PART TWO

AIR CONDITIONING

Introduction to HVAC Systems

- The goal of the heating, ventilating, and air conditioning (HVAC) system is to create and maintain a comfortable environment within a building.
- **Comfort Requirements**
  - Temperature
  - Humidity
  - Air movement
  - Fresh air
  - Clean air
  - Noise levels
  - Lighting
  - Furniture and work surfaces

- A comfortable environment, however, is broader than just temperature and humidity. Comfort requirements that are typically impacted by the HVAC system include:
  - Dry-bulb temperature
  - Humidity
  - Air movement
  - Fresh air
  - Cleanliness of the air
  - Noise levels

- Some HVAC systems address these comfort requirements better than others.
- In addition, there are other factors that affect comfort but are not directly related to the HVAC system.
- Examples include adequate lighting, and proper furniture and work surfaces.

2.1 Fundamentals of Air-conditioning

- *Air conditioning is a combined process that performs many functions simultaneously.*
- *It conditions the air, transports it, and introduces it to the conditioned space.*
- *It provides heating and cooling from a central plant or rooftop units.*
- *It also controls and maintains the temperature, humidity, air movement, air cleanliness, sound level, and pressure differential in a space within predetermined limits for the comfort and health of the occupants of the conditioned space or for the purpose of product processing.*

Continued…

- *The term HVAC&R is an abbreviation of heating, ventilating, air conditioning, and refrigerating.*
- *The combination of processes in this commonly adopted term is equivalent to the current definition of air conditioning.*

2.1.1 Comfort and Process Air-Conditioning Systems

- *An air conditioning or HVAC&R system is composed of components and equipment arranged in sequence to condition the air, to transport it to the conditioned space, and to control the indoor environmental parameters of a specific space within required limits.*

Most air conditioning systems perform the following functions:

1. *Provide the cooling and heating energy required;*
2. *Condition the supply air, that is, heat or cool, humidify or dehumidify, clean and purify, and attenuate any objectionable noise produced by the HVAC&R equipment;*
3. *Distribute the conditioned air, containing sufficient outdoor air, to the conditioned space; and*
4. *Control and maintain the indoor environmental parameters – such as temperature, humidity, cleanliness, air movement, sound level, and pressure differential between the conditioned space and surroundings — within predetermined limits.*

- *Parameters such as the size and the occupancy of the conditioned space, the indoor environmental parameters to be controlled, the quality and the effectiveness of control, and the cost involved determine the various types and arrangements of components used to provide appropriate characteristics.*

2.1.2 Classification of Air-Conditioning Systems

There are various ways of classifying air conditioning systems.

The most common classification method is shown in Fig. 2.1.

