Ch-10 Refrigeration & Air conditioning

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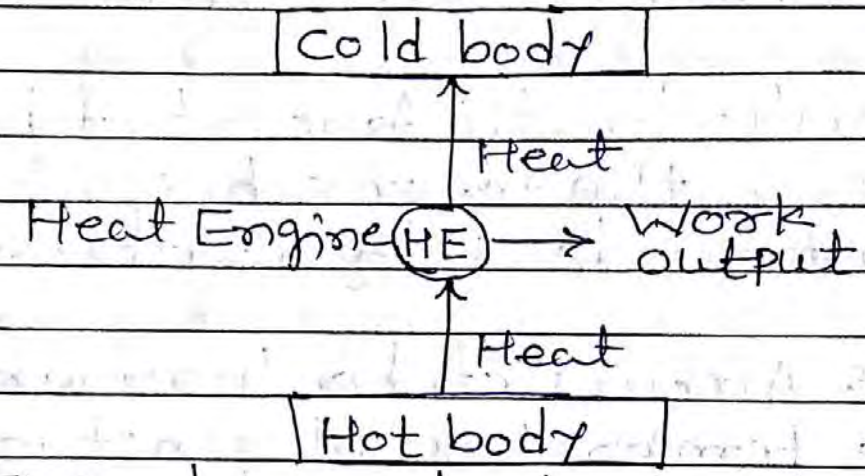
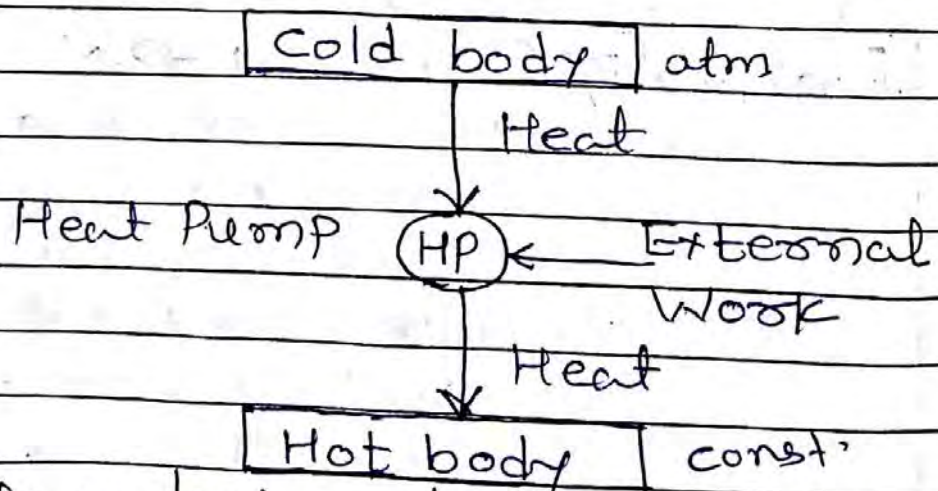
* → Heat Pump :



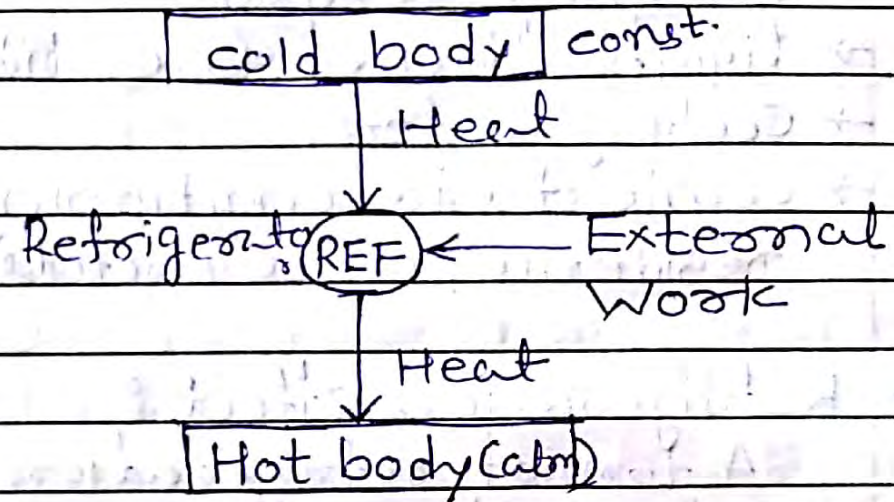
→ It is device which absorbs heat from cold body and delivers to hot body and maintain constant temperature for hot body for useful purpose.

