Refrigeration and air conditioning

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INTRODUCTION

- Refrigeration is defined as the process of removing heat from a body/enclosed space so that its temperature is first lowered and then maintained at a level below the temperature of surroundings.
- Applications of Refrigeration:
  - Manufacturing of ice
  - Preservation of perishable articles like food, fruits, vegetables, medicines in storage/transportation.
  - Cooling of liquids in chemical process plants.
  - Air conditioning for human comfort
  - Cooling of water/beverages
  - Liquefaction of gases like nitrogen, hydrogen
  - Process industries

SYSTEMS OF REFRIGERATION

Various refrigeration systems working over a cycle are:

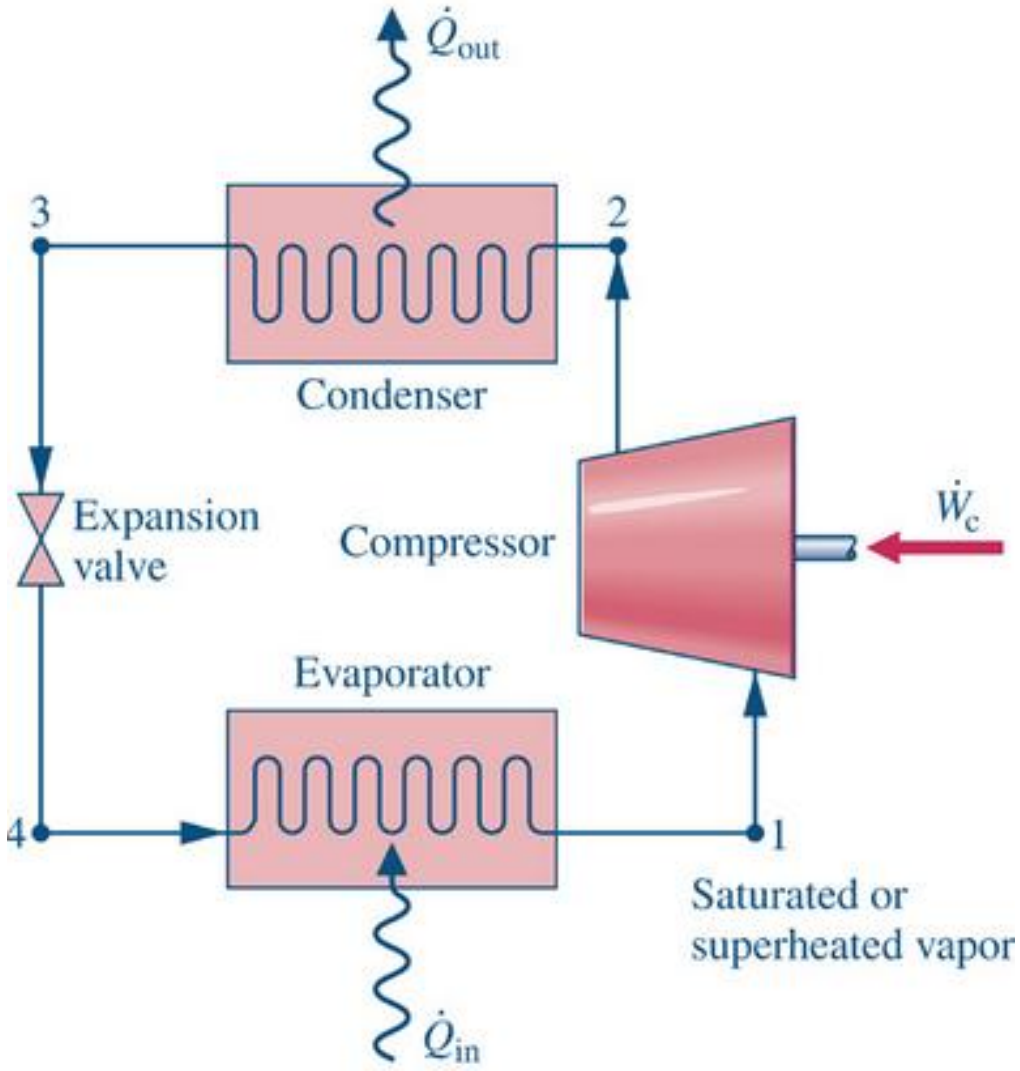
1. Air refrigeration cycle
2. Vapour compression cycle
3. Vapour absorption cycle

