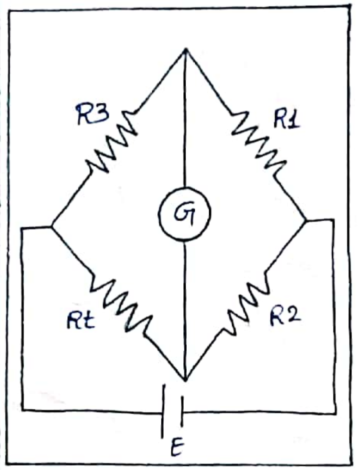
RESISTANCE THERMOMETER

Definition :- Resistance thermometer is a device that is used to determine temperature by the variation in the Resistance of a Conductor. It is commonly known as Resistance Temperature Detector (RTD) & it is an accurate temperature sensor.

Working Principle :- When the temperature of the metal increases, there is an increase in the vibrational amplitude of an atomic nuclei of the material [illegible] increases [illegible] collision of free electrons with that of the bounded ions. Thus, the interruption in motion of the electron [illegible] increase.



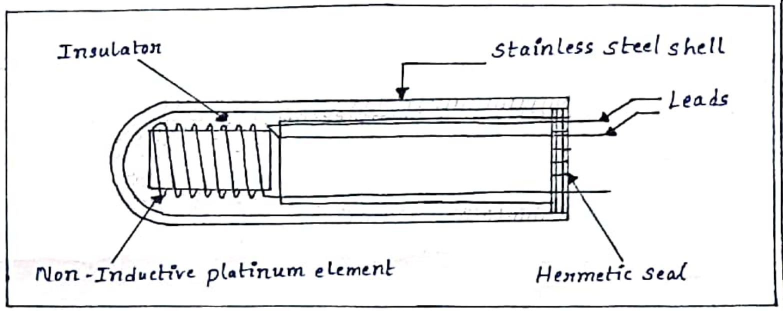
Circuit :- The resistance thermometer circuit is basically a Wheatstone bridge circuit. However, it is not exactly a wheatstone bridge but a modification of the circuit. It is connected to one arm of the Wheatstone bridge. The Resistors R_1 and R_2 are fixed resistances and R_3 is the variable resistance. R_t is the detector resistance that is used in the circuit. At Balance condition,

$$R_t = \frac{R_2}{R_1} \times R_3$$

If $R_1 = R_2$

Then $R_t = R_3$

The variable resistance R_3 used is nothing but an adjustable potentiometer. We use lead wires to connect the detector resistance to our circuit.



Construction of a Detector Resistance

A platinum resistance thermometer consists of a platinum coil that is present inside a cross frame. We place the whole arrangement in an evacuated tube which is made of stainless steel. The coil arrangement generates very little strain when there is an rise in temperature. This may cause an undesireable change in resistance. For the construction, the pure platinum wire must be used. The purity of the platinum can be confirmed using the formula $\frac{R_{100}}{R_0}$. In the case of pure platinum material, the value must be greater than 1.390. The Relation of Resistance with respect to that of temperature can be given by the Equation.

$$\boxed{R_t = R_0 (1 + \alpha t + \beta t^2)}$$

Material used :-

Platinum is the most common material used in resistance thermometers due to its stability, linearity and wide temperature range.

Advantages :-

(1) It gives an accurate result.
(2) It is used in various Industrial applications.
(3) The temperature range is between −200°C to 1000°C.
(4) It has endless applications.

Disadvantages :-

(1) The sensitivity of platinum is extremely less for a small change in temperature.
(2) The response time is quite slow.
(3) RTD is not used for dynamic temperature measurement.

