a hot body is known as refrigerant.

III. MAIN COMPONENTS OF SIMPLE VAPOUR COMPRESSION REFRIGERATION SYSTEM

Fig. 1 shows the schematic diagram of a simple vapor compression refrigeration system. It consists of the following five essential

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parts as [1]

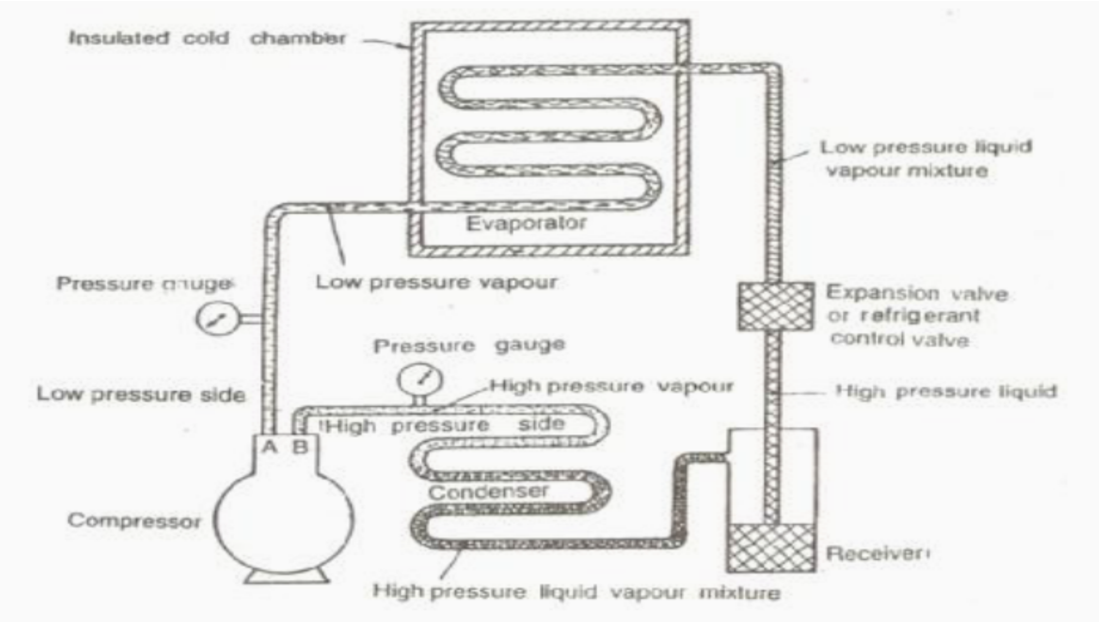

Fig.1. Simple vapor compression refrigeration system [1]

A. Compressor

The low pressure and temperature vapor refrigerant from evaporator is drawn into the compressor through the inlet or suction valve A, where it is compressed to a high pressure and temperature. This high pressure and temperature vapor refrigerant is discharged into the condenser through the delivery or discharge valve B.

B. Condenser

The condenser or cooler consists of coils of pipe in which the high pressure and temperature vapor refrigerant is cooled and condensed. The refrigerant, while passing through the condenser, gives up its latent heat to the surrounding condensing medium which is normally air or water.

C. Receiver

The condensed liquid refrigerant from the condenser is stored in a vessel known as receiver from where it is supplied to the evaporator through the expansion valve or refrigerant control valve.

D. Expansion Valve

It is also called throttle valve or refrigerant control valve. The function of the expansion valve is to allow the liquid refrigerant under high pressure and temperature to pass at a controlled rate after reducing its pressure and temperature. Some of the liquid refrigerant evaporates as it passes through the expansion valve, but the greater portion is vaporized in the evaporator at the low pressure and temperature.

E. Evaporator

An evaporator consists of coils of pipe in which the liquid-vapor. Refrigerant at low pressure and temperature is evaporated and changed into vapor refrigerant at low pressure and temperature. In evaporating, the liquid vapor refrigerant absorbs its latent heat of vaporization from the medium (air, water or brine) which is to be cooled.

IV. WORKING OF A SIMPLE VAPOUR COMPRESION REFRIGERATION SYSTEM

Refrigeration system is based upon the Clausius statement of second law of thermodynamics. This statement shows, “It is

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impossible to construct a device which, operating in a cycle, will produce no affect other than the transfer of heat from a cooler to a hotter body. The construction of vapor compression refrigeration system is illustrated in fig. 2. This system consists of four basic components, i.e. a compressor, an evaporator, a condenser and capillary tubes. Here the compressor delivery head, discharge line, condenser and liquid line form the high pressure side of the system. The expansion line, evaporator, suction line and compressor suction head form the low pressure side of the system. A drier is also installed in the liquid line which contains silica gel and absorbs traces of moisture presented in the liquid refrigerants so that it does not enter the narrow cross section of the expansion device causing moisture chocking by freezing.[2]

