★ Unit - 3 ★

Refrigeration & Air-Conditioning

Refrigeration - A process in which heat is rejected & low temperature is maintained.

Refrigerant :- A substance which absorbs the heat & maintain the low temp.

(A) Primary - Such refrigerant cooled by itself.
ex - R-12, R-22, R-134a, NH_3 etc.

(B) Secondary - not cooled by itself.
they get coolness by another and then getting cooled & they cool the another thing.
ex. NaCl

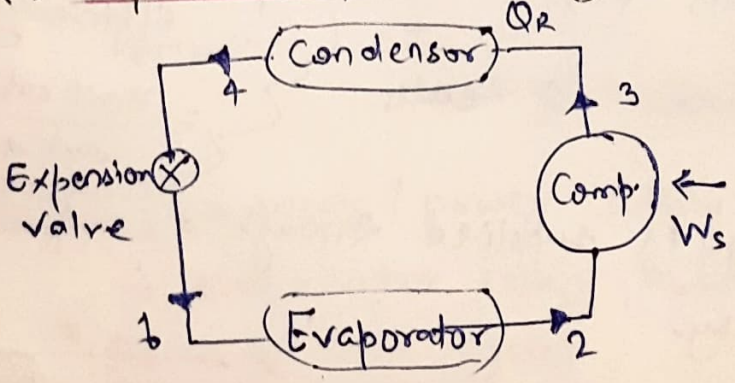
Refrigeration Cycle:- Cycle in which refrigeration process is taken place, in which heat is rejected & low temp is maintained.

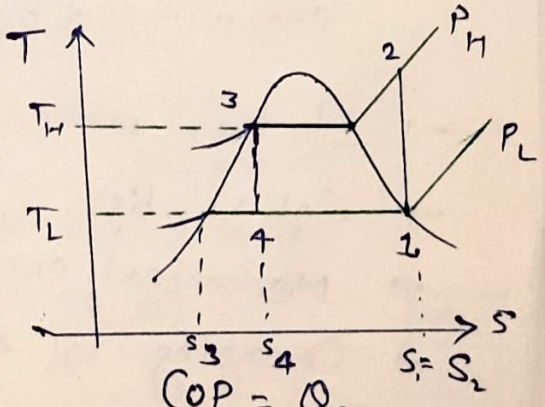
ex VCR → Vapor Compression cycle
VAR → Vapor Absorption cycle

unit → Ton of Refrigeration (TR)

COP ⇒ Cofficient of performance

(i) Vapor Compression cycle





$$COP = \frac{Q_a}{WD}$$

(A) Compressor ⇒ Increase temp & pressure

(B) Condentor ⇒ Reject latent heat and convert high vapor into liquid form.

Expension valve :- reduce pressure & temp of refrigerant.

Evaporator :- Evaporates liquid refrigerant, no heat is absorbed or rejected.

Working

- Compression process → get vapour form, increase temp & pressure. $W = h_2 - h_1$
- Condensing process → Reject the latent heat from high pressure & temp. vapour refrigerant. condens into liquid form. (Phase will change) (Low temp, High Pres)
- Expension valve → through mm hole, particle will pass and pressure & temp will decrease in liquid form. (No latent Heat absorbed.) (with some vapour)
- vapourizing process → liquid + vapour is evaporated and change into vapour. at constant Pressure & temp. (High)

Isentropic process → 1 to 2 & 3 to 4
condensor process 2 to 3
evapourated process 4 to 1

$$COP = \frac{1}{\text{Efficiency}}$$

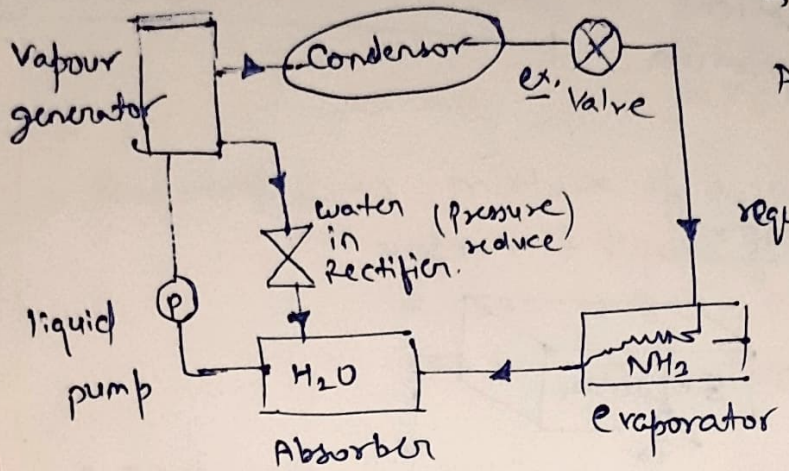
$$= \frac{\text{Heat extracted}}{\text{work done.}}$$

→ It has more wear & tear.
→ Cop is high.
→ Mechanical energy is supplied through a compressor
→ Charging is easy.

x _____ x _____ x 335 kJ ⇒ latent heat.

