I. **FREQUENTLY ASKED QUESTIONS:**

II. Q no.1. Define refrigeration.

Ans 1. Refrigeration or cold storage of food is a gentle method of food preservation. It involves removal of heat from food products so that their temperature is first lowered, and then maintained at low temperature compared to that of the surroundings. The preservation of food by refrigeration is based on a very general principle in physical chemistry: molecular mobility is depressed and consequently chemical reactions and biological processes are slowed down at low temperature.

Q no. 2. What are the different types of refrigeration systems?

Ans 2. Refrigeration systems are of the following types:

A. Non-cyclic refrigeration systems: These systems include ice refrigeration, refrigeration by evaporation, and refrigeration by dry ice. These systems were used before the invention of cyclic refrigeration systems.

B. Cyclic refrigeration systems: These include the air refrigeration cycle, vapor compression refrigeration cycle, and vapor absorption cycle.

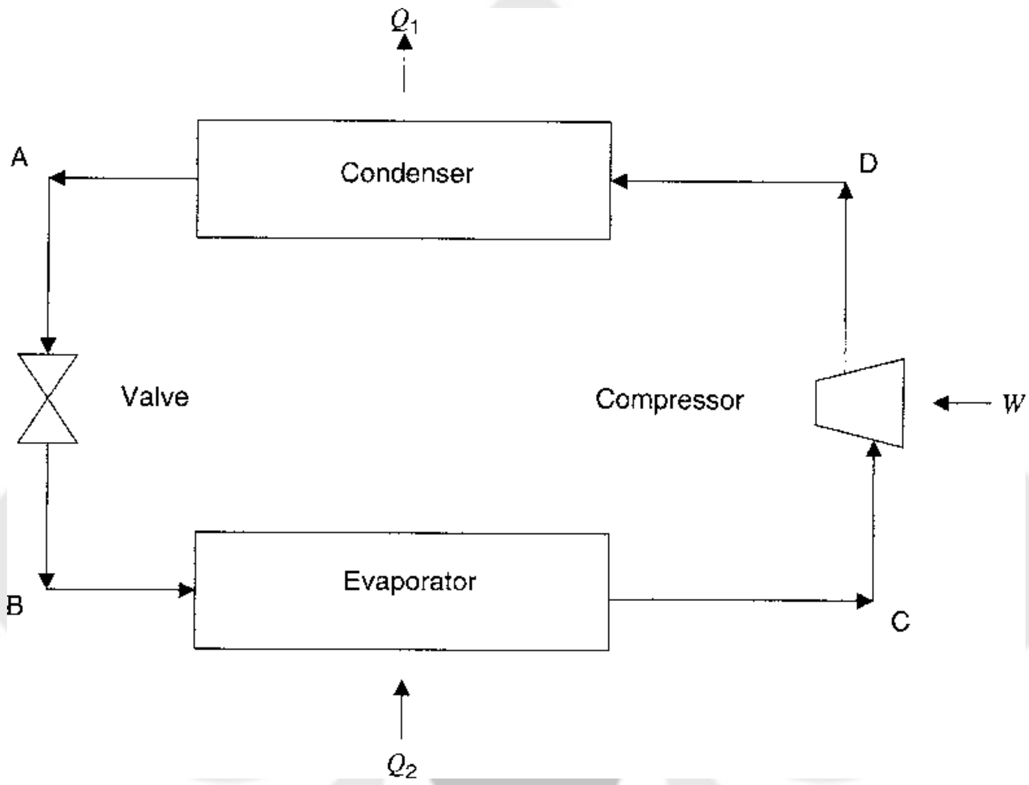
C. Other refrigeration systems: These are thermoelectric refrigeration cycle, steam-jet refrigeration cycle, vortex tube refrigeration system etc.

Q no. 3. Explain the principle of a vapor compression refrigeration system.

Ans 3. A refrigeration system may be considered as a pump that conveys heat from a region of low temperature to another region that is at a high temperature. The low temperature side of a refrigeration system is maintained at a lower temperature than the system it is cooling to allow spontaneous heat flow into the refrigeration system. The high temperature side must have a temperature higher than ambient to allow dissipation of the absorbed heat to the surroundings. In some instances, this absorbed heat is utilized as a heat source for use in heating processes. Maintaining a high and a low temperature in a refrigeration system is made possible by the use of a refrigerant fluid that is continuously recirculated through the system. By reducing the pressure, a low boiling temperature is made possible, allowing for absorption of heat in the form of the heat of the refrigerant's vaporization as it is vaporized at the low pressure and temperature. The vapors, when compressed to a high pressure, will condense at the high temperature and the absorbed heat will be released from the refrigerant as it condenses back into liquid at the high temperature and pressure.

Q no. 4. Represent vapor compression refrigeration by means of a schematic diagram.

