



ROHINI

COLLEGE OF ENGINEERING & TECHNOLOGY

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(AUTONOMOUS)

AI3001 REFRIGERATION AND COLD STORAGE

UNIT IV

Application of refrigeration and air conditioning

Refrigeration and air conditioning (RAC) applications are vast, spanning from domestic comfort and food preservation (fridges, AC units) to crucial industrial processes like chemical manufacturing, pharmaceuticals, data center cooling, and metal treatment, alongside essential roles in medical fields (vaccine storage, surgery) and transportation, all working by removing heat to control temperature, humidity, and air quality for comfort, product quality, and safe operations.

Comfort & Residential

Home AC: Cooling and dehumidifying homes, offices, and vehicles.

Water Coolers: Providing chilled drinking water.

Food & Beverage Industry

Preservation: Chilling, freezing, and storing meat, poultry, fish, fruits, vegetables, dairy, and beverages to extend shelf life.

Processing: Cooling products during manufacturing (e.g., dairy, juices) and making ice.

Industrial Processes

Chemical & Petrochemical: Controlling temperatures for reactions, processing petroleum, and manufacturing synthetic rubber.

Manufacturing: Cooling concrete for dams, treating air for blast furnaces, textile processing, and metal treatment.

Data Centers: Essential for cooling servers to prevent overheating.

Healthcare & Pharmaceuticals

Medicine Storage: Keeping vaccines, hormones, and other sensitive drugs at required low temperatures.

Surgical Support: Providing controlled environments during operations.

Pharmaceutical Manufacturing: Maintaining precise environmental conditions to prevent contamination.

Transportation

Refrigerated Transport: Maintaining cold chains for perishable goods during shipping (trucks, ships, planes).

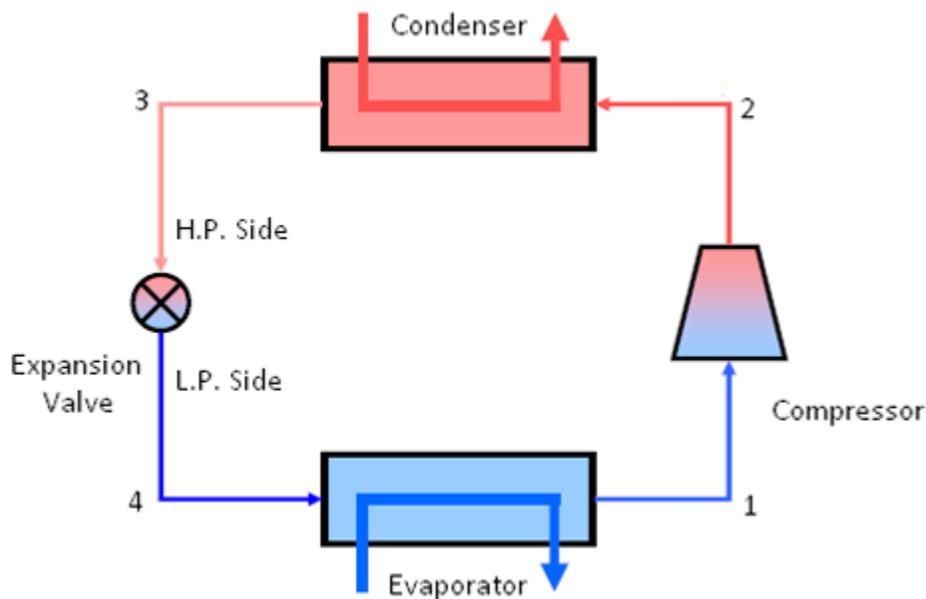
Other Applications

Ice Making: Large-scale production for various uses.

Research: Extremely low-temperature cooling in scientific research (cryogenics)