* **1TR** = 1000 x 335 kJ in 24 hour
= cooling effect by melting of 1000 kg of ice at 0°C temp in 24 hr
1TR = 210 kJ/min = 3.5 kW

iii) Vapour Absorption Refrigeration cycle (VAR)



→ Used in Ice making Plants.
less wear & tear.

Advantage

liquid is compressed required input work is less

→ expensive
→ complex and space consuming.
→ less efficient for large plant.
→ Cop is less.
→ Heat energy is utilized.
→ Charging is difficult.

Absorber → Absorbs the refrigent (H_2O)

Condensor → Convert vapour to liquid form.

Vapour generator → Used to generate the heat

liquid pump → transfer the fluid ~~from~~ one place to another part.

~~Evaporator → generate~~

pressure reducing valve → which reduce pressure & convert in liquid.

expension valve → reduce pressure & temp of refrigerent.

propert at low temp $NH_3 + H_2O$ mix
at high temp → NH_3 & H_2O are seperate.

***Working** → work / power supply to liquid pump.
→ evaporator (NH_3), Absorber (H_2O)

NH_3
H_2O

*(Aqua amonia cycle)

→ Heat supply to generator H_2O (liquid) + NH_3 (vapor) seperate
→ Pressure reducing valve consume hot water and amonia will collect in Condensor (weak ↓ solution)
→ Condensor (Rich) convert it in liquid.

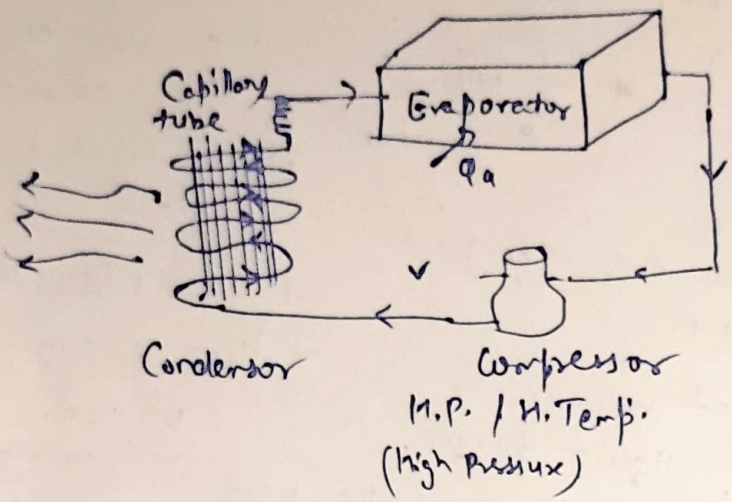
- **Nomenclature of Refrigerant**

$C_aH_bF_cCl_d$ = chemical formula.

Name = R (a-1) (b+c) c

$(b+c+d = 2a+2)$

Domestic Refrigerator



- **Application of Refrigeration**
  - In water cooler to supply cold water.
  - To produce ice.
  - For preservation of food, veg., ice cream, medicine, blood, tissues.
  - Industrial application.
  - AC in Houses, offices, hospti.

Desirable Property of Refrigerant

- Low boiling point, freezing point high Q_a
- Easy to liquify.
- Chemical stability.
- Odourless, No hazards effect.
- Low cost
- Non flammable

Types of refrigerant

(R3)

- Halocarbons (Freons) → CFC → R11, R12, R113
  HCFC → R22, R123
  HFC → R134a
- Azeotropic → mixture of two or more refrigerants vapour + liquid form.
  R-502 ⇒ 8.8% R22 + 51.2% R115
  R-503 ⇒ 40.1% R23 + 59.9% R13
- zeotropic → mixture of composition in liquid phase is differ.
- Inorganic → CO_2, NH_3, H_2O etc
- Hydrocarbon → R170, R290 etc. industry & domestic.

* Air Conditioning System

→ Temperature is maintained.
→ Dust particle are removed
→ Moisture & Humidity is maintained.