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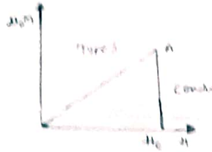
TYPE I AND II SUPERCONDUCTORS

Type - I Superconductor :-

(a) Type I superconductors are those superconductors that lose their superconductivity very easily (or) abruptly when placed in the external magnetic field. As you can see from the graph of the Intensity of magnetization (M) versus applied magnetic field (H), when the type I superconductor is placed in the magnetic field, it suddenly (or) easily loses it's superconductivity at the critical magnetic field (H_c)



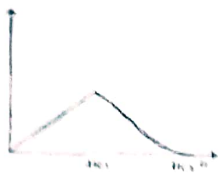
(b) Type I superconductors are also known as Soft Superconductors, because of this reason i.e they lose their superconductivity easily

(c) Type I superconductors perfectly obey the meissner effect

(d) Example of Type I superconductors: Aluminium (H_c - 0.0105 tesla); Zinc (H_c = 0.0054)

TYPE - II Superconductor :-

(a) Type II superconductors are those superconductors that lose their superconductivity gradually but not easily (or) abruptly when placed in the external magnetic field. As you can see from the graph of the Intensity of magnetization (M) versus applied magnetic field (H), when the Type II superconductor is placed in the magnetic field, it gradually loses it's superconductivity. Type - II superconductors start to lose their superconductivity at the lower critical magnetic field (H_{c1}) and completely lose their superconductivity at the upper critical magnetic field (H_{c2})



(b) The state between the lower critical magnetic field (H_{c1}) and upper critical magnetic field (H_{c2}) is known as vortex state (or) same intermediate state

(c) Type II superconductors are also known as Hard superconductors, because of this reason that is they lose their superconductivity gradually but not easily.

(d) Type II superconductors obey the meissner effect but not completely

(e) Example of Type II superconductors: NbN [H_c = 8×10^6 tesla]; $Babi_3$ [H_c = 59×10^3 tesla]

APPLICATIONS OF SUPERCONDUCTORS

1. Power Transmission: Electrical power transmission through any conductor is always accompied by energy loss I^2R. If superconductors are used, the losses will be eliminated.

2. Superconducting magnets :- An electromagnet made by using coils of superconducting wires (or) cables is called superconducting magnet. Superconducting magnets are used in magnetic resonance Imaging (MRI), technique

3. Electrical applications - Cryotron :- Cryotron consists of a wire of superconducting material A around which another wire of superconducting material B is wound in the form of solenoid. The wire A is called as gate.

→ The Cryotron is based on the principle of disappearance of superconductivity above H_c.

→ If a current is made to flow through B, then it will produce a magnetic field, if the magnetic field greater than H_c, then A will become a normal conductor. Now current through A is stopped

→ By removing the current through B. Now A switches back to superconducting state. The current will again flow through A.

→ Therefore tantalum A acts as a gate and niobium B as control and the system acts as a fast acting switch

4. Maglev vehicles :- The maglev vehicle (say a train) consists of superconducting magnets built in it's base. Say the vehicle runs over an aluminium track in which a current is flowing. The train is set afloat by magnetic levitation. A speed of 321 miles/hour was recorded in 1979 by a magnetic levitated train in Japan

5. Very strong magnetic fields : Very strong magnetic field can be generated with coils made of superconducting materials. The cost is lesser than conventional electromagnets. Used in research and diagnostic equipments in medicine

Presented by
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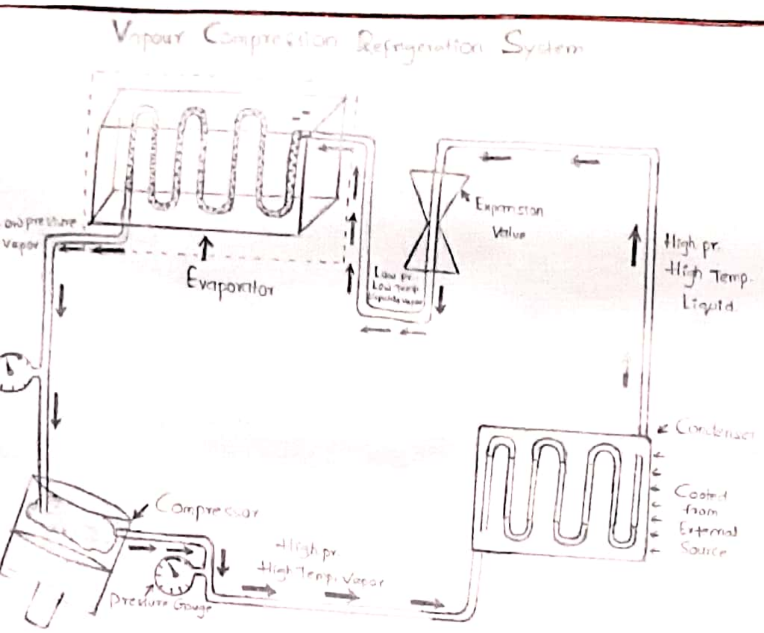
Vapour Compression Refrigeration System