VAOUR COMPRESSION REFRIGERATION SYSTEM

- Most popular and widely used
- Working substance is a refrigerant like
  - R-11 (Ccl_3F)
  - R- 12 (Ccl_2F_2
  - R-22 ($CHcl_2F2$)

The refrigerant used alternately undergoes a phase change from vapour to liquid and liquid to vapour during the cycle without leaving the system.

Vapour compression refrigeration cycle (VCR cycle)



VAPOUR COMPRESSION REFRIGERATION SYSTEM

- System consists of following components:
  - Compressor
  - Condenser
  - Liquid receiver
  - Expansion valve and
  - Evaporator
- Evaporator: Low pr, low temp liquid refrigerant passes through evaporator coils where it absorbs latent heat from chamber and converts into vapour.
- Compressor: heart of the refrigeration system . When Freon gas passes through a compressor it gets highly compressed i.e. pressurized and its temperature also becomes very high. As it leaves the compressor, Low pr vapour from evaporator compressed to high pr super heated vapour. Since compression work done on vapour, its temperature increases.

- Condenser: high pr. high temp vapour cooled at const pr by rejecting heat to condenser cooling medium➔converts hot vapour into liquid➔collected in liquid receiver.
- Expansion valve: High pr liquid from receiver pumped to an expansion valve which regulates the flow of liquid into evaporator. Also reduces pressure of liquid➔ low pr low temp liquid refrigerant enters evaporator.
- *Refrigeration cycle of the refrigerant keeps on repeating indefinitely till your refrigerator is running. Since the refrigerant vapor is compressed in this cycle, it is also called as Vapor Compression Cycle.*

HOUSEHOLD REFRIGERATOR

- Used for preserving food by keeping it cool. Food lasts longer when kept at temperature just above freezing temperature.

- Parts of household refrigerator are:
- **1) Refrigerant**: Flows through all the internal parts of the refrigerator-It carries out the cooling effect in the evaporator.
- 2) **Evaporator/chiller/freezer**: Refrigerant at very low pressure and temperature enters the freezer. Evaporator made up of several turns of copper/aluminum tubing. Refrigerant absorbs the heat from the substance to be cooled in the evaporator, gets evaporated and it enters the compressor.
- 3) **Compressor:** Located at the back of the refrigerator and in the bottom area. Takes in the refrigerant from the evaporator and discharges it at high pressure and temperature. Driven by the electric motor and is the major power consuming devise of the refrigerator.
- 4) **Condenser**: Thin coil of copper tubing located at the back of the refrigerator. The refrigerant from compressor enters the condenser where it is cooled by the atmospheric air, losing heat absorbed by it in the evaporator and the compressor. To increase the heat transfer rate of the condenser, it is finned externally.

