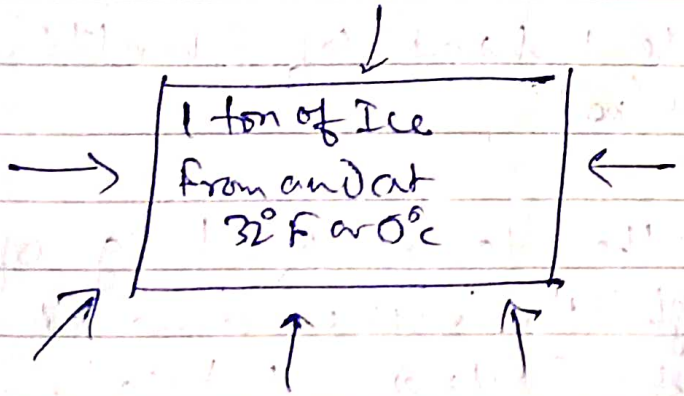
Books:

(1) P. L. Ballaney
(2) C. P. Arora
(3) Manohar Prasad
(4) Domkundwar
(5) Rossat.
(6) Stocker & Jones
(7) ASHRAE fundamentals
(8) Carrier Handbook
(9) Althouse → (Modern Air Conditioning)
(10) Sparks & Gillio
(11) Lang → Principle of refrigeration
(12) Moore → " " Air Conditioning

Refrigeration

means production of cold
↓
By the abstraction of heat

Unit of refrigeration:



time taken for melting is 24 hrs.
1 ton of Refrigeration i.e. 1TR.

Actually 1 ton = 2204.6 lbs

But by mistake it is taken as 2000 lbs.

Standard we consider always 2000 lbs

1 Small ton of Ice

1 TR : (Defination)

The amount of cooling produced on melting of 1 small ton of Ice ~~from~~ and at 32°F or 0°C in a day of 24 hrs, is called 1 TR.

Fundamentally :

F.P.S : To ~~rise~~ raise the temp of 1 lb of water ~~through~~ per 1°F, the amount of heat reqd. (specific heat) is called 1 B.Th.U or Btu (99% industries use)

The Latent heat of melting of ice is 144 Btu/lb.

M.K.S : To ~~rise~~ raise the temp of 1 kg of water ~~through~~ per 1°C, the amount of heat reqd. is called 1 K Cal.

In this system Latent heat

Ofice is 80 kcal/kg.

Centigrade heat unit

Now $\boxed{1 \text{ lb of water} \times 1^{\circ}\text{c} = 1 \text{ C.H.U.}}$

Now F.P.S:

$$\frac{2000 \text{ lbs} \times 144 \frac{\text{Btu}}{\text{lb}}}{24} = 12000 \text{ Btu/hr is termed as 1 TR}$$

$$= 200 \text{ Btu/min} \quad ,,$$

M.K.S: $\quad 1 \text{ ton} = 2204.6 \text{ lbs} \Rightarrow 1 \text{ kg} = 2.2046 \text{ lbs}$

$$\frac{\frac{2000}{2.2046} \text{ kg} \times 80 \frac{\text{kcal}}{\text{kg}}}{24} = 3023.980163 \text{ kcal/hr}$$

$$= 50.39967 \text{ kcal/min}$$

$$\simeq 50 \text{ kcal/min}$$

$$\boxed{1 \text{ kCal} = 4.1868 \text{ kJ}}$$

Now $1 \text{ TR} = \frac{3023.980163 \times 4.1868}{60} \text{ kJ/min}$

$$= 211.0133 \text{ kJ/min}$$

$$\simeq 211 \text{ kJ/min}$$

$$1 \text{TR} = 3.5168 \text{ kJ/sec}$$

$\simeq$ 3.5 KW

If we write

1 TR = 3.5 KW

= 3.5 KJ/s

= 3.5×60 KJ/min

= 210 KJ/min

Therefore, If we write 3.5 KW = 1TR then we always use 210 KJ/min instead of 211 KJ/min.

* The working substance used in R.A.C is called Refrigerant.

