Broadcasting Towers Operation

WEEK 9 – Air Conditioning

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Objectives

At the end of the topic students will be able to:

1. Understand the basics of Air Conditioner (AC).
2. Explain the working principle of AC.
3. Explain the applications of AC.

Turn and talk

- Today, we're diving into the world of an incredible technology that not only keeps us cool but also plays a crucial role in our everyday lives. Think about those hot and dry summer days when you walk into a refreshing room. Isn't it amazing how something we often take for granted can make such a big difference? Consider the science behind a cool place and the impact on our environment.
- I want you to turn to your partner and share your thoughts on how you think AC can our daily lives and what innovations you might envision for the future.
- Then after 5 minutes of pair and share, by cold calling, we will share what we discussed.

9.0 Air Conditioner (AC)

- An air conditioner (AC) is a device that cools indoor air by removing heat and moisture, improving comfort in enclosed spaces like buildings or vehicles.
- It works by circulating air over a set of coils filled with refrigerant, which absorbs heat and releases it outside to maintain optimal indoor conditions, especially during hot weather.
- Air conditioning is the process of altering the properties of air (primarily temperature and humidity) to more favourable conditions.
- The control of these conditions may be desirable to maintain the health and comfort of the occupants, or to meet the requirements of industrial processes irrespective of the external climatic conditions.

9.1 Types of AC

- To understand the types of AC, let us first understand their simple concept: there are two sets of metal coils; the first one collects the heat from the house and the second one disperses the heat outside. The key part being the refrigerant, a liquid mixture that transfers heat between the two sets of coils.
- Mainly two broad categories are available which may be sub-divided into further types according to the applications and requirements.
- Stand-Alone AC units (1 device). Examples: Portable AC, window AC, floor mounted AC and thru-the-wall AC.
- Split-System AC units (2 devices). Examples: Central AC, mini-split AC, wall-mounted AC and ceiling AC.

(https://learnmetrics.com/air-conditioner-types/)

9.1 Types of AC cont'd

- In stand-alone AC units, both coils are inside one device (usually located inside the house). They are easier to install and move around (especially portable AC units), cheaper to buy but noisier (compressor is located inside the house) and low capacity in comparison to split-system AC units.

A portable AC is a stand-alone unit with an air vent to release hot air. It has wheels to be moved freely.

A window AC faces the indoors on one side and the outdoors on the opposite side. Installed through a window or a wall.

A wall-mounted AC unit is installed up against a wall. Two pipes go through the wall to release the hot air outdoor.

(https://learnmetrics.com/air-conditioner-types/)

9.1 Types of AC cont'd

- Window AC: These units are installed in a window or through a wall, with all components housed in a single box. They are typically used for cooling individual rooms or small spaces.
- Split AC: Consists of two units - an indoor unit containing the evaporator coil and an outdoor unit containing the compressor and condenser coil. They are connected by refrigerant lines and are suitable for cooling individual rooms or multiple rooms.
- Portable AC: These units are movable and can be placed in different rooms as needed. They usually vent hot air through a window or a vent kit.
- Central AC system: Used for cooling entire buildings or homes, these systems have a central unit that distributes cooled air through ducts to various rooms.

9.1 Types of AC cont'd

- Ductless Mini-Split system: Like split systems but without ductwork, these units consist of an outdoor compressor/condenser unit and one or more indoor air-handling units. They are flexible for cooling individual rooms or zones.