HOUSEHOLD REFROGERATOR CONTD…

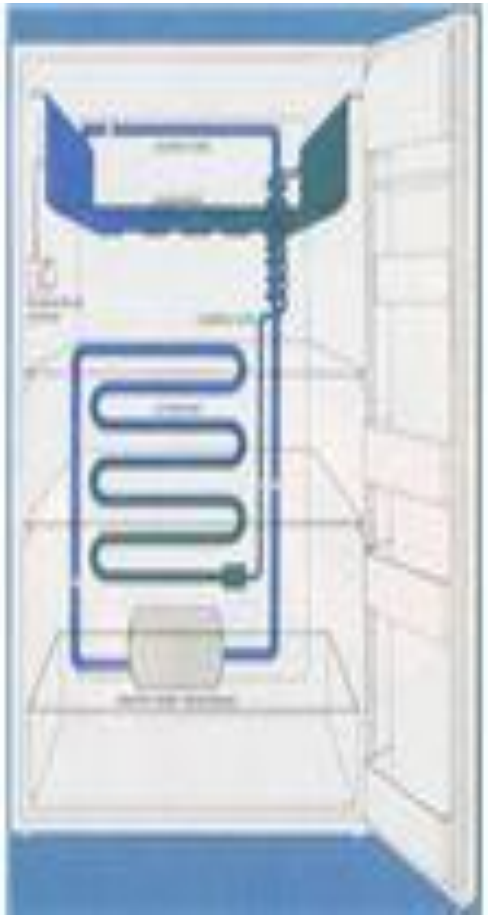
- **5) Expansive valve/ capillary tube**: Refrigerant from condenser enters the expansion devise, which is the capillary tube in case of the domestic refrigerators. It is thin copper tubing made up of number of turns of the copper coil. When refrigerant passed through the capillary its pressure and temperature drops down suddenly.

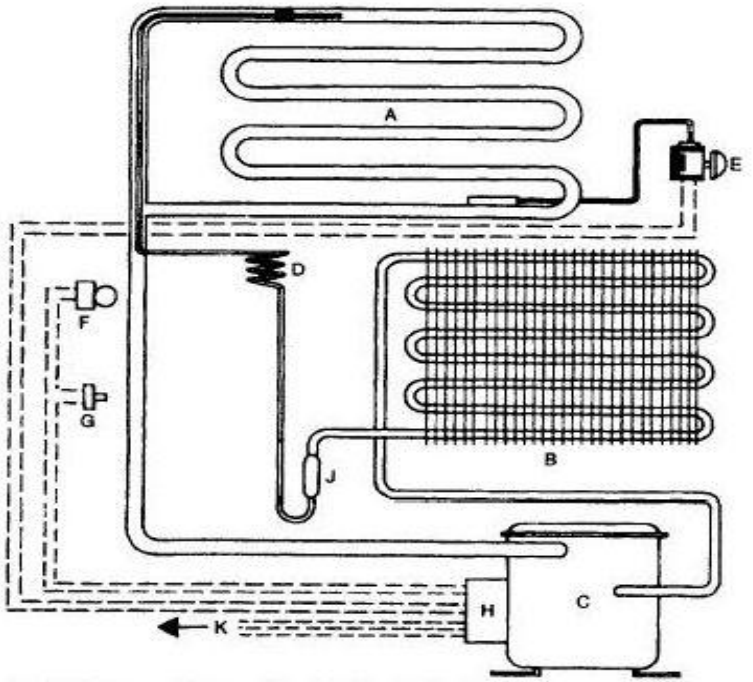
- **6) Temperature control devise/ thermostat**: Thermostat to control the temperature inside the refrigerator, whose sensor is connected to the evaporator. The thermostat setting can be done by the round knob inside the refrigerator compartment. When the set temperature is reached inside the refrigerator , thermostat stops the electric supply to the compressor and compressor stops and when the temperature falls below certain level it restarts the supply to the compressor.
- **7) Defrost system**: Helps remove the excess ice from the surface of the evaporator. Operated manually by the thermostat button or there is automatic system comprising of the electric heater and the timer.

HOUSEHOLD REFROGERATOR CONTD…

- Accumulator: If throttling action of capillary tube not rapid enough to maintain pace with changing load, chances that some refrigerant may leave evaporator in liquid condition. It is a safety device, prevents liquid refrigerant from flowing into compressor.
- Refrigerant tubing: Passageway for circulation of refrigerant, in liquid/vapour form.
- Cabinet: Space where food to be cooled is stored. Cabinet walls insulated, which prevents heat transfer.
- Precautions during usage of refrigerator:
- Should be placed atleast 15-20 cm away from wall.
- Hot fluids should not be stored in.
- Stabilized electrical supply necessary to avoid overloading of compressor.

