Refrigerants :-

Naming of Refrigerants :-

(1) Saturated hydrocarbon :- (Single bond)

$C_m H_n F_p Cl_q$

$2m+2 = n+p+q$ (saturated)

→ **$R\,(m-1)(n+1)\,p$**

eg (i) CCl_2F_2

$m=1,\ m-1=0$

$n=0,\ n+1=1$

$p=2$

R012 or R12

(ii) R11

R011 → $(m-1)$, $(n+1)$, p

$C H_0 F_1 Cl_3$

$CFCl_3$

(iii) R22

R022 → $(m-1)$, $(n+1)$, p

CHF_2Cl

(iv) C_2F_3Cl

$m=2$

$n=0$

$p=3$

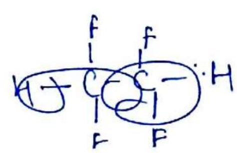
R113

(v) R134

$m-1=1,\ m=2$

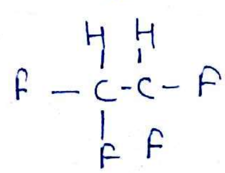
$n+1=3\ \ n=2$

$p=4$



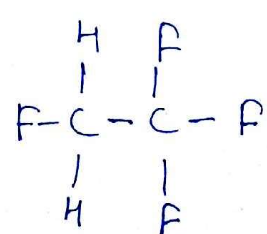
$C_2H_2F_4Cl_0$

$C_2H_2F_4$



Symmetric

or



asymmetric R134a

② Unsaturated hydrocarbon (double bond)

$C_m H_n F_p Cl_q$

$2m = n + p + q$

→ $R1(m-1)(n+1)P$

eg C_2H_4

$R1(2-1)(4+1)(0)$

R1150

③ Inorganic

R (700 + mol. mass)

NH_3 → R717

H_2O → R718

Air → R729

SO_2 → R764

CO_2 → R744.

④ Azetrope :-

(as a pure substance)

R – (500+ random No.)

R 502

→ ingredient (Sec but)

* The mixture of refrigerent behaving as pure substance is called azetrope.

Properties of the Refrigerent

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1) Normal Boiling Point (NBP) :-

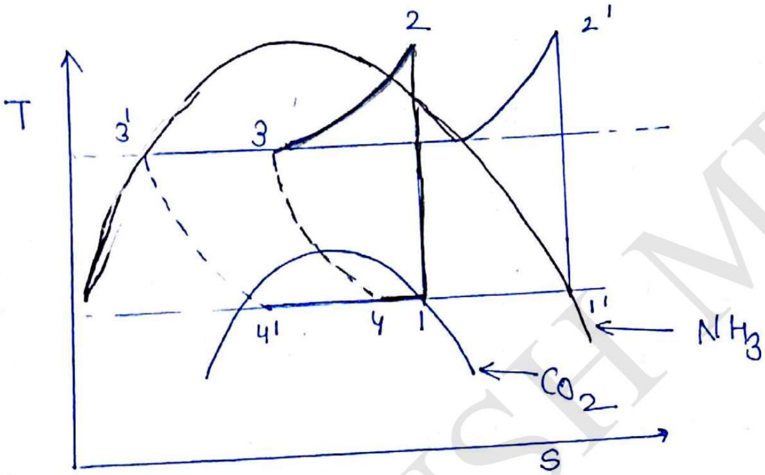
→ The minimum pressure in the cycle is desired to be above atmospheric pressure. This is because if the leakage occurs, we dont want air to leak inside the system because it will bring water vapour with it self which may freeze at low temp. hence chocking the system.

→ If the evaporator pressures are close to atmospheric pressure then for the refrigerent to boil at very low temp. the normal boiling point should be lower than the desired temp. Hence low NBP refrigerent are desirable.

→ low NBP refrigerent are high pressure refrigerents a high NBP refrigerents are low pressure refrigerents.

Note: The air if enters in the system get trapped in the condensor. It increase condensor pressure, compressor power and cooling water temp. ~~The~~ The removal of trapped air in the condensor is called '<u>purging</u>.'

(2) Critical Point temprature :-



R.c. $= \uparrow \dot m \times (R.E \downarrow)$

$T_{cr}\downarrow$, $\dot m \uparrow$, R.E.$\downarrow$, $\dot W \uparrow$, COP$\downarrow$, Vol $\uparrow$

The critical temp. of the refrigerent should be sufficiently more than the Condensor temp., to Facilitate heat transfer during phase change. CO_2 and ethylen have very low critical temp hence they are unidesirable.