Classification —

(i) based on unit

- Unitory AC (1 unit used for) (only for room)
- Central AC → malls, distribute centre to all direction

(ii) based on season

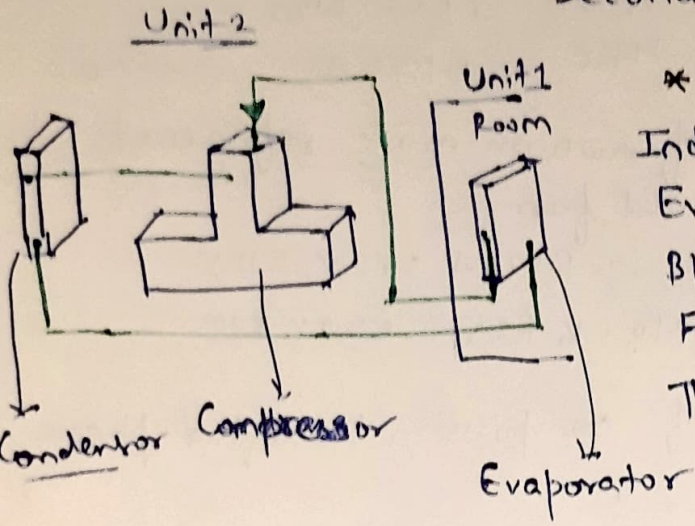
- Summer AC → temp ↓, moist ↓
- Winter AC → temp ↑, moist ↑

(iii) * based on construction

- Window AC
- Split AC

cement etc

(A) Split AC → Consists two parts (Unit)
One indoor unit → Connected by
Second → outdoor unit. pipe & wire.



* Components

Indoor
Evaporator
Blower/fan
Filters
Themostats

Outdoor
Compressor
Condenser coil
Fan
Expansion valve

Working based on VCR cycle. transfer heat from the indoor air to Outside enviornment.

Steps

(i) Thermostat senses the temp.
temp of room >> then AC turns on.

(ii) Compressor compresses low pressure gas into high high temp & high pressure gas.

(iii) Condensor → Reject the heat & convert into high pressure liquid.

(iv) Expension valve drop pressure, reduse pressure & temp.

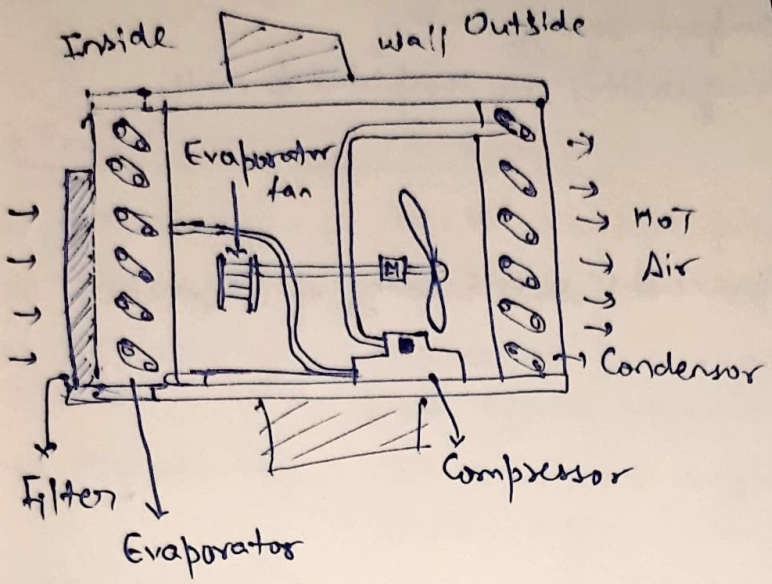
(v) Heat Absorption in Evaporator → absorbs heat from air and evaporates.

(vi) Cycle Repeats.

Advantage over (AC window)

→ Better Asthetics
→ efficient cooling of longer room.
→ More installation flexibility.

(A) Window AC



Parts (15)

Evaporator Fan
Evaporator
Expension valve
Filter
Condenser
Compressor

* A window AC is a compact, self-contained unit designed to cool a single room.
It is typically mounted in a window or a hole in an external wall.

working

based on refrigeration cycle, which involves heat absorption & release using a refrigera

1. Thermostat detects temperature -
2. Compressor starts → compresses the low pressure gas into a high pressure, high temp gas.
3. Heat release at the condenser → A fan blow outside air over the coil & refrigerant loses heat to outside, becoming becoming high pressure liquid.
4. Expension valve → reduce the pressure & temp. of liquid.
5. Heat absorption at evaporator → Refrigerant absorbs heat from the air & evaporates.
6. cycle repeats ~ - - --

Disadvantage

(i) Noise
(ii) Cooling effect.
(iii) Installation Difficult.

Application of AC

→ Homes & offices → comfort cooling.
→ Maintain indoor air quality in Hospital & malls.
→ in vehicles.
→ Factories & labs.
→ Data centers to prevents overheating of servers.