



SNS COLLEGE OF TECHNOLOGY

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UGC

DEPARTMENT OF FOOD TECHNOLOGY

COURSE CODE & NAME: 19FTT301 & Refrigeration & Cold Chain
Management

III YEAR / V SEMESTER

UNIT : I INTRODUCTION TO REFRIGERATION

TOPIC 1 : Refrigerants - classification and thermodynamic properties



Important Refrigerants



1. Carbon dioxide:

Carbon dioxide is widely used as a refrigerant in mechanical systems refrigerant, marine services, hospitals, etc. due to its excellent safety properties. It is odorless, non-toxic, non-flammable, non-explosive and non-corrosive.

2. Sulfur dioxide:

Sulfur dioxide was widely used as refrigerant during the early 20th century. However, its use has been restricted nowadays because of its many inherent disadvantages. It is highly toxic, non-flammable, non-explosive, non-corrosive and works at low pressures



3. Ammonia:

Ammonia is one of the earliest types of refrigerants which is still widely used in many applications due to its inheritance excellent thermal properties, It is toxic in nature, flammable explosive under certain conditions, it has low specific volume, high refrigerating effect, low piston displacement in case of reciprocating compressors make it an ideal refrigerant for cold storage's, ice plants, packing plants

4. Freon-11:

Freon-11 (Trichlorofluoromethane) is used under low operating pressures; it is non-toxic, non-corrosive and non-flammable. Due to low operating pressure and high displacement, it is used in systems employing centrifugal compressors. It is used for air-conditioning applications.



5. Freon-12:

Freon-12 (Dichloro difluoromethane) is non-flammable, non-toxic and non-explosive. It is highly chemically stable. If it is brought into contact with open flame or heater elements, it decomposes into highly toxic constituents. It has not only excellent safe properties but also condenses at moderate pressure under normal atmospheric conditions.

6. Cryogenic refrigerants:

Cryogenic refrigerants are those refrigerants which produce minus temperature in between range -157°C to -273°C in the refrigerated space. The cryogenic refrigerants have a shallow boiling point at atmospheric pressure. Some of the widely used cryogenic refrigerants are Helium, Nitrogen, Oxygen, Hydrogen.

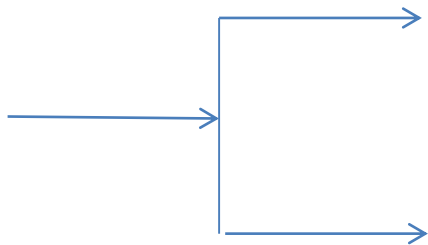


Properties of Refrigerants



Refrigerant : is the fluid used for heat transfer in a refrigerating system that absorbs heat during evaporation from the region of low temperature and pressure, and releases heat during condensation at a region of higher temperature and pressure.”

Refrigerants:



Primary Refrigerant

Secondary Refrigerant





Properties of Refrigerants



- Refrigerant is the working fluid used in refrigerators .

Commonly used refrigerants are:

1. **Ammonia** : Used in ice plants, large cold storages, etc.
2. **Carbon dioxide** : Used in marine refrigerators, dry ice making etc.
3. **Methyl chloride** : Used in domestic & industrial refrigerators
4. **Fluorocarbons** : Freon -11,12,13,22,113,114, etc.

These are used in domestic & industrial applications. These chemicals damage the ozone layer and hence they are being replaced.



Properties of Refrigerants



PRIMARY REFRIGERANTS-

- The working mediums or heat carriers which directly take part in the refrigeration system and cool the substance by the absorption of latent heat are called as Primary refrigerants.

Eg: Freon Ammonia , Carbon dioxide, Sulphur dioxide etc.

SECONDARY REFRIGERANTS-

- These are circulating substances which are first cooled with the help of primary refrigerants and then employed for cooling purposes.

Eg:- Ice, Solid CO₂ , Chilled water, brine solutions.