Ans 4. Vapor compression refrigeration system is represented as:



Q no. 5. What properties should a refrigerant have that enable their use in refrigeration systems?

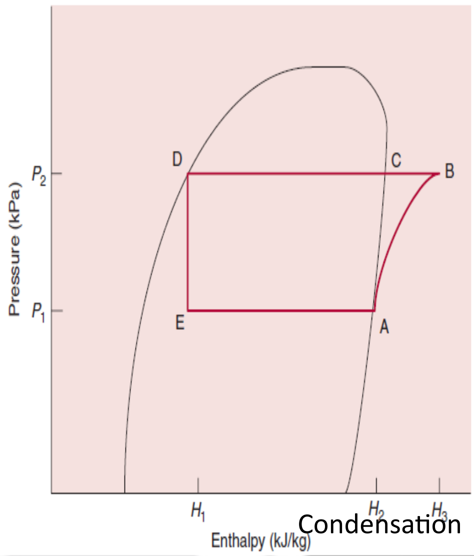
Ans 5. The following properties make a fluid suitable to be used as a rerfrigerant:

- High latent heat of vaporization
- High condensing pressure
- Lower freezing temperature than that of the evaporator
- High critical temperature
- Nontoxic

- Nonflammable
- Noncorrosive
- Chemically stable
- Economical
- Environmental friendly

Q no. 6. Depict vapor compression cycle on a pressure-enthalpy chart.

Figure 6.18 A pressure–enthalpy chart for a vapor-compression refrigeration cycle under saturated conditions.



Q no. 7. What is the utility of a pressure-enthalpy diagram?

Ans 7. The P-H diagram is a graphical representation of the refrigerant as it travels through the refrigeration system. It can be used to predict several system conditions, such as the pressure and temperature for the refrigerant at various locations within the system. It can also be used to demonstrate the effects of system changes to these conditions. For example, it can be used to predict the approximate discharge temperature of the refrigerant leaving the compressor. It can demonstrate how an excessive suction line pressure drop and excessive return vapor temperature can cause an increase in the discharge temperature.

Compression

Q no. 8. What is COP?

Ans 8. The performance of a refrigeration system is measured by the ratio of the useful refrigeration effect obtained from the system to the work expended on it to produce that effect. This ratio is called the coefficient of performance. It is used to indicate the efficiency of the system. The coefficient of performance (C.O.P.) is defined as a ratio between the heat absorbed by the refrigerant as it flows through the evaporator to the heat equivalence of the energy supplied to the compressor C.O.P.

$$\mathbf{C.O.P} = \frac{H_2 - H_1}{H_3 - H_2}$$

Q no. 9. What is chilling injury?

Ans 9. Fruits and vegetables are damaged by subjecting them to too low temperatures leading to chilling injury. At these temperatures, the tissues weaken because they are unable to carry on normal metabolic processes. Various physiological and biochemical alterations occur in the sensitive species in response to low-temperature exposure. These alterations lead to the development of a variety of chilling injury symptoms, such as surface pitting, discoloration, internal breakdown, failure to ripen, growth inhibition, wilting, loss of flavor, and decay.

Q no. 10. A cold storage room is being maintained at 2°C using a vapor-compression refrigeration system that uses R-134a. The evaporator and condenser temperatures are −5 and 40°C, respectively. The refrigeration load is 20 tons. Calculate the mass flow rate of refrigerant and the C.O.P. Assume the unit operates under saturated air conditions.

Solution. Given:

Room temperature = −2°C

Evaporator temperature = −5°C

Condenser temperature = 40°C

Refrigeration load = 20 tons

Approach:

Draw the refrigeration cycle on a pressure–enthalpy diagram for R-134a.

From the diagram, obtain the required enthalpy values.

1. On a pressure–enthalpy chart for R-134a, draw lines EA and DC, representing the evaporator and condenser conditions. Follow the constant-entropy curve (may require interpolation) from A to intersect horizontal line DC extended to B. From point D, draw a vertical line to intersect line EA at point E. Thus, ABCDE represents the refrigeration cycle under saturated conditions for the given data.

