Subject: Air conditioning systems (types and selection) and its relation with occupants activities.

Air conditioning: It is that branch of engineering science which deals with conditioning of air i.e. supplying and maintaining desirable internal atmospheric conditions for human comfort, irrespective of external conditions. It also deals with conditioning of air for industrial purposes, food processing, storage of food and other materials.

تكييف الهواء هو فرع من فروع العلوم الهندسية الذي يتعامل مع تكييف الهواء ، أي تجهيز والحفاظ على الظروف الداخلية المرغوبة لراحة الإنسان، بغض النظر عن الظروف الخارجية. كذلك أيضا فإنه يتعامل مع تكييف الهواء للأغراض الصناعية مثل عمليات حفظ الأغذية ، وتخزين المواد الغذائية وغيرها من المواد.

Factors affecting comfort air conditioning

1. **Temperature of air:** In air conditioning, the control of temperature means the maintenance of any desired temperature within an enclosed space even through the temperature of the outside air is above or below the desired room temperature. This accomplished either by the addition or removal of heat from enclosed space. It may be noted that occupants feels comfortable when the air is at 21 C with 50% RH.

١. درجة حرارة الهواء: في تكييف الهواء ، السيطرة على درجة الحرارة يعني تثبيت درجة حرارة المرغوبة داخل الحيز حتى لو كانت درجة حرارة الهواء الخارجي أعلى أو أقل من درجة حرارة الغرفة المطلوبة. ويتم ذلك إما عن طريق إضافة أو إزالة الحرارة من مكان مغلق. وتجدر الإشارة إلى أن شاغلي الحيز يشعرون بالراحة عندما يكون الهواء عند ٢١ درجة مئوية بنسبة ٥٠٪ رطوبة نسبية.

2. **Humidity of air:** The control of humidity of air means the decreasing or increasing of moisture contents of air during summer or winter respectively in order to produce comfortable and healthy conditions. In general, for summer air conditioning, the RH should not be less than 60% whereas for winter air conditioning, it should not be more than 40%.

٢. رطوبة الهواء: إن التحكم في رطوبة الهواء يعني تقليل أو زيادة محتويات رطوبة الهواء خلال الصيف أو الشتاء على التوالي من أجل خلق ظروف مريحة وصحية. بشكل عام ، بالنسبة لتكييف الهواء في الصيف ، يجب ألا تقل نسبة الرطوبة النسبية عن ٦٠٪ ، بينما يجب ألا تزيد نسبة تكييف الهواء في فصل الشتاء عن ٤٠٪

3. **Purity of air:** It is an important factor for the comfort of occupants. It has been noticed that people do not feel comfortable when breathing contaminated air, even if it is within acceptable temperature and humidity ranges. Therefore, air purification is essential to keep it free from dust.

٣. نقاء الهواء: عامل مهم لراحة الناس . وقد لوحظ أن الناس لا يشعرون بالراحة عند استنشاق الهواء الملوث ، حتى إذا كان في حدود درجات الحرارة والرطوبة المقبولة. لذلك ، من الضروري تنقية الهواء لإبقائه خاليًا من الغبار و الملوثات الاخرى.

4. **Motion of air(Air Distribution):** The motion or circulation of air is another important factor which should be controlled, in order to keep constant temperature throughout the conditioned space. Therefore it is necessary that there should be equal-distribution of air throughout the conditioned space.

٤.حركة الهواء: تعتبر حركة أو دوران الهواء عاملاً هامًا آخر يجب التحكم فيه ، من أجل الحفاظ على درجة حرارة ثابتة في جميع أنحاء الحيز المكيفة. لذلك من الضروري أن يكون هناك توزيع متساو للهواء في جميع أنحاء المساحة المكيفة.

Air conditioning systems:

. An air conditioning system: consists of an air conditioning plant and a thermal distribution system

. Air, water or refrigerants are used as fluid media for **transferring energy** from the plant to the conditioned space.

. A thermal distribution system is required **to circulate** the media between the conditioned space and the plant and also to required amount of fresh air for **ventilation**.

.HVAC systems can be classified into central and local systems according to multiple zones, location, and distribution. Central HVAC systems locate away from buildings in a central equipment room and deliver the conditioned air by a delivery ductwork system. **Central HVAC systems** contain all-air, air-water, all-water systems. **Local HVAC systems** can be located inside a conditioned zone or adjacent to it and no requirement for ductwork.