Household refrigerator



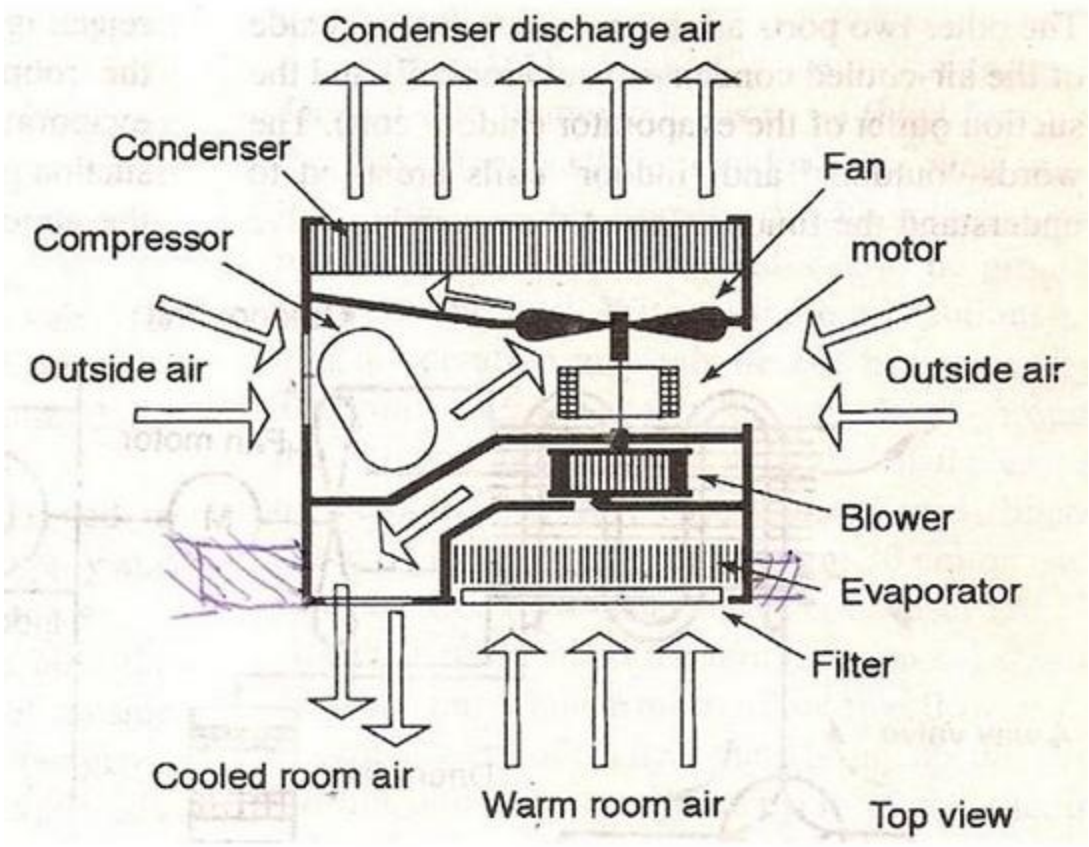


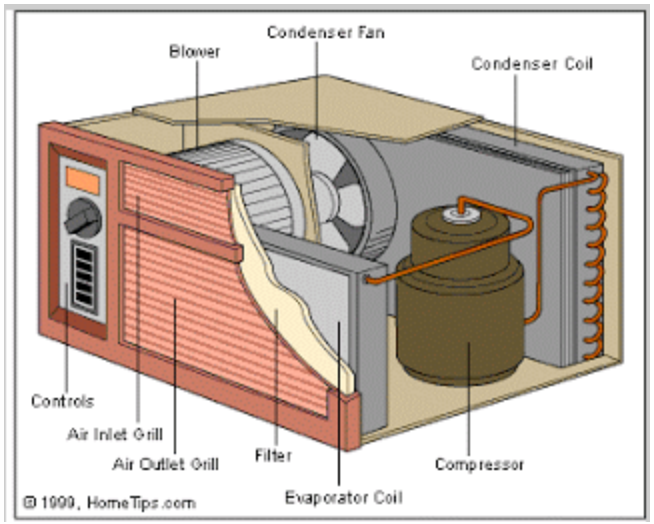
A evaporator
B condenser
C compressor
D capillary
E thermostat and cold control
F interior light
G door switch
H compressor control box
J filter drier
K mains electrical supply