→ External work required to convey heat from cold body to hot body.



→ It is a device which remove heat from cold body and reject to hot body and maintain low temperature for useful purpose.

→ In this device, external work is required to convey heat from cold body to hot body.



*→ Refrigerator: It is a device used to maintain the low temperature below the atmosphere temperature within required space.

*→ Refrigeration: The method of reducing the temperature of a system below surrounding temperature and maintain it at the lower temperature by continuously abstracting the heat from it.

*→ Application of Refrigeration:
→ Storage and transportation of food
→ Preservation of medicines and syrup

→ Manufactoring of ice, rubber Product textile
→ Processing of Petroleum and others chemical Products
→ liquification of gases like N_2, O_2, H_2 etc.
→ Cooling waters
→ Comfort air conditioning of hospital, residence, office, hotels.

* → Refrigeration effect :
A ton of refrigeration is defined as "Refrigerating effect Produced by melting of 1 ton of ice from and at 0°C in 24 hours".
→ The latent heat of ice is 335 KJ/kg.
Refrigeration effect Produced by 1 ton (1000 kg) ice in 24 hours

$$= \frac{335 \times 1000}{24} \text{ KJ/hr}$$

$$= 14000 \text{ KJ/hr}$$

$$= \frac{14000}{60} \text{ KJ/min}$$

$$= 232.6 \text{ KJ/min}$$

$$= \frac{232.6}{60} \text{ KJ/s}$$

$$= 3.8888 \text{ KW}$$

→ Actual Practice, 1 ton = 900 kg

$$1 \text{ ton} = \frac{335 \times 900}{24} \text{ KJ/hr}$$

$$= 210 \text{ KJ/min}$$

$$= \frac{210}{60} \text{ KJ/s}$$

$$= 3.5 \text{ kw}$$

*→ Coefficient of Performance:
Ratio of refrigerating effect to the work required to compress the Refrigerant in the compressor.

$$COP = \frac{\text{Refrigerating effect (kw)}}{\text{Work of compressor (kw)}}$$

*→ Refrigerants:
The refrigerant is a heat carrying medium which absorb heat from space & reject heat to outside the refrigerator. The Refrigerant is working medium under going various processes of refrigeration cycle which are used to Produce Refrigeration.

Properties of a good refrigerant:

(1) If should have high latent heat of Evaporation.

(2) It should have high thermal conductivity for rapid heat transfer.
(3) It should have non toxic, non flammable and non corrosive.
(4) It should have low specific heat at liquid state & high specific heat at vapor state.
(5) It should have low saturation pressure
(6) It should have high coefficient of Performance.
(7) It should have economical in initial cost and maintenance cost.
(8) Leak detection should be easy.

* > Types of Refrigerators:

(1) Natural Refrigerator:
Cooling effect Produce effect produced by evaporation of liquid. When liquid Evaporate it absorb heat from surrounding and Produce cooling. Similarly Solid Sublimation (melting). it absorb heat From surrounding and Produce cooling effect.

(2) Mechanical Refrigerator:
Mechanical refrigeration effect Produced by external source of mechanical energy or heat energy

