A simple vapor compression refrigeration system consists of the following equipments:

i) Compressor ii) Condenser iii) Expansion valve iv) Evaporator.

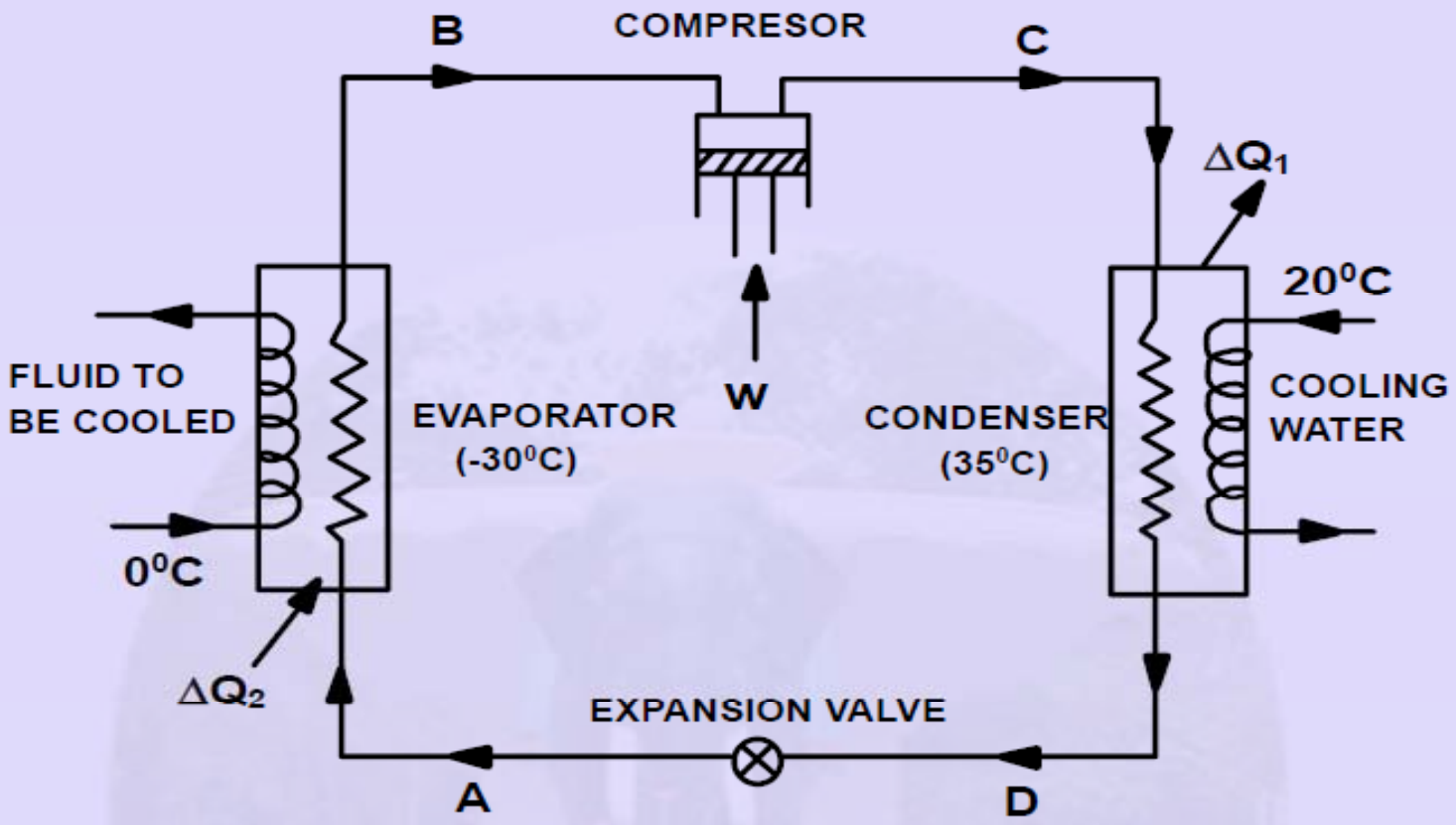

Fig.6.5. Simple vapour compression system

The schematic diagram of the arrangement is as shown in Fig.6.5. 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. The exchange of energy is as follows:

a) *Compressor requires work, δw. The work is supplied to the system from the surroundings.*

b) *During condensation, heat δQ_1 the equivalent of latent heat of condensation etc, is lost from the refrigerator.*

c) *During evaporation, heat δQ_2 equivalent to latent heat of vaporization is absorbed by the refrigerant.*

d) *There is no exchange of heat during throttling process through the expansion valve as this process occurs at constant enthalpy.*