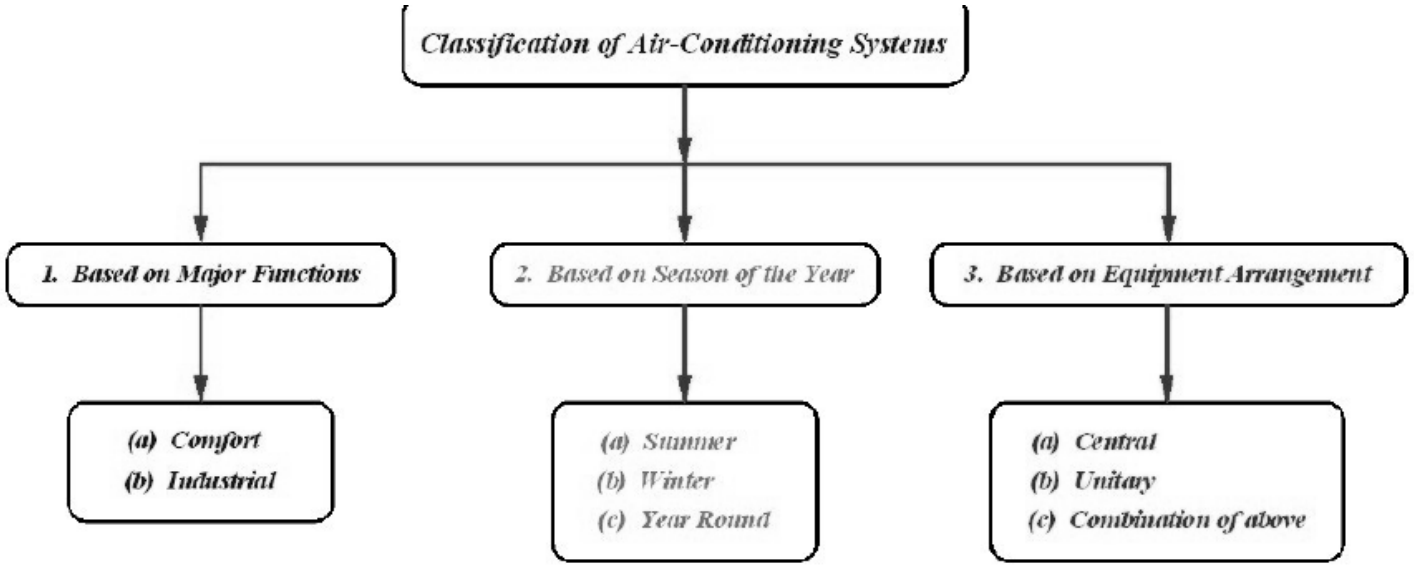

Fig. 2.1 Classification of Air Conditioning Systems

Classification Based on Major Functions

(a) Comfort Air-Conditioning Systems

Comfort air-conditioning systems provide occupants with a comfortable and healthy indoor environment to carry out their activities.

- *The various sectors of the economy using comfort air conditioning systems are:*

1. Commercial Sector

- *The commercial sector includes office buildings, supermarkets, department stores, shopping centers, restaurants, etc.*
- *In light commercial buildings, the air conditioning system serves the conditioned space of only a single-zone or comparatively smaller area.*

2. Institutional Sector

- *The institutional sector includes such applications as schools, colleges, universities, libraries, museums, indoor stadiums, cinemas, theaters, concert halls, and recreation centers.*

3. Residential and Lodging Sector

- The residential and lodging sector consists of hotels, motels, apartment houses, and private homes.
- Many systems serving the lodging industry and apartment houses are operated continuously, on a 24-hour, 7-day-a-week schedule, since they can be occupied at any time.

4. Health-Care Sector

- The health care sector encompasses hospitals, nursing homes, and convalescent care facilities.
- Special air filters are used in hospitals to remove bacteria and particulates of sub-micrometer size from areas such as operating rooms, nurseries, and intensive care units.

- *The relative humidity in a general clinical area is often maintained at a minimum of 30%.*

5. Transport Sector

- *The transportation sector includes aircraft, automobiles, railroad cars, buses, and cruising ships.*
- *Passengers demand ease and environmental comfort, especially for long distance travel.*

(b) Process Air-Conditioning Systems

Process air conditioning systems provide needed indoor environmental control for manufacturing, product storage, or other research and development processes.

The following areas are examples of process air conditioning systems:

1. Textile Mills

- *In textile mills, natural fibers and manufactured fibers are hygroscopic.*
- *Proper control of humidity increases the strength of the yarn and fabric during processing.*

- *For many textile manufacturing processes, too high relative humidity can cause problems in the spinning process.*
- *A lower relative humidity, on the other hand, may induce static electricity that is harmful for the production process.*

2. Electronic Products

- *Many electronic products require clean rooms for manufacturing such things as integrated circuits, since their quality is adversely affected by airborne particles.*
- *Relative-humidity control is also needed to prevent corrosion and condensation and to eliminate static electricity.*

- *Temperature control maintains materials and instruments at stable condition.*

3. Precision Instruments

- *Precision manufacturers always need precise temperature control during production of precision instruments, tools, and equipment.*

4. Pharmaceutical Products

- *Pharmaceutical products require temperature, humidity, and air cleanliness control.*

5. Refrigerated Warehouses

- *Modern refrigerated warehouses provide relative-humidity control for perishable foods between 90 and 100%.*