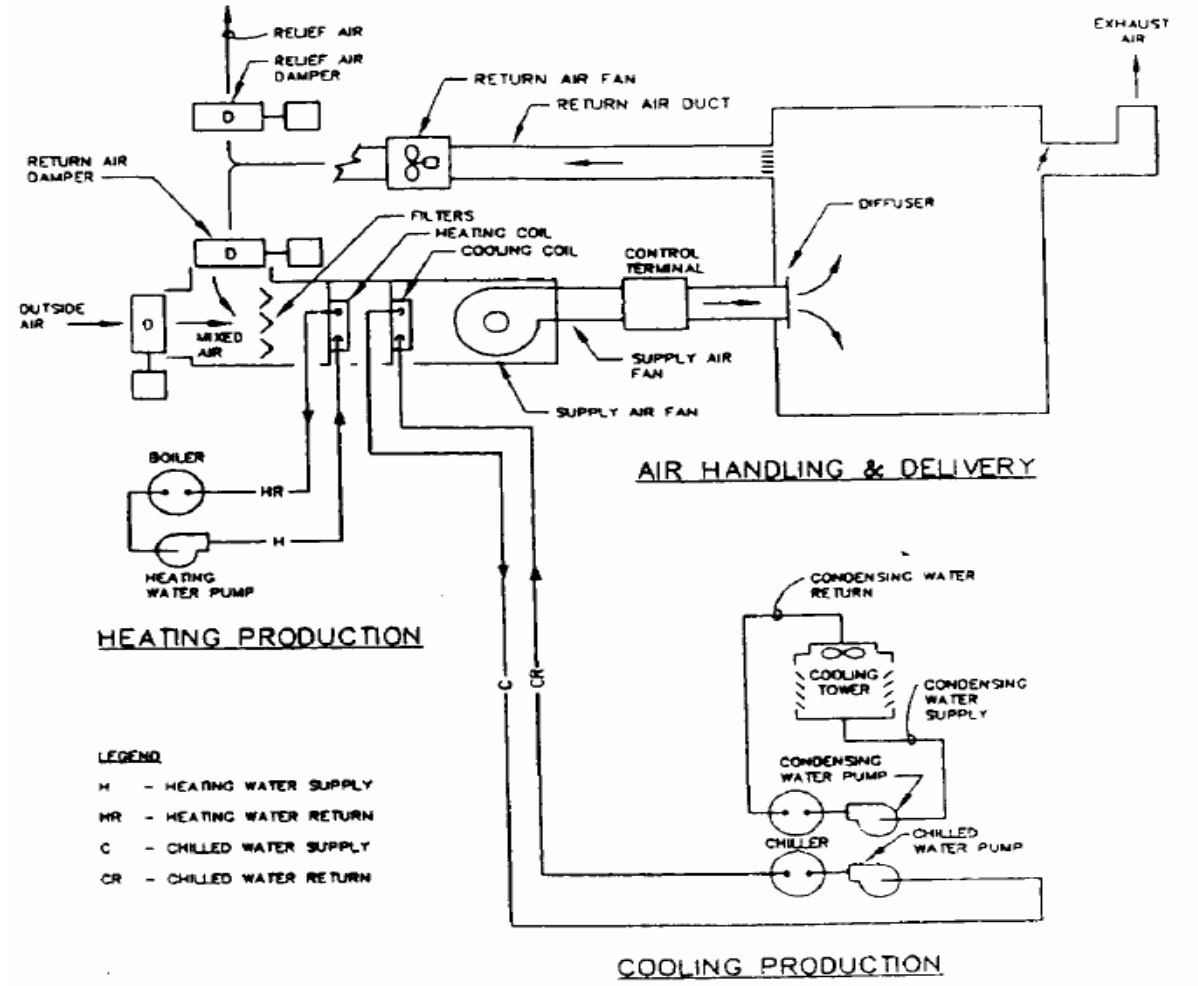


Figure: Central HVAC system

Air-conditioning systems = air handling systems + ducts + air distribution devices (diffusers,grilles……etc)