Indoor and outdoor parts of several types of AC units

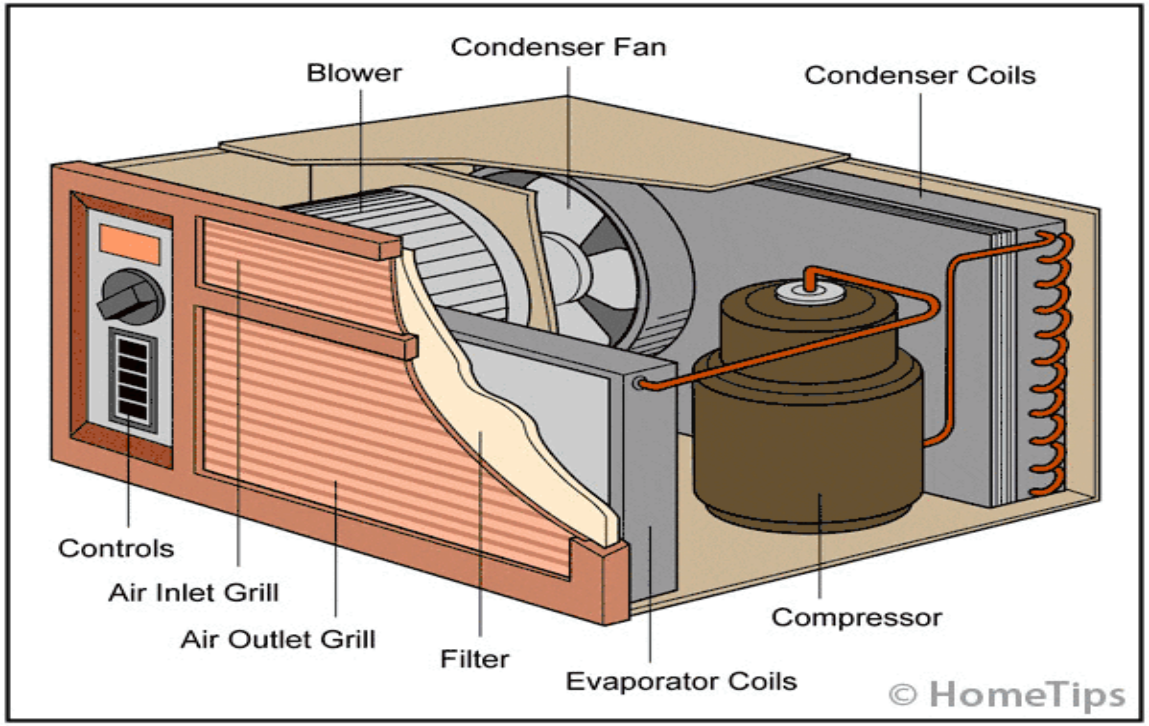
(https://learnmetrics.com/air-conditioner-types/)

9.2 Parts of AC

- Indoor unit: Evaporator coil, Fan, covers, filters, and electronic circuit.
- Outdoor unit: Compressor, Condenser coil, Fan and covers.
- Compressor: Compresses the refrigerant gas, increasing its pressure and temperature.
- Condenser coil: Releases the heat absorbed from the indoor air to the outside.
- Evaporator coil: Absorbs heat from the indoor air, cooling it down.
- Expansion valve: Regulates the flow of refrigerant into the evaporator coil.
- Fan: Circulates air over the evaporator coil to cool the indoor air and over the condenser coil to release heat outside.
- Filter: Removes dust and particles from the air before it enters the evaporator coil.

9.2 Parts of AC cont'd

- Thermostat: Monitors and controls the temperature of the room.
- Drainpipe: Removes the condensed water from the evaporator coil.



(https://www.hometips.com/how-it-works/air-conditioners-room-window.html)

9.3 AC concept

- Matter is found in one of three different states: solid, liquid, or vapor (gas).

  The state depends upon the nature of the substance, the temperature, and the pressure or force exerted on it.

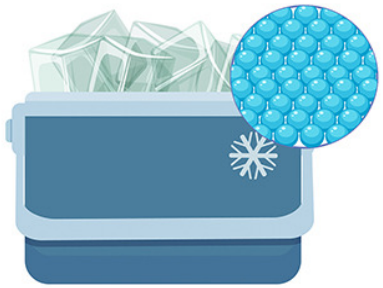
- Water occurs naturally in all three states: solid ice, liquid water, and water vapor, depending upon the temperature and pressure of the location.

- Water is a substance that can be found naturally in solid, liquid, and vapor states.

9.3 AC concept

THREE STATES OF WATER

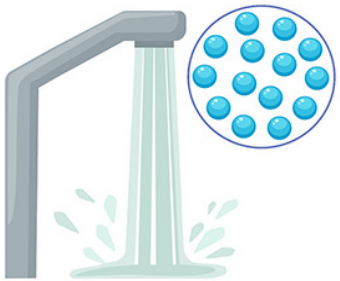
SOLID



The **solid state** of water refers to ice. In this state, water molecules are organized in an orderly and rigid structure.

Water freezes at 0 degrees Celsius (32 degrees Fahrenheit) under normal pressure conditions.