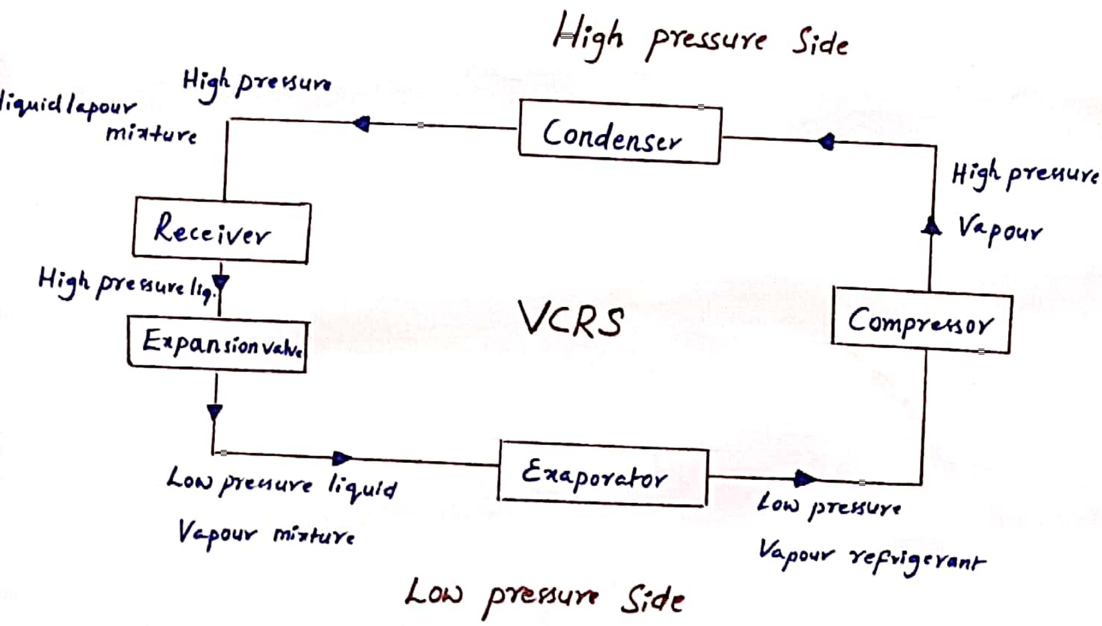


Simple Vapour Compression Refregralion System

Refrigeration:- Refrigeration may be defined as the process of removing heat from a substance under controlled conditions.

- It also includes the process of reducing & maintaining the temperature of body below a general temparature of its surrounding.
- In other words the refrigeration means a continued extraction of heat from a body whose tempeature is already below the temparature of the surrounding.

- A vapour compression refrigeration system is an improved type of air-refrigeration system in which a suitable working substance, termed as refrigerant is used.
- It condenses & evaporates at temperatures & pressures close to the atmospheric conditions.
- The refrigerants generally used for this purpose are ammonia (NH_3), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), etc.
- The refrigerant used, does not leave the system but is circulated throught the system.
- The system comprises of components such as
  - i) Compressor
  - ii) Condenser & receiver
  - iii) Expansion valve
  - iv) Evaporator.