Thermal distribution system

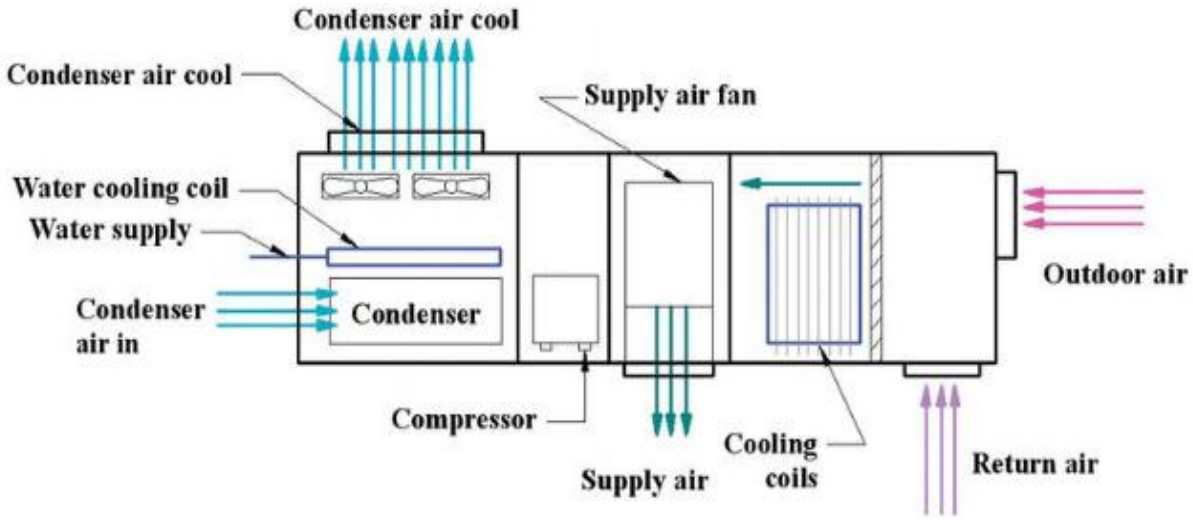


Figure: Packaged rooftop HVAC system

How to Select (choice) of air conditioning system?

Selection of a suitable air conditioning system depends on:

1- Building types: commercial, residential, and industrial

2- Building design: (if there is very little space for running ducts around the building, an all-air system may not fit in the available space.).

3- Location issues : site conditions, peak summer cooling conditions, summer humidity, peak winter heating conditions, wind speeds, sunshine hours

4- Availability and Cost: if chilled water is available from the adjacent building, it would probably be cost advantageous to use it, rather than install new unitary refrigerant-based units in the new building.

5- Indoor Requirements and Loads: The location effects and indoor requirements provide all the necessary information for load calculation for the systems.

6- The project budget and the architectural design of building.

Equipment used in an Air Conditioning System

1- Air conditioning unit
2- Circulation fan
3- Supply duct
4- Supply outlets
5- Return outlets
6- Filters

Classification of air conditioning systems:

1. According to the purpose

a) Comfort air conditioning system

1-The air is brought to the required dry bulb temperature and relative humidity for human health, comfort and efficiency.

2- If the sufficient data of the required condition is not given, then it is assumed to be 21 °C DBT and 50% RH.

3- The comfort air conditioning may be adopted for homes, offices, shops, restaurants, theaters, hospitals, schools, etc.

b) Industrial air conditioning system

1-The inside DBT and RH of the air is kept constant for proper working of machines and for proper research and manufacturing processes.

2- Industrial air conditioning is very beneficial because some of the sophisticated electronic and other machines need particular DBT and RH. Sometimes these machines also require a particular psychrometric processes.

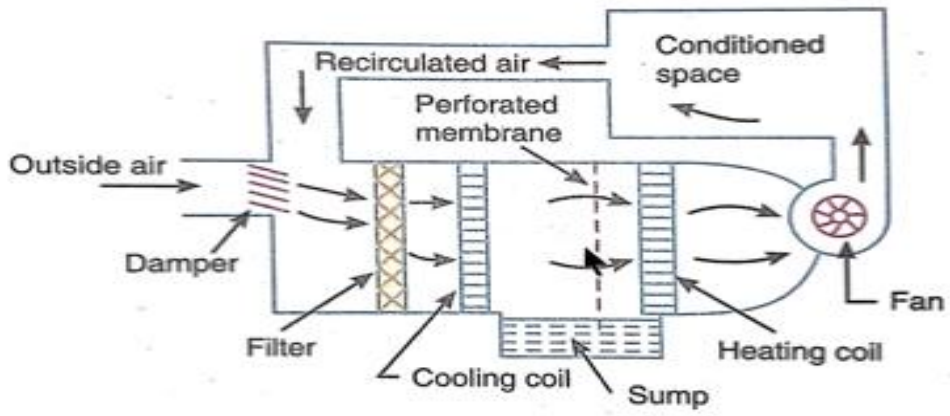
3- This system is used in textile mills, paper mills, machine-parts manufacturing plants, tool rooms, photo-processing plants, etc.