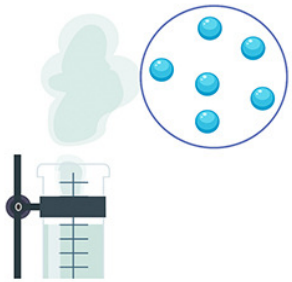
LIQUID



The **liquid state** of water is its natural state. Molecules have enough thermal energy to move freely but not enough to escape the cohesion of the liquid.

Liquid water has a freezing temperature of 0 degrees and a boiling point of 100 degrees.

GAS



The **gaseous state** of water is known as water vapor. In this state, water molecules have enough thermal energy to overcome cohesive forces and escape into the surrounding space.

Water boils and turns into vapor at 100 degrees Celsius.

(https://www.worksheetsplanet.com/what-are-the-three-states-of-water/)

9.3 AC concept cont'd

- **Changes of state and related terms**
- A solid is a substance that cannot be compressed and has strong resistance to flow.
- A liquid is a substance that cannot be compressed. A substance in a liquid state has a fixed volume, but no definite shape.
- A vapor is a substance that can be easily compressed, has no resistance to flow, and no fixed volume.
- A fluid is a substance that can flow, as vapor and liquids are.
- The boiling point is the temperature at which a liquid substance turns to a vapor. For water at normal sea level conditions, the boiling point is 212°F (100°C).

9.3 AC concept cont'd

- The condensation point is the temperature at which a vapor substance turns to a liquid.
- A melting point is related to the temperature at which a solid turns to a liquid.
- A substance changes to a vapor if the temperature rises above its boiling point. A vapor condenses to liquid if the temperature falls below boiling point.
- Latent heat is the "extra" heat that is needed to transform a substance from one state to another.
- Convection is defined as heat energy transfer that involves the movement of a fluid (gas or liquid)
- Conduction is the flow of heat energy through a material without the movement of any part of the material itself.

9.3 AC concept cont'd

- When the solid reaches its melting point, or the liquid reaches its boiling point, their temperatures stop rising. The solid begins to melt, and the liquid begins to boil.
- **Temperature, volume, and pressure of a vapor**
- Increasing the temperature of a vapor, while keeping the volume confined in the same space, increases the pressure. Decreasing the temperature decreases the pressure.
- This relationship between temperature and pressure in vapor is why a can of nonflammable refrigerant can explode when heated by a flame; the pressure buildup inside the can will eventually exceed the can's ability to contain the pressure.

9.3 AC concept cont’d

- Increasing the pressure by compressing a vapor increases the temperature. Decreasing the pressure by permitting the vapor to expand decreases the temperature.
- The temperature at which a liquid boil (and vapor condenses) rises and falls with the pressure.
- Pressure in a sealed system that contains both liquid and vapor rises and falls with the temperature.
- Air conditioning may be defined as the production of an artificial atmosphere specially adopted to requirement or air-conditioning means control of temperature, humidity, purity and movement of air.

9.4 Working principle of AC

- An air conditioner works by removing heat from indoor air and expelling it outside, creating a cooler indoor environment. It draws warm air from the room and passes it over evaporator coils containing a refrigerant that absorbs the heat, causing the refrigerant to evaporate into a gas.
- This gas is then compressed, increasing its pressure and temperature. The hot, high-pressure gas is passed through condenser coils outside, where it releases heat to the outside air and condenses back into a liquid.
- The liquid refrigerant then passes through an expansion valve, reducing its pressure and temperature, making it ready to absorb heat again.
- This cycle repeats continuously, effectively cooling the indoor air and dehumidifying it, enhancing the cooling effect and comfort.

9.4 Working principle of AC cont’d

- An air conditioner operates by leveraging the principles of thermodynamics to transfer heat from the indoor environment to the outside. The process begins with the evaporator coils, which are located inside the unit. Warm air from the room is drawn into the air conditioner and passes over these coils. The coils contain a refrigerant, a special fluid that absorbs heat from the air. As the refrigerant absorbs heat, it evaporates and transforms from a liquid into a gas. This phase change is crucial because it allows the refrigerant to carry the absorbed heat away from the indoor air, effectively cooling it.
- Once the refrigerant has evaporated into a gas, it moves to the compressor. The compressor, often considered the heart of the air conditioning system, plays a vital role by compressing the gaseous refrigerant.