Classification Based on Season of the Year

Air conditioning systems are classified as:

a) Winter Air-Conditioning System, and

b) Summer Air-Conditioning System

based on the season of the year.

a) Winter Air-Conditioning Systems

- *Maintain indoor atmospheric conditions for winter comfort.*
- *Accomplished by heating and dehumidifying the supply air.*
- *Heating of air is done by passing the air stream over heating coils, steam pipes, etc.*

- *Dehumidification is done by passing the air stream over dehumidifiers.*

b) Summer Air-Conditioning Systems

- *Maintain indoor atmospheric conditions for summer comfort.*
- *Accomplished by cooling and humidifying the supply air.*
- *Cooling of air the air stream is done by means of mechanical refrigeration.*
- *Humidification is done by spraying moisture into the air stream.*

Classification Based on Equipment Arrangement

These classification methods are shown in Fig. 2.2.

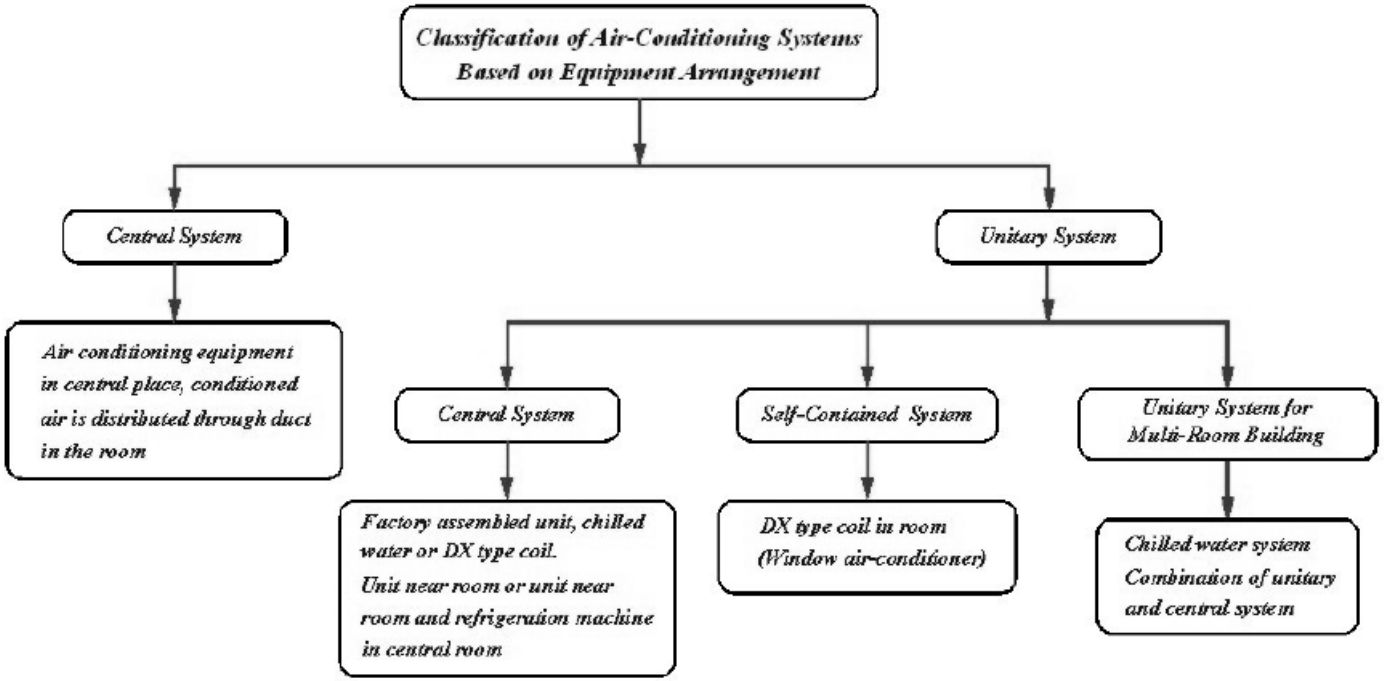

Fig. 2.1 Classification Based on Equipment Arrangement

AC systems can also be classified according to their construction and operating characteristics.