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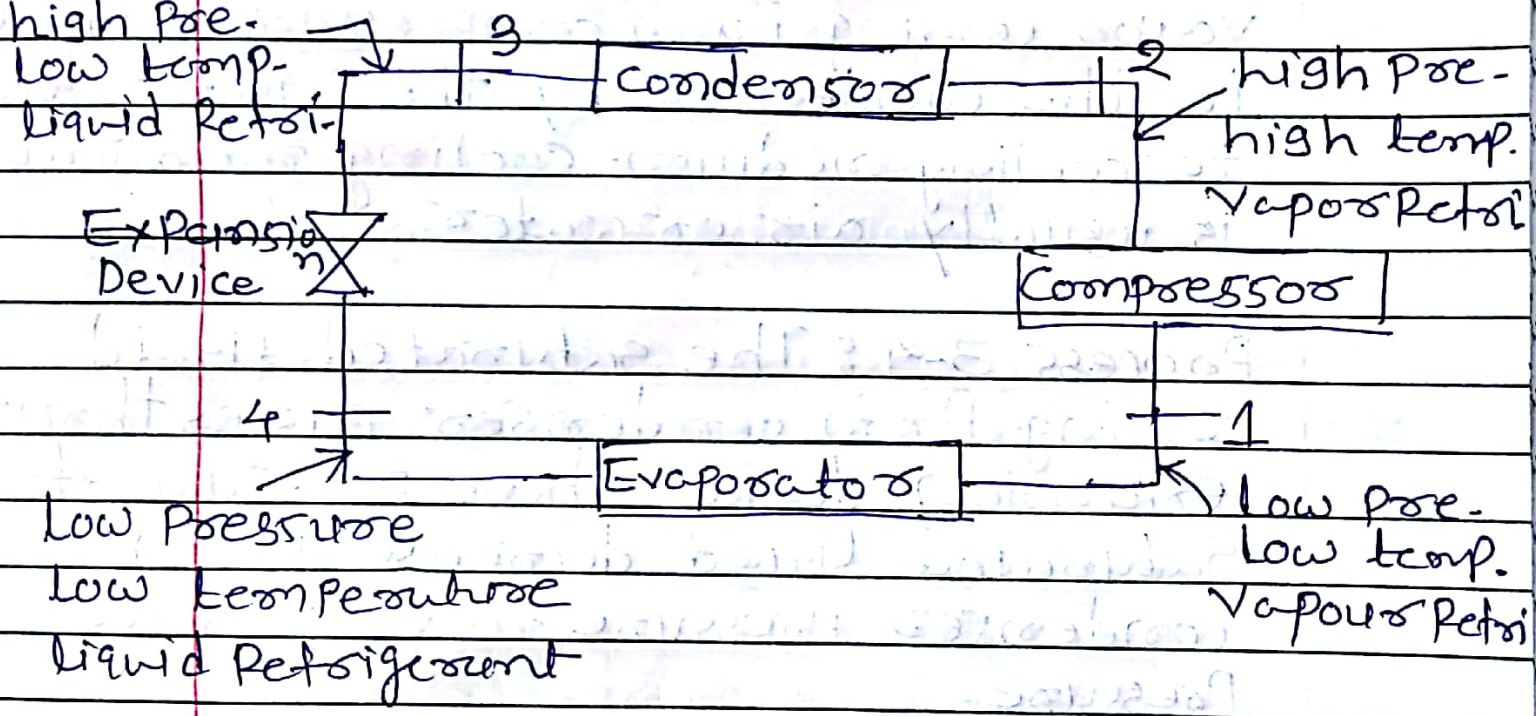
Mechanical refrigerator classified

<1> Air Refrigerator
<2> Vapour compression Refrigerator
<3> Vapour absorption Refrigerator

*→ Vapour Compression Refrigeration System:



→ The vapor compression Refrigeration system is most Popular & Widely used in refrigeration & air conditioning for both domestic and industrial application.

→ The flow diagram of a vapor compression Refrigerating system. It consist of ① Evaporator ② Compressor ③ condenser ④ Expansion device