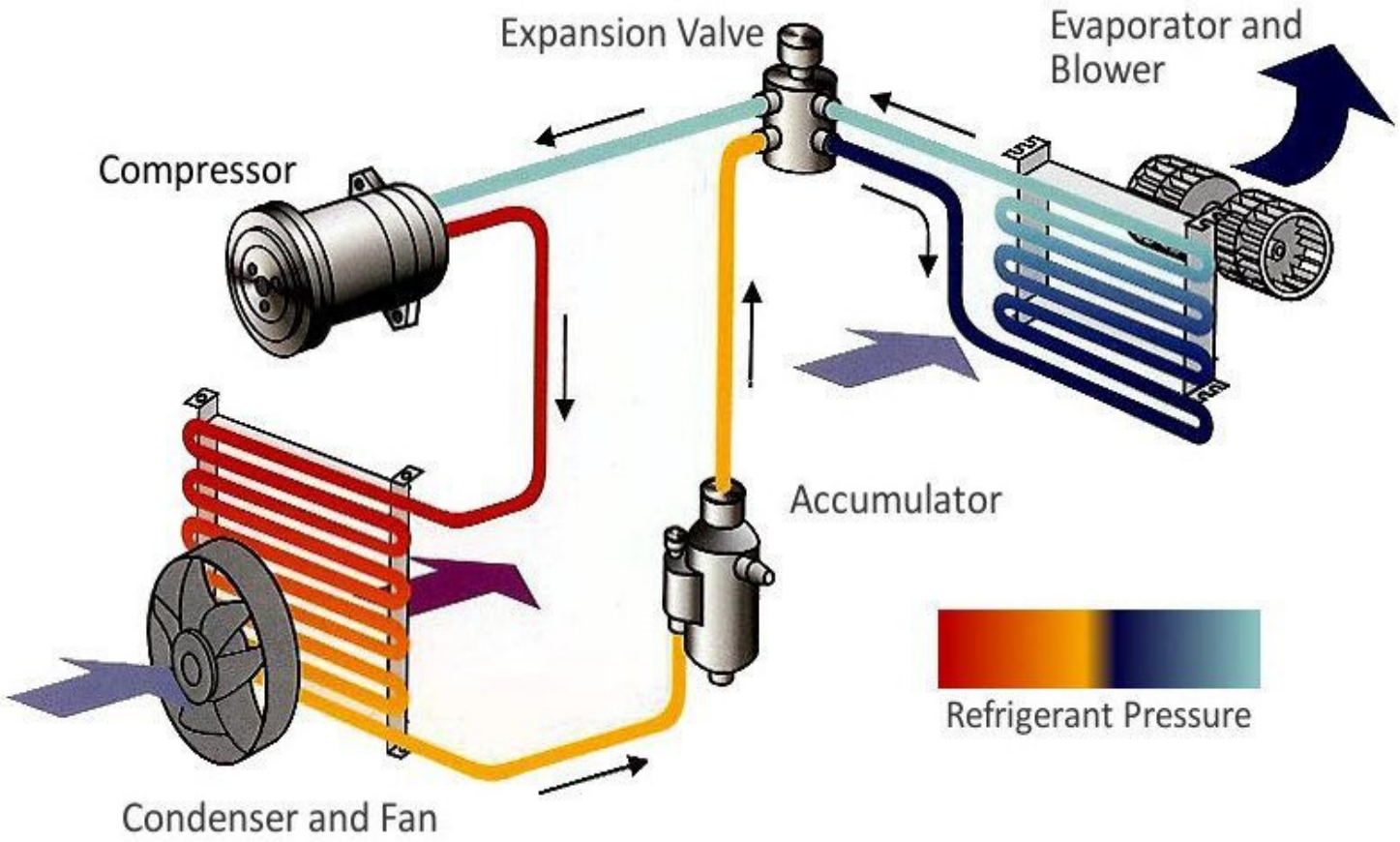
9.4 Working principle of Ac cont’d

- This compression process increases the pressure and temperature of the refrigerant gas, making it much hotter than the surrounding environment. The high-pressure, high-temperature gas is then ready to release the absorbed heat when it reaches the next stage of the cycle.
- The hot refrigerant gas is then directed to the condenser coils, which are located outside the building. As the gas passes through these coils, it releases the absorbed heat to the outside air.
- This heat exchange causes the refrigerant to cool down and condense back in to a liquid state. The condenser coils are designed to maximize the surface area for heat exchange, ensuring that the refrigerant can efficiently release the heat it has carried from the indoor environment.