a) Individual Room Air Conditioning Systems

- *Employ a single, self-contained room air conditioner, a packaged terminal, a separated indoor-outdoor split unit, or a heat pump.*
- *A heat pump extracts heat from a heat source and rejects heat to air or water at a higher temperature for heating.*
- *Unlike other systems, these systems use a totally independent unit or units in each room.*
- *Individual air conditioning systems can be classified into two categories:*

- *Room air conditioner (window-mounted)*
- *Packaged terminal air conditioner (PTAC), installed in a sleeve through the outside wall.*

b) Unitary Packaged Air Conditioning Systems

- *Employ either a single, self-contained packaged unit or two split units.*
- *A single packaged unit contains fans, filters, DX coils, compressors, and condensers.*
- *In the split system, the indoor air handler comprises controls and the air system, containing mainly fans, filters, and DX coils; and the outdoor condensing unit is the refrigeration system, composed of compressors and condensers.*

- *Rooftop packaged systems are most widely used.*
- *Packaged air conditioning systems can be used to serve either a single room or multiple rooms.*
- *A supply duct is often installed for the distribution of conditioned air, and a DX coil is used to cool it.*

c) Central Air Conditioning Systems

- *In central air conditioning system, air is cooled or heated by coils filled with chilled or hot water distributed from a central cooling or heating plant.*
- *It is mostly applied to large-area buildings with many zones of conditioned space or to separate buildings.*
- *The refrigeration system in a central plant is usually in the form of a chiller package.*

- *Chiller packages cool the chilled water and act as a cold source in the central hydronic system.*
- *The boiler plant, consisting of boilers and accessories, is the heat source of the heating system.*

- *An air-handling unit (AHU) consists of supply fan(s), filter(s), a cooling coil, a heating coil, a mixing box, and other accessories.*
- *It is the primary equipment of the air system.*
- *An AHU conditions the outdoor/ recirculating air, supplies the conditioned air to the conditioned space, and extracts the returned air from the space through ductwork and space diffusion devices.*

- *Modern air conditioning control systems for the air and water systems and for the central plant consist of electronic sensors, microprocessor-operated and -controlled modules.*
- *Control systems using digital signals compatible with the microprocessor are called direct digital control (DDC) systems.*
- *Outputs from the control modules actuate dampers, valves, and relays by means of pneumatic actuators in large buildings and by means of electric actuators for small projects.*

2.1.3 Components of an Air-Conditioning Systems

Essential components of a typical year-round AC system are, Fig. 2.3:

1. Boiler

- *Furnishes hot water at high pressure and temperature to hot-water coils.*
- *Supplies hot water to fin-tubes radiators for direct heating of the room air.*

2. Refrigeration Machinery

- *Comprises a compressor, a condenser and an evaporator.*
- *The evaporator acts as cooling coil over which the air stream passes.*

- *The temperature of the air leaving the cooling coil is controlled to suit the desired condition in the air conditioned space.*

3. Fan

- *Draws in the proper amount of air and lets the air pass through filters, heating/cooling coils, humidifiers/ dehumidifiers, etc. into the supply duct system.*

4. Filter

- *Filters the supply air from dirt particles, etc.*

5. Heating/ Cooling Coil

- *The air stream is heated or cooled as it passes over the heating or cooling coil, respectively.*