Properties of Refrigerants



Classification Refrigerants

Thermodynamic properties:

- Low freezing point
- Low boiling point

Chemical properties:

- Non-toxic
- Non-flammable and non-explosive
- Non-corrosive to metal
- High latent heat of vaporization

Physical Properties:

- Low specific heat
- A low specific volume of vapor
- Low viscosity



Properties of Refrigerants



Boiling temperature. The boiling temperature of the refrigerant at atmospheric pressure should be low

Refrigerant	Boiling temperature (oC) at atmospheric Pressure
R-11	+21.77
R-12	-29
R-21	+9
R-22	-41
R-30	+39.8
R-40	-23.7
R-113	+47.6
R-717	-33.3
R-764	-10



Courtesy : <https://parenting.firstcry.com/articles/magazine-10-boiled-food-recipes-for-healthy-lifestyle/>



Properties of Refrigerants



Freezing temperature: The freezing temperature of a refrigerant should be well below the operating evaporator temperature

<i>Refrigerant</i>	<i>Freezing temperature (°C)</i>
R-11	-111
R-12	-157.5
R-21	-135
R-22	-160
R-30	-96.9
R-40	-97.5
R-113	-35
R-717	-77.8
R-764	-75.6



Properties of Refrigerants

Evaporator and condenser pressure : Both the evaporating (low side) and condensing (high side) pressures should be positive (i.e. above atmospheric) and it should be as near to the atmospheric pressure as possible.

Refrigerant	Evaporator pressure	Condenser pressure	Compression ratio
R-11	0.2021	1.2607	6.24
R-12	1.8262	7.4510	4.08
R-21	0.3618	2.1540	5.95
R-22	2.9670	12.0340	4.05
R-30	0.0807	0.7310	9.06
R-40	1.4586	6.5310	4.47
R-113	0.0676	0.5421	8.02
R-717	2.3634	11.67	4.94
R-764	0.8145	4.5830	5.63



Properties of Refrigerants



Critical temperature and pressure : The critical temperature of a refrigerant is the highest temperature at which it can be condensed to a liquid, regardless of a higher pressure.

<i>Refrigerant</i>	<i>Critical temperature (°C)</i>	<i>Critical pressure (bar)</i>
R-11	198	43.8
R-12	112	41.2
R-21	178.5	51.65
R-22	96	49.38
R-30	216	44.14
R-40	143	66.83
R-113	214	34.14
R-717	133	113.86
R-744	31	73.8
R-764	157	78.7



Properties of Refrigerants



Coefficient of performance and power requirements : For an ideal refrigerant operating between - 15°C evaporator temperature and 30° C condenser temperature,

<i>Refrigerant</i>	<i>Coefficient of performance</i>	<i>kW/TR</i>
R-11	5.09	0.694
R-12	4.70	0.746
R-22	4.66	0.753
R-30	4.90	0.716
R-40	4.90	0.716
R-113	4.92	0.716
R-717	4.76	0.738
R-729	5.74	0.619
R-744	2.56	1.372
R-764	4.87	0.724



Properties of Refrigerants



Latent heat of vaporization : A refrigerant should have a high latent heat of vaporization at the evaporator temperature.

<i>Refrigerant</i>	<i>Refrigerating Effect</i>	<i>Latent heat of vaporisation</i>	<i>Mass of refrigerant</i>	<i>Volume of liquid refrigerant</i>
R-11	157.3	195.7	1.34	0.918
R-12	116.5	159.0	1.81	1.404
R-22	161.5	218.1	1.31	1.115
R-30	313.6	377.7	0.676	0.507
R-40	350.0	421.0	0.603	0.67
R-113	125.1	164.5	1.7	1.1
R-717	1105.4	1316.5	0.19	0.32
R-744	129.3	274.0	1.63	2.73
R-764	329.5	394.7	0.64	0.474



Assessment



1. What is the desirable characteristics of a refrigerant?
 - a. it should not be toxic
 - b. it should not be non-corrosive
 - c. it should have minimum enthalpy of vaporization
 - d. all of the above
2. What is the disadvantage of ammonia using as a refrigerant?
 - a. Ammonia cannot be detected in case of leakage
 - b. Ammonia has a bad effect on ozone layer
 - c. Ammonia is toxic in nature
 - d. Ammonia has higher energy cost



Assessment



3. When two refrigerating cycles are used in series with two different refrigerants, the system is known as
- Dual refrigeration system
 - Cascade refrigeration system
 - Vapour absorption refrigeration system
 - None of the above
4. Which refrigerant is widely used in refrigeration facilities of food as cooling of fresh vegetables, dairy products, meat and fish and similar process industries?
- Sulphur dioxide
 - Ethyl chloride
 - Propane
 - Ammonia



THANK YOU..."