Figure 56 *Domestic refrigerator details*

WINDOW AIR CONDITIONER

- Air conditioning is defined as the process of simultaneously controlling temperature, humidity, and circulation of air and cleanliness of air in an enclosed space. Whereas Refrigeration involves only control of temperature in space.
- Air conditioning is needed for human comfort as well as for industrial applications.
- Condenser and evaporator fitted at two ends.
- Hermetically sealed compressor in the middle.
- A blower fitted behind evaporator coils which pumps air into upper compartment. Blower pulls air through cooling coil and filter fitted on the face of coil. Air then discharged back to room through upper compartment.
- Condenser cooling by fan that pulls air from side and throws over the condenser coils.. Fan and blower both run by same motor.



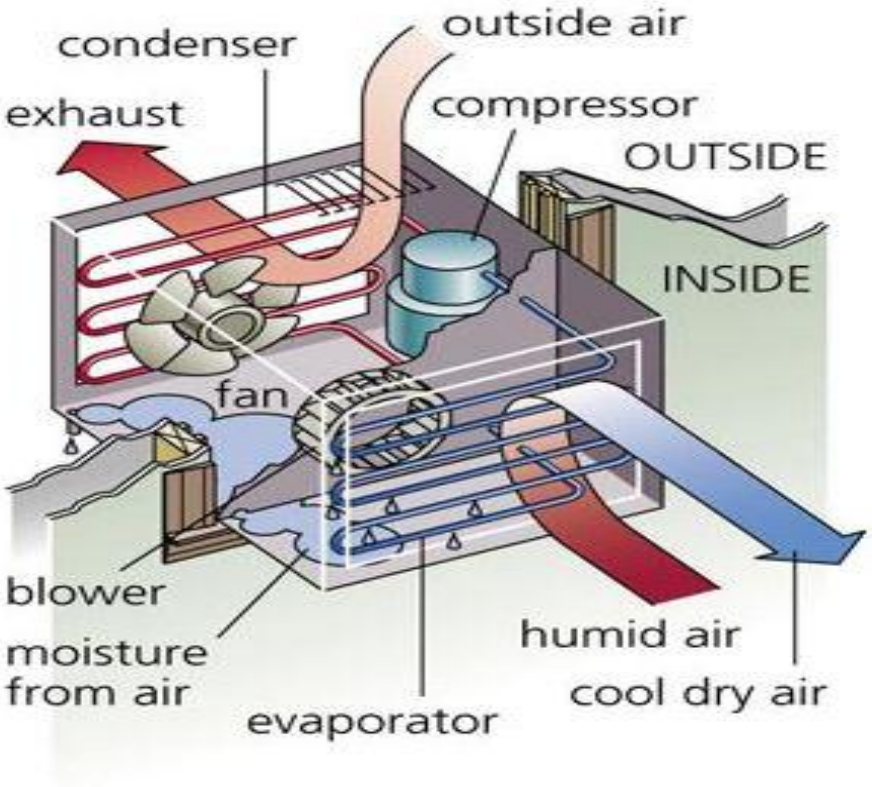


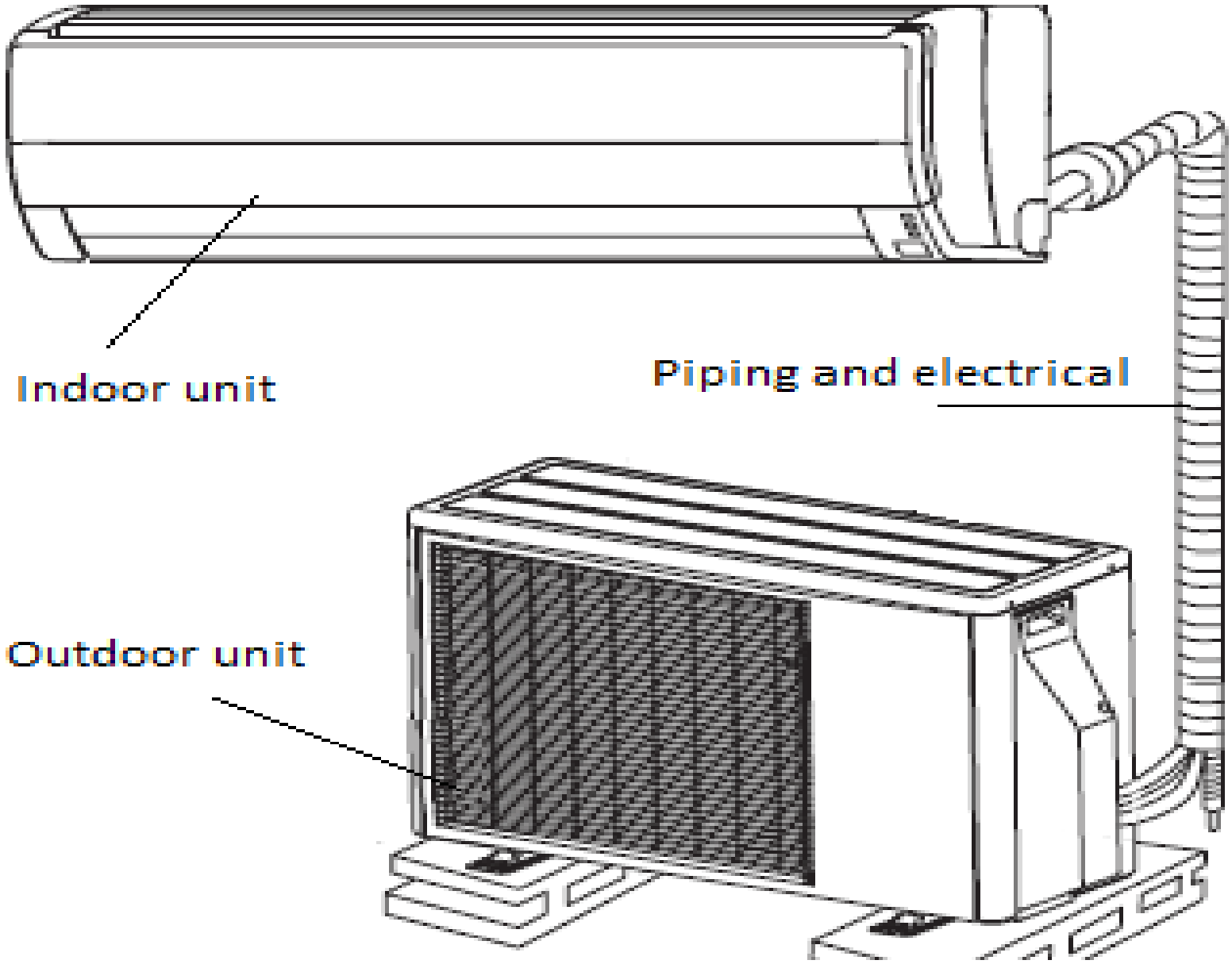
Control panel has three knobs. One controls speed of blower motor to give high cool or low cool. Second, of a thermostat to sense temperature of room air sucked in by the blower, allowing user to set room temperature. Third operates a flap in the insulated cabin to allow ventilation air supply.

Limitations: No control over humidity, Most window air conditioners don't provide heating for winter.

Split air conditioner

- Splitting the window air conditioner in two parts.
- Evaporator placed inside the room while assemble of other components placed outside the room.
- Consumption of power is more as condensing fan and blower driven by separate motors.
- Noise in window AC is due to compressor which is outside in a split unit.
- Compressor power requirements increases due to long refrigerant lines.


condenser
outside air
exhaust
compressor
OUTSIDE
INSIDE
fan
blower
moisture
from air
evaporator
humid air
cool dry air


Indoor unit
Piping and electrical
Outdoor unit