Simple Vapor Compression Cycle:

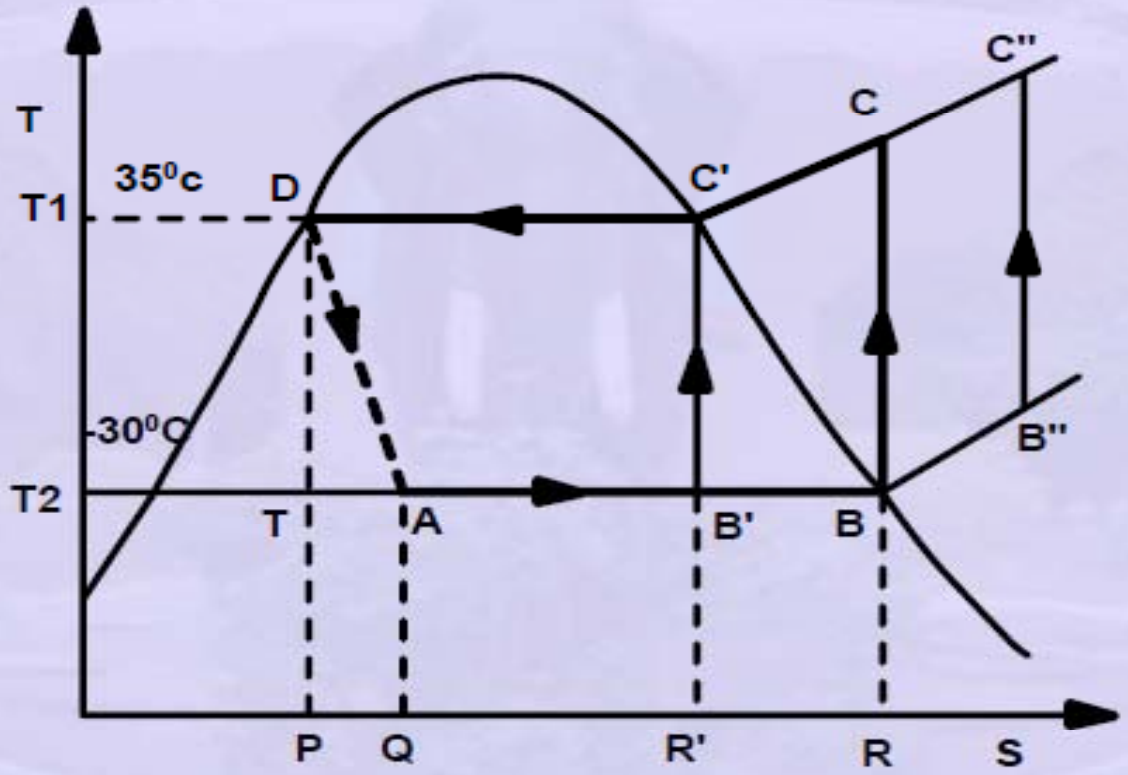

Fig.6.5.1. T-s diagram of refrigeration cycle

Figure 6.5.1 shows a simple vapor compression refrigeration cycle on T-s diagram for different compression processes. The cycle works between temperatures T_1 and T_2 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 given below:

i) *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'.*

ii) *Process C-D (C'-D or C"-D): Heat rejection in condenser at constant pressure.*

iii) *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.*

iv) *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").*

COP of Vapor Compression Cycle:

$$COP = \frac{\text{Heat extracted at low tempreature}}{\text{Work supplied}}$$

Heat extracted at low temperature = Heat transfer during the process A-B = refrigerating effect.

$$q_2 = (h_B - h_A)$$

Work of compression = w = $(h_c - h_B)$ (adiabatic compression).

$$\text{So, COP} = \left\{\frac{h_B - h_A}{h_c - h_B}\right\}$$

Now, heat rejected to the condenser, $= q_1 = w + q_2$

$$= (h_C - h_B) + (h_B - h_A)$$

$$= (h_C - h_A) = (h_C - h_D)$$