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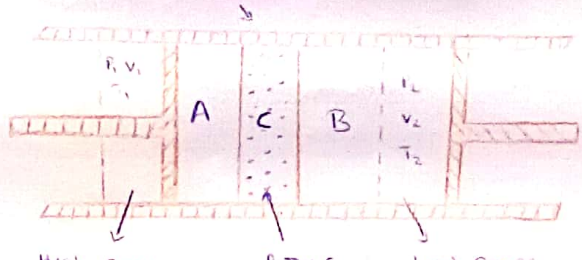
Joule Thomson Effect



Joule and thamson observed that when a gas is all to expand freely through a porous plug from a regin of High Pressure to a region to low press adiabatically, the gas get cool This effect is known as Joule Thomson effect.

$\boxed{W = PV}$ work done in chamber A
$= P_1V_1$

work done in chamber B
$= P_2V_2$

Net word done
$\Delta W = P_2V_2 - P_1V_1$ —①

Since the expansion is do adiabatically
$\Delta q = 0$

from this first law of thermodynamic

$$\Delta q = \Delta E + \Delta W$$
$$0 = \Delta E + \Delta W$$
$$\Delta E = -\Delta W$$
$$\Delta E = -(P_2V_2 - P_1V_1)$$
$$\Delta E = -P_2V_2 + P_1V_1$$
$$E_2 - E_1 = -P_2V_2 + P_1V_1$$
$$\{H = (E + PV)\}$$
$$E_2 + P_2V_2 = E_1 + P_1V_1$$
$$H_2 = H_1$$
$$H_2 - H_1 = 0$$
$$\boxed{\Delta H = 0}$$

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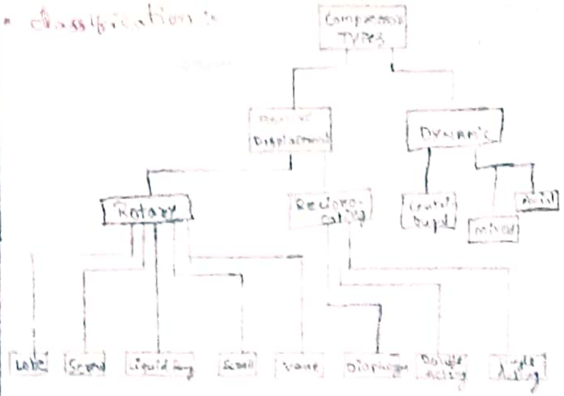
TYPES OF COMPRESSORS

- What is Compressor
- Compressors are mechanical device that compresses gases. It is widely used in industries and has various application.
- How they are different from pumps
- Major difference is that compressors handles the gases and pumps handles the liquids
- As gases are compressible the compressor also reduces the volume of gas
- Liquids are relative incompressible
- Why we need?
- Compressor have many everyday uses, such as in:
- Air conditioners (car home)
- Home and Industrial refrigeration
- Hydraulic compressors for Industrial machines
- Air compressors for Industrial manufacturing

- Classification:



→ Positive displacement:

Positive displacement compressors operate by forcing a fixed volume of fluid from the inlet pressure section of the compressor into the discharge zone of the compressor.

Reciprocating compressors:-

- mechanical piston type
  - → single acting
  - → double acting
  - → diaphragm type:-

Single acting compressor

→ A single acting reciprocating piston compressor consists of a single cylinder which only takes in and discharges fluid at one end

Double acting compressor

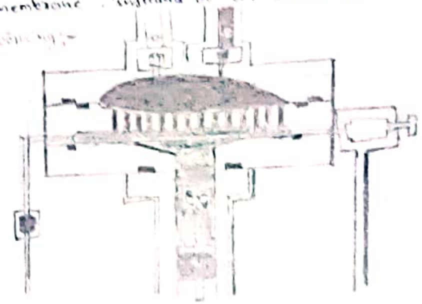
→ A double acting unit also has only one cylinder but it is piped up to take in and discharge fluid at both ends

- Diaphragm Type:

→ A diaphragm compressor is a variant of the classic Reciprocating compressor.

→ The compression of gas occurs by means of flexible membrane, instead of an intake element.