Domestic Refrigerator

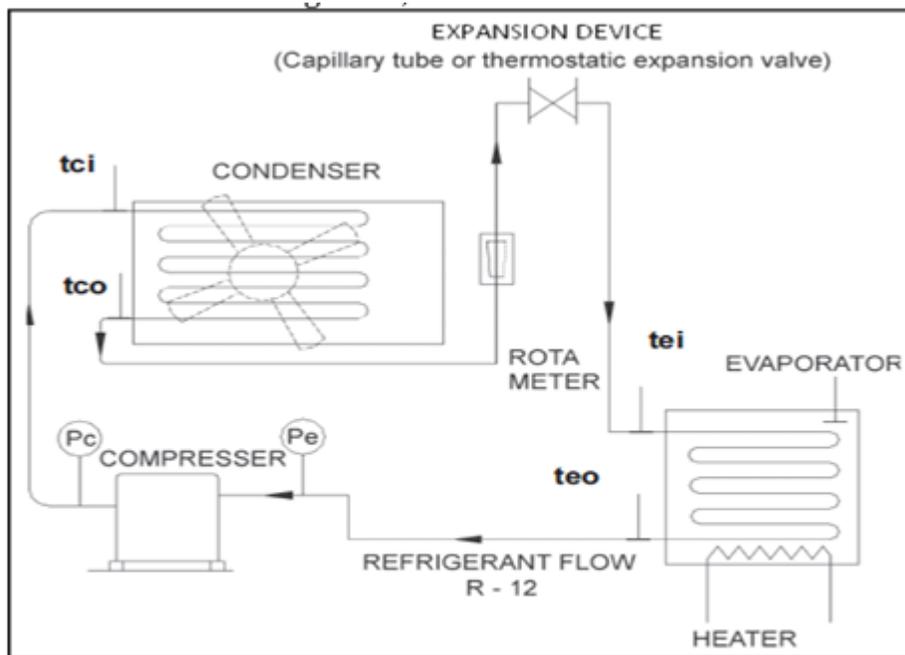
DESCRIPTION: The household refrigerator works on vapour compression refrigeration cycle. The refrigerant vapour is compressed by means of compressor to a pressure at which temperature obtained at the end of compression will be more than atmosphere so that at this high temperature it will reject heat to atmosphere and will get condensed. The condensate is then allowed to pass through a capillary so that the pressure and temperatures are lowered. Capillary device acts as a throttling unit. At low pressure and temperature refrigerant is supplied to the evaporator where load is kept, it absorbs the heat and refrigerant gets converted into gaseous phase and it is again supplied to compressor and cycle is repeated.



The evaporator in the household refrigerator is always fitted in the cabinet of the refrigerator at the top portion and the concealed type of evaporator is used. The condenser is mounted at the back of the cabinet. The expansion device used in household refrigerator is capillary tube. Capacity of household refrigerator is

expressed in terms of litre. The refrigerators manufactured by various manufactures are available in capacities ranging from 90 litres to 380 litres. (The capacity of household refrigerator is expressed in terms of litre, it is defined as the amount of water occupied in the cabinet. It specifies the space available for keeping various commodities in refrigerator.)

In the household refrigerator the air circulation inside the cabinet is maintained by natural convection. The temperature in freezer is around - 5 to -10°C, the temperature is increased at the bottom most portion where vegetable crisper is kept. Also there is provision for keeping stuff like eggs, water, etc. fitted in the door of refrigerator. The refrigerator body is insulated with insulating materials like PUF (Polyurethane foam). Magnetic strips are provided to avoid thermal leakage through

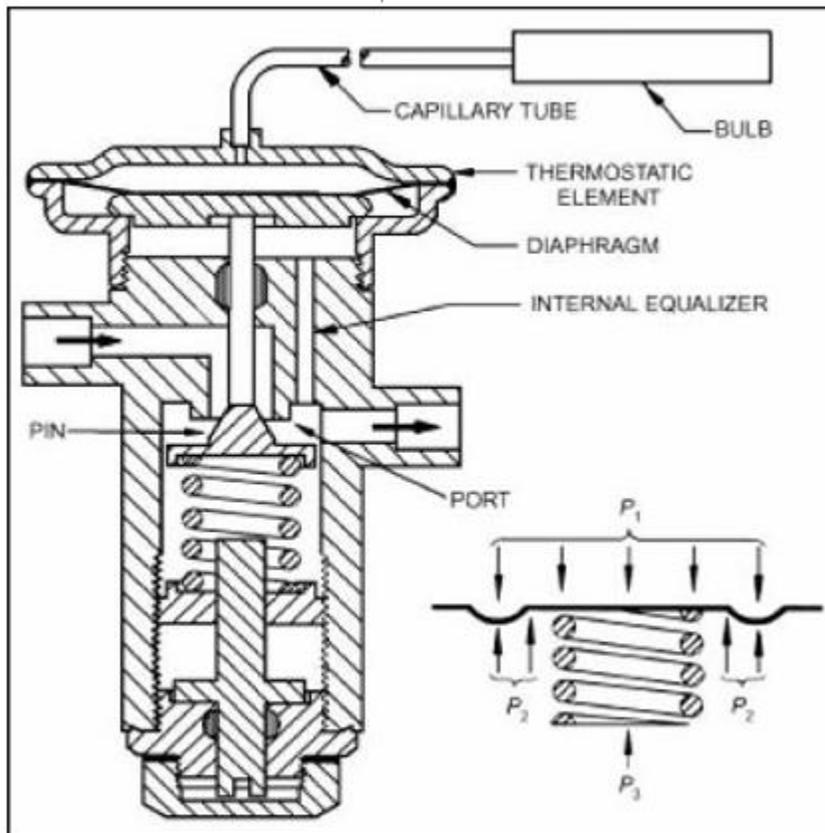


doors

ATTAINMENTS OF FREEZING AND DEFROSTING IN REFRIGERATOR:

Freezing and Defrosting done by two ways: 1. Thermostat 2. Defrosting Unit 1. Thermostat: Thermostat is used to control the temperature in the refrigerator by varying time to idle time ratio. The bulb of the thermostat is clamped to the evaporator or freezer. The thermostat bulb is charged with few drops of refrigerant.