2. From the chart, read the following:

Evaporator pressure = 243 kPa

Condenser pressure = 1,015 kPa

H 1 = 156 kJ/kg

H 2 = 296 kJ/kg

H 3 = 327 kJ/kg

3. Mass flow rate of refrigerant (noting that 1 ton of refrigeration = 303,852 kJ/24 h) is

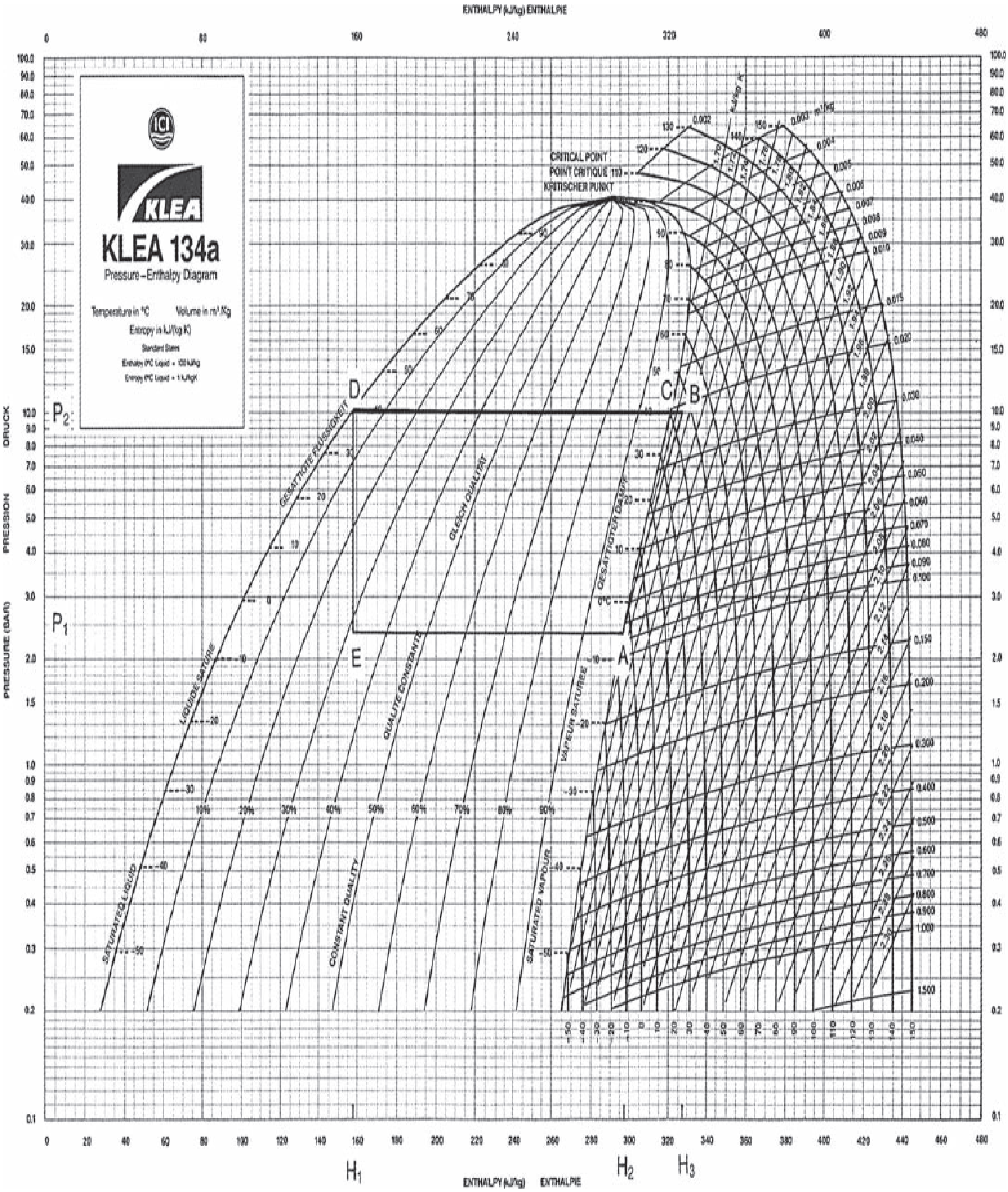
$$m = \frac{(20 \text{ tons})(303852 \text{ kJ /ton})}{(24 \text{ h})(3600 \text{ s /h})(296 \text{ kJ /kg } 156 \text{ kJ /kg})}$$

$$= 0.502 \text{ kg/s}$$

4. From the equation for C.O.P, coefficient of performance is calculated as:

$$\text{C.O.P} = \frac{(296 \text{ kJ / kg} - 156 \text{ kJ / kg})}{(327 \text{ kJ /kg} - 156 \text{ kJ /kg})}$$

$$= 4.52$$


ENTHALPY (kJ/kg) ENTHALPIE
KLEA 134a
Pressure–Enthalpy Diagram
Temperature in °C
Volume in m³/kg
Entropy in kJ/(kg K)
Standard States
CRITICAL POINT
POINT CRITIQUE
KRITISCHER PUNKT
PRESSURE (BAR)
PRESSION
DRUCK
P2
P1
D
C
B
E
A
SATURATED LIQUID
LIQUIDE SATURE
GESATTIGTE FLUSSIGKEIT
CONSTANT QUALITY
QUALITE CONSTANTE
GLEICH QUALITAT
SATURATED VAPOUR
VAPEUR SATUREE
GESATTIGTER DAMPF
10% 20% 30% 40% 50% 60% 70% 80% 90%
H1
H2
H3
ENTHALPY (kJ/kg) ENTHALPIE