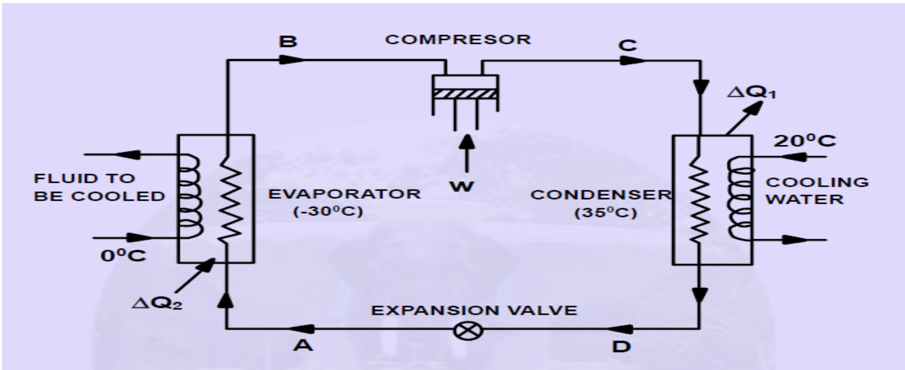

Fig. 2. The schematic diagram of a simple vapor compression refrigeration system. [2]

The schematic diagram of the arrangement is as shown in Fig.2. The low temperature, low pressure vapor at state B is compressed by a compressor to high temperature and pressure vapor at state C. This vapor is condensed into high pressure vapor at state D in the condenser and then passes through the expansion valve. Here, the vapor is throttled down to a low pressure liquid and passed on to an evaporator, where it absorbs heat from the surroundings from the circulating fluid (being refrigerated) and vaporizes into low pressure vapor at state B. The cycle then repeats.[3] The exchange of energy is as follows:

Compressor requires work, δw. The work is supplied to the system from the surroundings.
During condensation, heat δQ1 the equivalent of latent heat of condensation etc, is lost from the refrigerator.
During evaporation, heat δQ2 equivalent to latent heat of vaporization is absorbed by the refrigerant.
There is no exchange of heat during throttling process through the expansion valve as this process occurs at constant enthalpy.

V. SIMPLE VAPOUR COMPRESION CYCLE

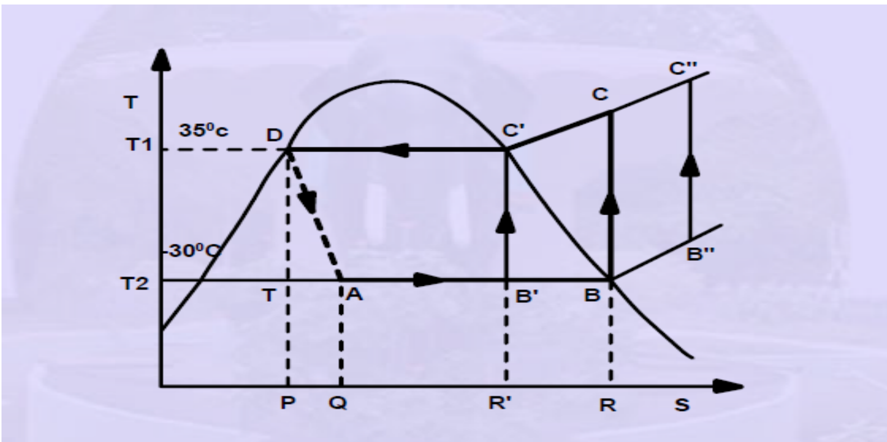

Fig. 3 T-s diagram of refrigeration cycle [3]

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Fig. 3. Shows a simple vapor compression refrigeration cycle on T-s diagram for different compression processes. The cycle works between temperatures T1 and T2 representing the condenser and evaporator temperatures respectively. The various process of the cycle A-B-C-D (A-B'-C'-D and A-B"-C"-D) are as: [3]

Process B-C (B'-C' or B"-C"): Isentropic compression of the vapor from state B to C. If vapor state is saturated (B), or superheated (B"), the compression is called dry compression. If initial state is wet (B'), the compression is called wet compression as represented by B'-C'.
Process C-D (C'-D or C"-D): Heat rejection in condenser at constant pressure.
Process D-A: An irreversible adiabatic expansion of vapor through the expansion value. The pressure and temperature of the liquid are reduced. The process is accompanied by partial evaporation of some liquid. The process is shown by dotted line.
Process A-B (A-B' or A-B") : Heat absorption in evaporator at constant pressure. The final state depends on the quantity of heat absorbed and same may be wet (B') dry (B) or superheated (B").

VII. CONCLUSION

It is concluded that, a vapor compression refrigeration system is an improved type of air refrigeration system in which a suitable working substance, termed as refrigerant is used to produce cooling effect. A vapor compression refrigeration cycle results, by eliminating impracticalities associated with reversed Carnot cycle and working on Clausius statement. Vapor compression refrigeration system is used in various appliances such as domestic refrigerator, water cooler, milk chiller, ice plant.

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