2. According to the season of the year

a) Summer air conditioning system

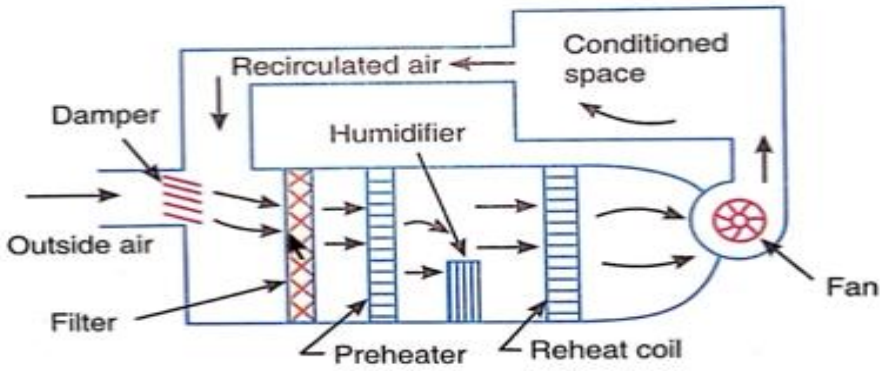
It is most important type of air conditioning, in which the air is cooled and generally dehumidified.

b)



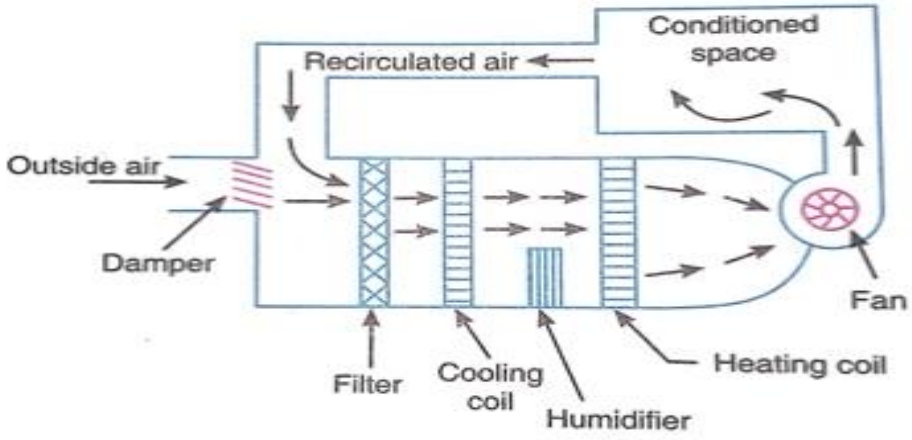
b) Winter air conditioning system

In winter air conditioning system, the air is heated which is generally accompanied by humidification.



c) **Year-round air conditioning system**

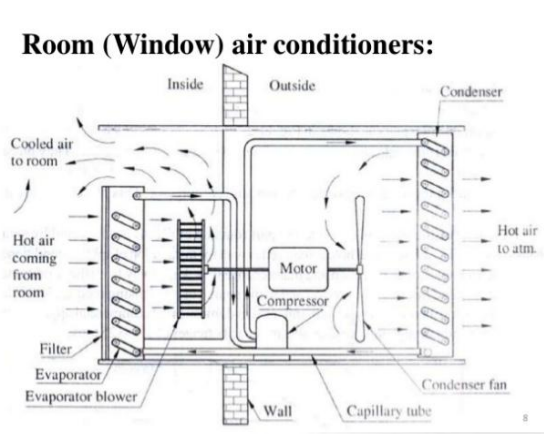
The year- round air conditioning system should have equipment for both the summer and winter air conditioning.

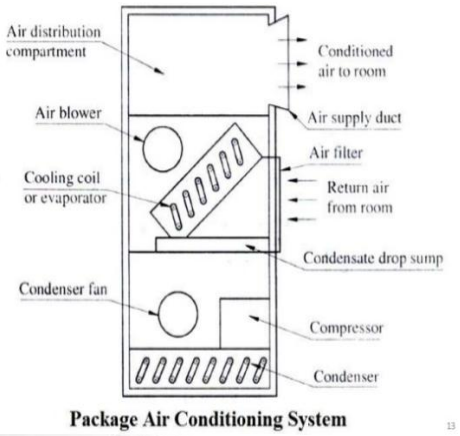


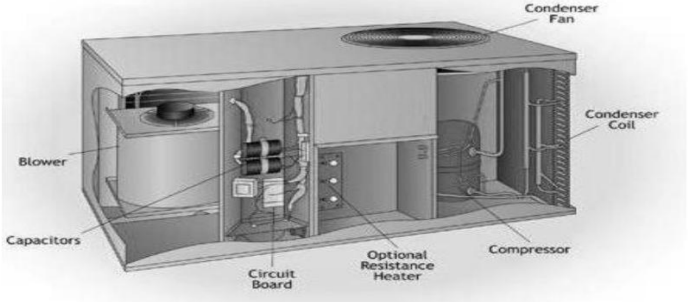
3. According to the arrangement of equipment