9.4 Working principle of AC cont'd

- Finally, the liquid refrigerant passes through an expansion valve, which reduces its pressure and temperature. This cooling effect prepares the refrigerant to absorb heat once again as it re-enters the evaporator coils.
- The cycle then repeats continuously, maintaining a cool and comfortable indoor temperature. Additionally, as the air conditioner removes heat from the air, it also reduces humidity, enhancing the overall comfort of the indoor environment.
- This continuous cycle of evaporation, compression, condensation, and expansion is what keeps your living space cool and pleasant.
- The working follows a cycle comprising of evaporation, compression, condensation and expansion

9.4 Working principle of AC cont'd



(https://www.serviceairconsingapore.com/important-parts-of-air-conditioner/)

9.5 Applications of AC

Residential

- **Home cooling**: AC are commonly used in homes to maintain a comfortable indoor temperature, especially during hot weather.
- **Humidity control**: They help in controlling humidity levels, making the indoor environment more comfortable.

Commercial

- **Office buildings**: AC systems are essential in office buildings to ensure a comfortable working environment for employees.
- **Retail stores**: They help in maintaining a pleasant shopping experience for customers by regulating temperature and humidity.

9.5 Applications of AC cont'd

Industrial

- **Manufacturing plants**: AC are used to maintain specific temperature and humidity levels required for various manufacturing processes.
- **Data centers**: They are crucial in cooling data centers to prevent overheating of servers and other equipment.

Specialized

- **Hospitals and Laboratories**: AC systems are used to maintain sterile and controlled environments necessary for medical procedures and experiments.
- **Transportation**: AC are installed in vehicles, including cars, buses, trains, and airplanes, to provide comfort to passengers.

9.5 Applications of AC cont'd

Others

- **Agriculture**: In some agricultural settings, AC is used to create optimal conditions for growing certain crops or maintaining livestock.
- **Museums and Libraries**: They help in preserving artifacts, books, and other sensitive materials by controlling temperature and humidity.
- **Broadcasting towers and cellular settings**: Outdoor telecom enclosures are subject to high levels of solar radiation. The effects of solar heating as well as the heat load inside enclosures mean that some form of cooling is necessary. So, there is a need to withstand the effects of adverse weather conditions.

9.6 Inspection of AC

The following are key steps involved in a thorough physical inspection of an AC:

Thermostat check

- **Functionality**: Ensure the thermostat is working correctly and set to the desired temperature.
- **Calibration**: Verify if the thermostat accurately reflects the room temperature.

Refrigerant levels

- **Measurement**: Check the refrigerant levels to ensure they are within the recommended range.
- **Leaks:** Inspect for any refrigerant leaks in the lines and connections.

Condenser and Evaporator coils

- **Condition**: Inspect the condenser and evaporator coils for dirt, debris, and damage.
- **Cleaning**: Clean the coils to improve efficiency and prevent overheating.

9.6 Inspection of AC cont'd

Air Filters

- **Inspection:** Check the air filters for dirt and clogs.
- **Replacement:** Replace or clean the filters as needed to ensure proper airflow.

Electrical components

- **Connections:** Inspect all electrical connections for signs of wear or damage.
- **Operation:** Test the operation of the blower motor, fan motor, and other electrical components.

Drainage system

- **Drain pan and line:** Check the drain pan, drain line, and p-trap for blockages and proper drainage.
- **Cleaning:** Clean the drainage system to prevent water damage and mold growth

9.6 Inspection of AC cont'd

Airflow and ductwork

- **Airflow measurement**: Measure the airflow to ensure it meets the system's specifications.
- **Duct inspection**: Inspect the ductwork for leaks, blockages, and insulation issues.

Overall system performance

- **Cooling capacity**: Measure the air temperature difference to determine the cooling capacity.

Physical inspection techniques

- Checking of physical and mechanical condition, verification of all equipment grounding, verification of one-line drawings match equipment.

9.6 Inspection of AC cont'd

Use of specialized tools

- **Refrigerant gauges:** Measure refrigerant pressure to ensure it falls within the recommended range.
- **Thermometers:** Check the temperature difference between the supply and return air to assess cooling efficiency.
- **Multimeters:** Test electrical components for proper voltage, current, and resistance.

Visual and initial inspection

- **Outdoor unit:** Inspect for signs of wear, damage, or obstructions like debris and vegetation that could block airflow.

9.6 Inspection of AC cont'd

- **Indoor components:** Check the evaporator coil and blower motor for dust buildup or leaks. Ensure air vents are unobstructed.