- Working:-



- Advantages:-
  - oil-free compression due to hermetic separation between gas and oil chamber
  - Abrasion-free compression due to static seals in the gas stream.
  - Automatic failure prevents damage shutdown in case of a diaphragm failure prevents damage.
  - Discharge pressure up to (3,000 bar)
- Applications
  - Automotive industry
  - Biogas plants
  - chemical and petrochemical industry
  - chip manufacturing
  - laboratory and research facilities
  - Food Industry
  - Hydrogen filling stations
- Rotary compressors:-

→ Rotary compressors function is in which fixed amount of air is displaced with each revolution.

- Scroll Type compressor:-
  - A scroll compressor operating in reverse is known as a scroll expander, and can be used to generate mechanical work from the expansion of a fluid compressed air or gas
- Advantages of Scroll compressor:-

→ The absence of pistons for gas compression enables scroll compressors to reach 100% volumetric efficiency, leading to reduced energy costs

→ Re-expansion losses, a typical feature of each piston stroke encountered in reciprocating models, are eliminated. In addition, valve losses are eliminated.

- Disadvantages of scroll compressor:

→ Being fully hermetic, perhaps the biggest disadvantage of scroll compressors is that they are generally not easily repairable.

→ ABRATION

- Applications

Since their introduction, scroll compressors have been successfully used in application involving food and fruit refrigeration, trucks transportation, marine containers as well as residential and small to medium scale commercial air-conditioning applications

- Liquid Ring Type

→ They are typically used as a vacuum pump but can also be used as a gas compressors.

→ The function of a liquid ring pump is similar to a rotary vane pump, with the difference being that the vanes are integral part of the rotor.

- Advantages:

→ Almost all gases and vapours are compressed even those containing dust and liquids.

→ There is only a very slight rise in the temperature of the gas

→ There is a high level of reliability in service with a minimum of maintenance required.

- Applications:-

Applications include vacuuming air and gas boosting / recovery, explosive gas boosting & chemical processes.

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:- STAGES OF REFRIGERATION :-

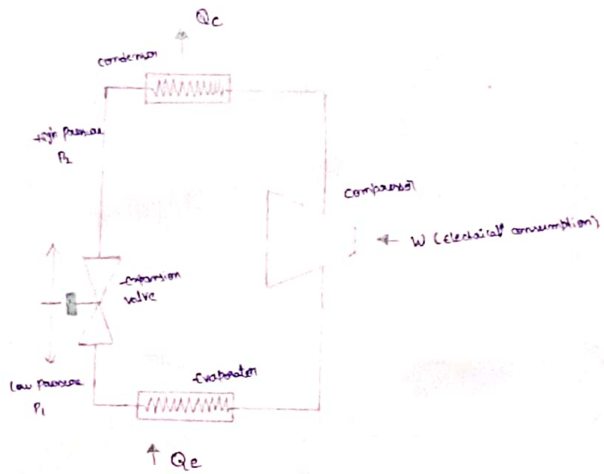
* The vapor compression refrigeration cycle involves four components:
  - (i) Compressor
  - (ii) Condensation
  - (iii) Throttling and Expansion
  - (iv) Evaporation

Compressor
Step 1 :- The refrigerant (for example R-717) enters the compressor at low temperature and low pressure. It is in a gaseous state. Here, compression takes place to raise the temperature and refrigerant pressure.

Condensation
Step 2 :- The condenser is essentially a heat exchanger. Heat is transferred from the refrigerant to a flow of water.

Throttling and Expansion
Step 3 :- When the refrigerant enters the throttling valve, it expands and releases pressure. Consequently, the temperature drops at this stage.

Evaporation
Step 4 :- At this stage of the vapor compression refrigeration cycle, the refrigerant is at a lower temperature than its surroundings. Therefore, it evaporates and absorbs latent heat of vaporization.



* Refrigeration or cooling process is the removal of unwanted heat from a selected object, substance, or space and its transfer to another object, substance, or space. Removal of heat lowers the temperature and may be accomplished by use of ice, snow, chilled water or mechanical refrigeration.

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