The temperature at which compressor motor starts, by closing the thermostat contacts is called cut-in temperature. Cut-out temperature is higher than cut-in temperature and the difference between the two is called differential. Higher is the differential, longer is the running time and less is the idle time of refrigerator. By changing range adjustment and differential, any cut-in and cut-out temperature can be adjusted for maintaining desired temperature in the refrigerator. P_1 = Thermostatic Elements Pressure P_2 = Evaporator Pressure P_3 = Pressure Equivalent of the Superheat Spring Force



Thermostatic Expansion Valve

As the temperature of the bulb increases, gas pressure in the bellows assembly increases, and this closes the compressor motor circuit and refrigerator starts. As the compressor runs, the thermostat bulb is cooled; gradually reducing the pressure in the bulb and this opens the circuit when desired temperature is attained. The refrigerator is provided with a control knob. By operating knob desired temperature

can be maintained. 2. Defrosting: The freezing of moisture on evaporator coil is called as frosting. The frost thickness increases due to frequent door openings, as the frost thickness increases the heat transfer through the coil decreases. This increases the running time of refrigerator and hence the power consumption. Therefore regular defrosting must be done when frost thickness increases above certain limit.

Generally following methods are used for defrosting.

- i) Defrosting by stopping unit: Stop the unit, keep door open and chill tray must be kept in defrost position till defrosting takes place.
- ii) Timer Defrosting: The most popular defrost system used in household refrigerator is clock timer defrost cycle. The number of defrost periods varies from one to four in 24 hours depending upon timer used. The timer contacts initiate either the defrost cycle or cooling cycle. When the timer is in the cooling cycle, the thermostat control the on-off periods of the compressor. When the timer is in the defrost cycle. The thermostat cannot turn the compressor ON. In other words, thermostat has no control on the compressor when the defrost timer is in the defrost position. The defrost cycle terminates approximately 20 minutes after being turned on. The defrost heater is wired in series with a bimetal thermostat whose contacts will open at some predetermined temperature, there by disconnecting the heater. The length and time it takes for the contacts of the bimetal thermostat to open is determined by the amount of frost on the evaporator.

DO AND DON'T – WHILE USING REFRIGERATOR:

1. The refrigerator should be placed away from the heat source such as sunrays, heating appliance, cooking gas, etc.
2. Install the refrigerator away from wall at least by one foot which provides good air circulation over condenser.
3. Hot fluids should not be kept in refrigerator.
4. Keep door openings at minimum.
5. Strongly flavored food must be kept wrapped.

6. Vegetables, fruits should be kept in polythene bags before placing into the refrigerator.

7. Clean with soft cloth. No soap, detergent should be used.

IN HOLIDAYS: 1. Remove every stored item including ice trays. 2. Defrost refrigerator. 3. Make refrigerator dry. 4. Disconnect three-pin plug. 5. Leave the door slightly open for movement of fresh air.

Ice manufacture

Ice manufacturing using an air conditioning system typically involves ice storage air conditioning (ISAC), where a chiller runs at night to freeze water into large ice blocks or ice-on-coil/ice-ball systems, storing "coolness" as ice, then circulating water through the ice during the day to provide chilled water for AC, reducing peak electricity demand. This works by using the standard refrigeration cycle (compressor, condenser, evaporator) to cool a secondary refrigerant (like brine) which then freezes water in tanks, using cheaper off-peak power, and later melting the ice for daytime cooling, efficiently managing energy loads.

How it works (Ice Storage Air Conditioning)

1. **Night (Ice Making):** A standard chiller runs during off-peak hours (night) when electricity is cheaper.
2. **Cooling Medium:** Cold refrigerant cools a secondary fluid (like chilled water or brine).
3. **Ice Formation:** This cold fluid flows through coils or plates in large, insulated tanks, freezing the surrounding water into ice.
4. **Day (Ice Melting):** During peak demand hours (day), the chiller can be turned off or run at a reduced capacity.
5. **Chilled Water Production:** Warm water is pumped through the ice storage tanks, melting the ice and creating chilled water, which then supplies the building's air conditioning system.