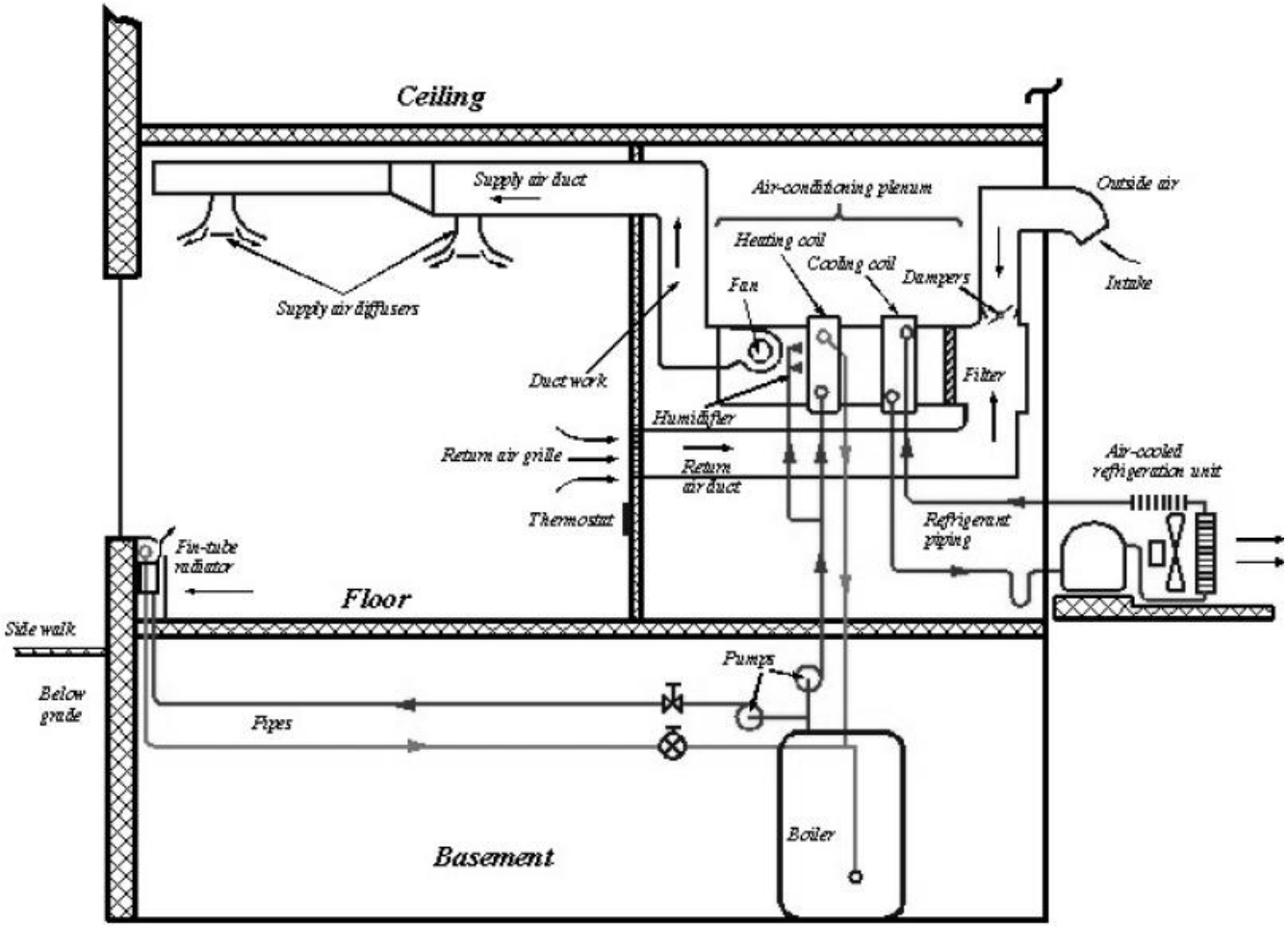

Fig. 2.3 Components of Air-Conditioning System

6. Humidifier/ Dehumidifier

- *Air stream is supplied with moisture to increase its humidity or dehumidified by removing moisture from it.*
- *These are accomplished by spraying water into the air stream or by passing it over cooling coils where some of the vapor in the air stream is separated out.*

7. Thermostat

- *The entire system is controlled by using a thermostat set for the desired condition.*

Air conditioning systems are either hydronic or all-air systems.