→ Water has one of the highest critical temp. among the commonly used refrigerent.

Note :- Since heat transfer in Bell Colemann Cycle is sensible hence the COP of this cycle is less than VCRS.

③ Latent heat and Specific heat :-

latent heat of the refrigerant should be high as it result in lower mass flow rate. specific heat should be low in liquid phase and high vapour phase.

$$R.C. = \dot{m}\downarrow (R.E\uparrow)$$
↳ LHT

④ Freezing point :- Freezing point should be lower than the required temp. to avoid freezing of refrigerent.

⇒ water has good thermodynamic property but because of it's high freezing point it is not used for refrigeration.

⑤ Viscosity : The viscosity of refrigerent should be low to eliminate viscous loss.

⑥ Pressure Ratio :- we should select a refrigerent which gives low pressure ratio corrosponding to the required evaporator and condenser temp.

$\eta_v \downarrow$ $\eta_v = 1 + C - C\left(\frac{P_2}{P_1}\right)^{1/n}$

⑦ Specific Volume at the inlet to the Compressor:-

The specific Volume at the Compressor inlet should be less because high specific ~~Volume result~~ ~~in larger size comp~~ Volume result in large size Compressor.

→ R11 & R113 have high specific Volume hence they are used with centrifugal Compressor.

⑧ Compressor discharge temprature:-

Compressor discharge temp. should be low. high compressor discharge temp. increase Compressor damage.

⑨ → Since NH_3 has high Compressor discharge temp. hence NH_3 Compressor are water Cooled.

Note:- NH_3 has a high latent heat of Vapourisatio

⑨ Toxicity and flammability:- The refrigerent should be non toxicity and non flammable.

→ NH_3 has very good thermodynamic properties but is not used in domestic application because of it's toxic and flammable nature.

(10) Action with the lubricating oil :-

(i) Complately immiscible :- refrigerents like NH_3 and CO_2 which are complately immissible with the lubricating oil are seprated with the help of an oil seprature installed b/w Compressor and Condensor. The seprated oil brough back to the compressor.

(ii) Complately missible: Refrigerent like R11 & R22 which are complately missible with the lubricating oil do not present much problem because the ~~seprated oil is brough~~ the oil which is washed away by the refrigerent is brought back in the compressor.

(iii) partialy missible!- The refrigerent like R22 present problem because the lubricating oil is washed away by the refrigerent Gets deposite it in the evaporator this leads to reduction in lubricating oil in the compresser hence wear & tear of compressor.

→ In such Cases we use synthetic oil in place of lubricating oil.

(ii) Action with material of Construction :-

→ NH_3 reacts with copper hence whenever NH_3 is used as refrigerent copper is not used as material of construction instead wrought iron or steel is used.

→ Freon's react with Al hence whenever Freon's are used as refrigerent Al is not used instead Cu is used as material of construction

leak detection test :-

(1) Halide torch test: it is used to detect the leakage of Freon's. In presence of Freon' the blue flame of hydrocarbon changes to bluish green.

(2) Sulphur Stick or Sulphur ribbon method :- it is used to detect the leakage of NH_3. White flumes of $(NH_4)_2S$ Amoniam sulphide are formed when sulphure stick brought close to leaking NH_3.

(3) Ammonia swab test :- A cloth dibbed in NH_3 is passed over leaking sulphur dia oxide (SO_2) white flumes of $(NH_4)_2S$ are formed.

(4) soap bubble test :- Soap water is used to identify the leakage of hydrocarbon.

Recent trend in Refrigeration:-

Cl element present in the refrigrent dissociates in presence of sunlight and reacts with O_3 which is situated in stratosphere.

→ ozone layer filters the harmful ultraviolet ray from the sun, hence it's depletion is undesirable

→ There for the use of refrigrent containing clorine (cl) has heed discourage and we have replaced R12 in domestic refrigerator with R134a.

→ The substitute for cloroflorocarbon (CFC) is

a) hydro carbon

b) florocarbon

c) hydro floro carbon

d)

	Name of Ref.	Use
1)	R-12	→ Domestic Ref. (Earlier)
2)	R134a	→ Domestic ref. (Now) & car A/c's
3)	R-22	→ window A/c
4)	R-11	→ Central A/c
5)	NH_3	→ Industrial Application (ice making)
6)	Air	→ Air craft + A/c
7)	CO_2	→ transport refrigeration and direct contact food refrigeration