Manufacturing Company's

E.I. du pont	use gas known as →	Freon eg. F22
Arctic	" →	Arctron
GEC	" →	Genetron (G22)
Methur	" →	Metron
Mafatlal group of industries	" →	Meffron.

Any substance that absorbs heat through expansion or vaporisation may be called a refrigerant.

Basically refrigerant are chloro. fluoro derivatives of alkanes, alkanes are saturated hydro. carbon (C_nH_{2n+2})

e.g. CH_4 (Methane)
C_2H_6 (Ethane)
C_3H_8 (Propane)

Chemical formula

$C_mH_nF_pCl_q$

A substance behaves as a refrigerant if

$$2n+2 = n+p+q$$

ASHRAE

American Society of Heating, refrigerating and Air Conditioning Engineers

According to ASHRAE, refrigerant is designated as

R (n-1) (n+1) p

where R for refrigerant.

eg. R22 ⇒ R022.

i.e. $m-1=0$, $n+1=2$, $p=2$

$m=1$, $n=1$, $p=2$

$2m+2 = n+p+q$

Again, $2m+2 = n+p+q$

$2\times1+2 = 2+1+q$

$q=1$

CHF_2Cl (21 is derivative of methane)

Mono chloro difluoro methane.

eg. R12 ⇒ R012.

$m-1=0$, $n+1=1$, $p=2$

$m=1$, $n=0$, $p=2$

And, $2m+2 = n+p+q$

$2\times1+2 = 0+2+q$

$q=2$

CF_2Cl_2

Dichloro difluoro methane.

Similarly C_2H_6 is 170 etc.

* The refrigerants having Bromine atom are denoted by putting additional B and the number to indicate the number of Chlorine molecules replaced by Bromine.

Therefore, R-13 B1 is derived from R-13 with one Chlorine atom replaced

by Bromine. (CHF_2Br)

* Unsaturated compound in which digit 1 is put before (m−1). Thus ethylene is R-1150

$n+p+q = 2m$

$m-1 = 1, \quad n+1 = 5, \quad p = 0$

$m = 2, \quad n = 4, \quad p = 0$

Now, $2 \times 2 = 4 + 0 + q$

$q = 0$

C_mH_n type

C_2H_4 (ethylene)

* For inorganic refrigerants, the number is designated by adding molecular weight to 700.

eg. $CO_2 \rightarrow$ Mol.wt = 44 (R-744)

$NH_3 \rightarrow$ Mol.wt = 17 (R-717)

Types of refrigerants :

(1) Primary refrigerants
(2) Secondary refrigerants

Primary refrigerants :

Are those which used in vapour - Compression system.

Secondary refrigerants :

which are liquids used for transporting low temp heat energy from one location to another.

Other names for secondary refrigerants are antifreezes and brines.

Classification of Refrigerants :

The National Refrigeration Safety Code, USA Catalogues all the refrigerants into three groups :

(i) Group one refrigerants :

Are Considered the safest refrigerants on the basis of not being a fire hazard and not being toxic.

Group #1)	Class
R-744	5
R-12	6

*** Class one is the most toxic and class six is the least.

R-21	6
R-114	6
R-30	4
R-11	6
R-22	5
R-123	4
R-500	6
R-502	6
R-40 (methyl chloride)	4

Group two (2) refrigerant:

These refrigerants are toxic and irritating to breathe and may or may not be slightly inflammable.

Group 2	Class
R-717 (Ammonia)	2
R-113	4
R-160	4
R-40	4
R-611	3
R-764 (Sulphur dioxide)	1

Group three refrigerants:

These refrigerants have tendency to burn or form combustible mixtures with a wide range of concentration of air.

Group 3	class
R-600	5
R-170	5
R-601	5
R-290	5

Basis of choice of refrigerant:-

The following is a brief and rough review of the principal applications of some refrigerants.

✓ **Air**: The major use of air as a refrigerant is in aircrafts where the light weight of an air system compensates for its low c.o.p.

Ammonia:

Large industrial low temp installation are the applications where ammonia is most frequently used. Many new ammonia systems come into