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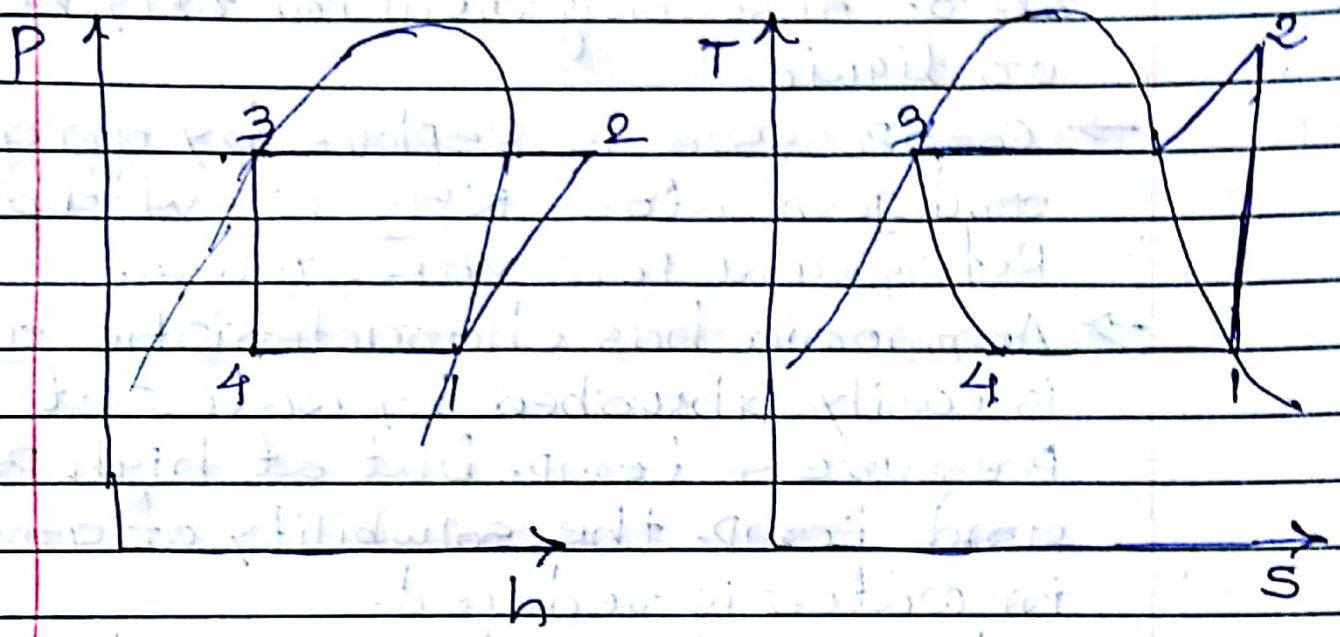
Process 1-2: Inlet of compressor, low Pressure and low temperature vapor enter the compressor. compressor compress the vapor at high temperature and pressure.

Process 2-3: High pressure, high temp. vapor coming from compressor condense in the condenser by the Rejecting heat to cooling medium. Cooling medium is usually air or water.