Hydronic Systems, Fig. 2.4

- *Are air-conditioning systems that use water as heating/cooling medium.*

All-Air Systems, Fig. 2.5

- *Are air-conditioning systems that use air as heating/cooling medium.*

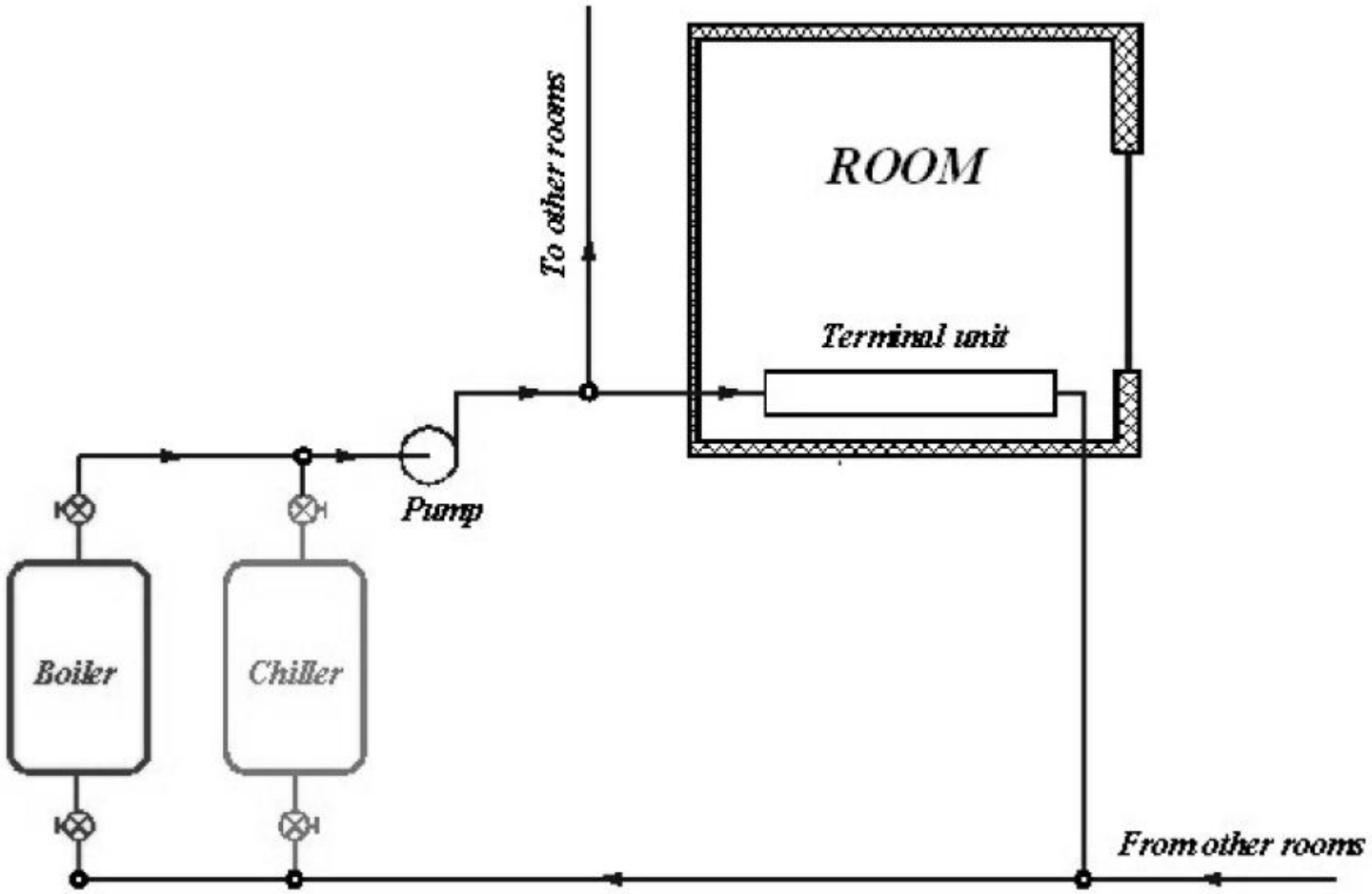

Fig. 2.4 Hydronic System

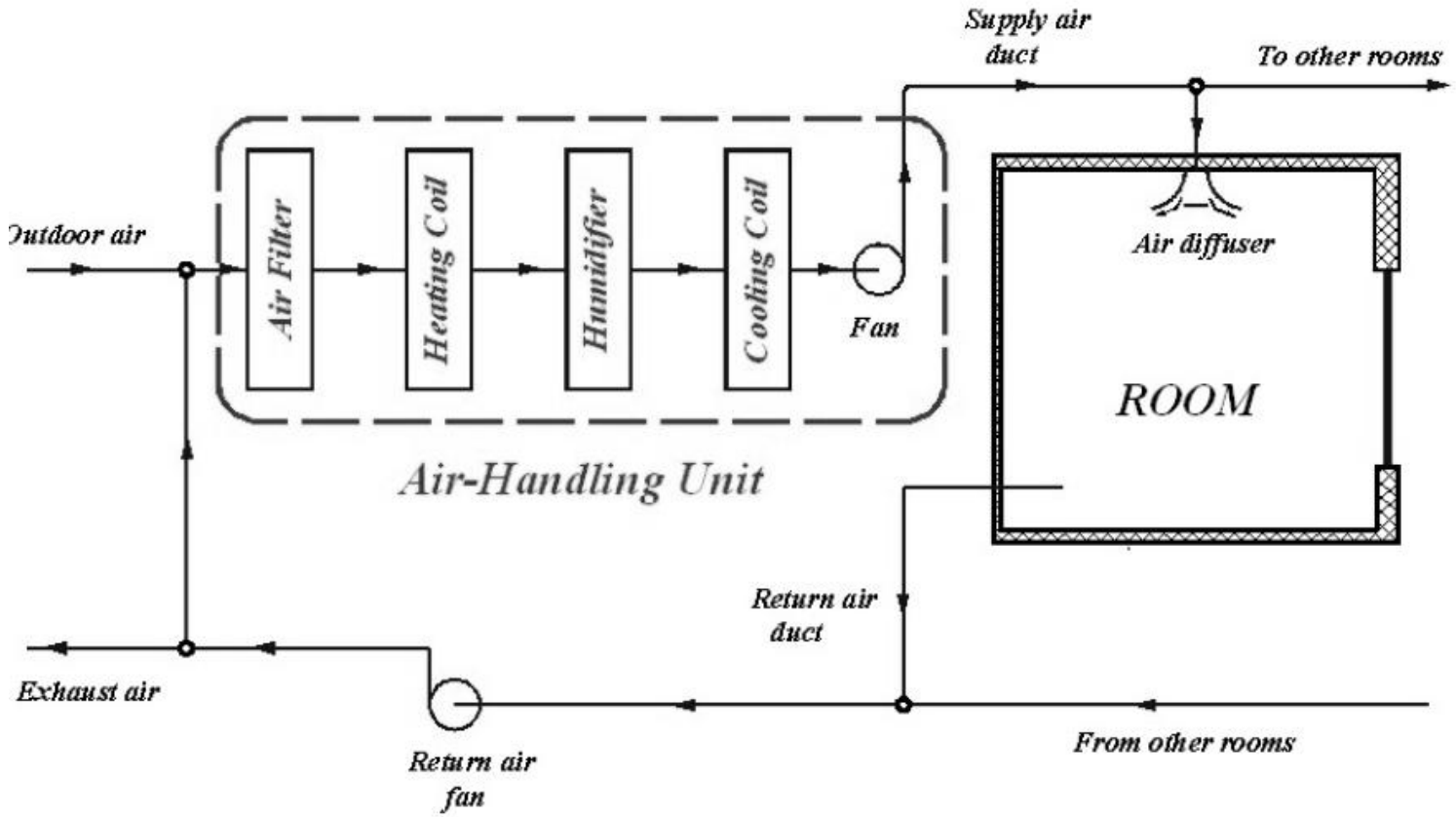

Fig. 2.5 All-Air System