a) Unitary air conditioning system

■Window air conditioner ■Split air conditioner ■Package air conditioner







b) Central air conditioning systems

■ Central air conditioning systems with CAV air-handling units

Constant air volume (CAV) system is an all-air system which accomplish cooling and heating by varying the supply air temperature and keeping the air volume constant. The system works well and maintains comfortable conditions in spaces with uniform heating and cooling requirements.

Fan is operated at constant speed and constant volume flow rate of air to the air-conditioning spaces is maintained irrespective of the space cooling load. The temperature of the supply air and the flow rate of the chilled water through the AHU coil are modulated in response to the cooling load changes of the spaces by sensing the return air temperature. **Hence, fan speed and fan power consumption remain the same even when space cooling load is low. The CAV systems are suitable for large and open spaces** where the variation of the cooling load is relatively uniform. As less chilled water is supplied to the AHU coil at low part-load conditions of the air-conditioning spaces, less dehumidification of supply air may occur in the AHU coil leading to the increase of space relative humidity.

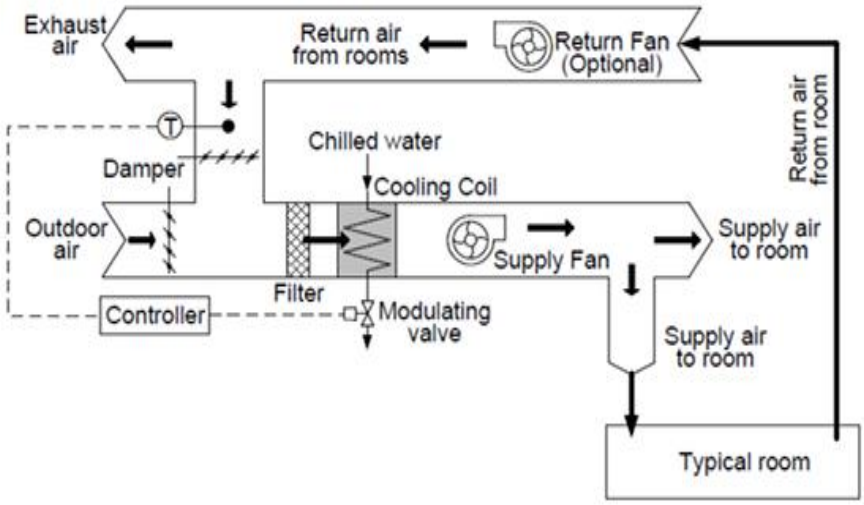


Figure 3.26 Schematic diagram of a typical constant air volume (without reheat coil)

■ Central air conditioning systems with VAV air-handling units

Variable Air Volume (VAV) system is an all air system which can satisfy the individual cooling requirements of multiple thermal zones. This is achieved by supplying air at a constant temperature from central plant to one or more VAV terminal units in each zone and adjusting the amount of supply air to meet required cooling loads.The primary benefit of VAV over constant volume systems (CV) is its ability to simultaneously provide the required level of cooling to any number of zones within a building.

In the variable air volume (VAV) systems, volume flow rate of air to the air-conditioning spaces is modulated based on space cooling load. Schematic diagram of a typical VAV system is shown in Figure-3.4. The temperature of the supply air is maintained constant irrespective of the space cooling load. The flow rate of the chilled water through the AHU

coil is modulated based on space cooling load. As the flow rates of the supply air and the chilled water are modulated together at low part-load, the required dehumidification of the supply air takes place in the AHU coil. If the cooling load fluctuates unevenly in different spaces, the VAV systems can conveniently maintain the required space conditions. **Fan could be operated at constant or variable speed.** The flow rate of air in the air-conditioning spaces is modulated in response to the change of the space cooling load using: (a) discharge dampers, (b) inlet guide vanes (IGVs) and (c) variable speed drive (VSD). Hence, fan power consumption changes with the variation of the space cooling load.

■ Central air conditioning systems with fan-coil units (All water systems)

4. According to the fluid media used in thermal distribution system

a) All air system:

b) All water system:

c) Air-water system:

d)Unitary refrigerant-based systems: like window air conditioner, split air conditioner