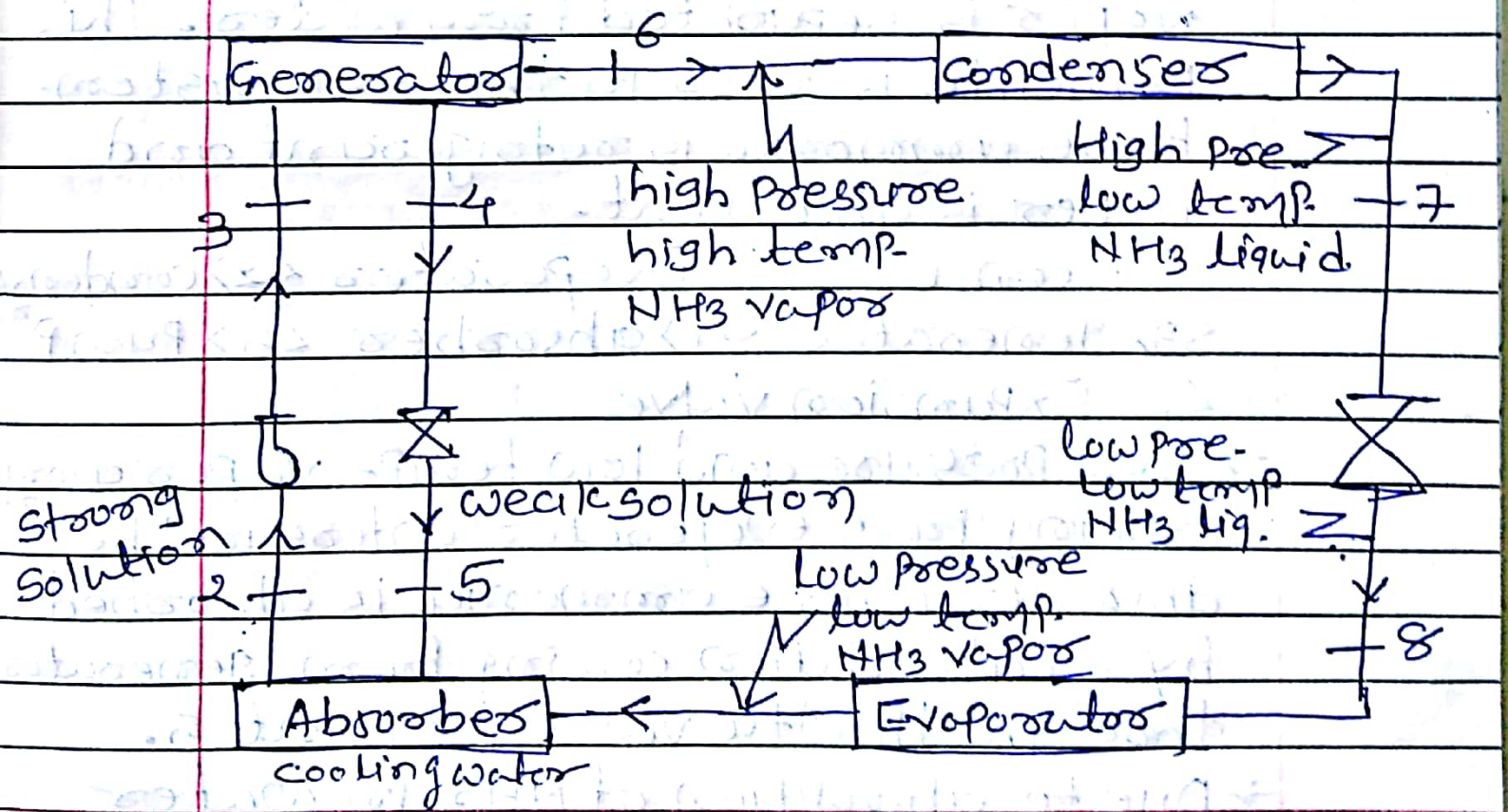
Process 3-4: The saturated liquid coming from condenser passes through expansion device where pressure of Saturated liquid decrease from Condenser pressure to evaporator Pressure.

Process 4-1: liquid Refrigerant coming from expansion device enters in to evaporator where it absorbs latent heat of evaporation from spice to be cooled. Due to absorption of heat liquid refrigerant converted in to saturated vapor or Superheated vapor at low Pressure & low temperature. And again

this vapor enters in to compressor and the cycle is repeated.



* → Vapor absorption Refrigeration system



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→ VAR system the Refrigerant coming from evaporator is absorbed by absorber. Absorbing medium may be solid or liquid.
→ Compressor is Replace by an absorber and generator. NH_3 is suitable Refrigerant for VAR system.
→ Ammonia has characteristic as it is easily absorbed by water at low Pressure & temp. but at high Pressure and temp. the solubility of ammonia in water is reduced.
→ When mixture of water and ammonia is heated by generator ammonia vapor is separated from water. This Principle is used in the VAR system. Here ammonia is refrigerant and water is absorbent.
→ It consist of <1> Evaporator <2> condenser <3> Generator <4> absorber <5> Pump <6> Expansion valve
→ Low Pressure and low temp. vapor ammonia coming from evaporator enters in the absorber where ammonia is absorbed by weak solution coming from generator through throttle valve at Point 5.
→ Due to absorption of NH_3 in water

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Solution become strong. If amount of NH_3 is more than water is called strong Solution.

→ During absorption process heat is released and rejected to cooling water. The strong solution from absorber is pumped in to generator, where it is heated & NH_3 vapor separated from solution.

→ In generator heat is supplied from external source. The weak solution at Point 4 is flowing back to absorber through throttle valve.

→ Again weak solution in absorber absorbs NH_3 vapor coming from evaporator. NH_3 vapor coming from generator at Point 6 passes through condenser and it condensed in condenser and reject heat to cooling water.

→ Then liquid NH_3 Point 7 throttled through expansion device and it enter in to evaporater Point 8. In the evaporator NH_3 evaporates by absorbing latent heat of evaporation to produce refrigerating effect. Thus cycle is completed.