Thermostat calibration

- **Accuracy check:** Verify the thermostat is set to the correct temperature and mode.

- **Responsiveness:** Adjust the thermostat settings and observe the system's reaction to confirm accurate communication between the thermostat and the AC unit.

Refrigerant levels inspection

- **Pressure measurement:** Use gauges to check refrigerant pressure.

9.6 Inspection of AC cont'd

- **Leak detection:** Look for any signs of refrigerant leaks, which can reduce cooling efficiency and damage the compressor.

Cleaning and maintenance

- **Coils:** Clean the condenser and evaporator coils to remove dirt and debris.
- **Filters:** Replace or clean air filters to ensure proper airflow.
- **Drainage System:** Clear the drain pan and line to prevent water damage and mold growth.

Electrical System Check

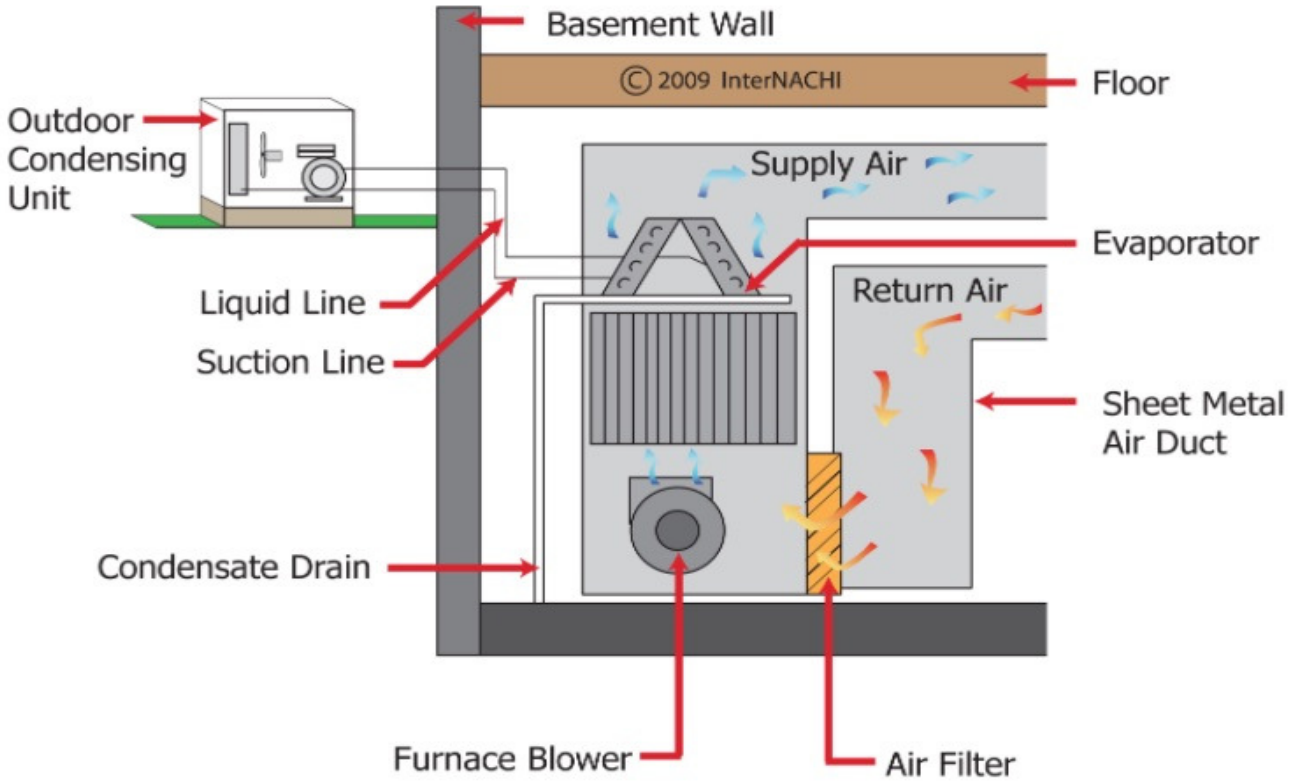
- **Connections:** Inspect all electrical connections for signs of wear or damage.
- **Component Testing:** Test the operation of the blower motor, fan motor, and other electrical components.

9.6 Inspection of AC cont'd

Airflow and Ductwork Inspection

- **Airflow measurement:** Measure the airflow to ensure it meets the system's specifications.
- **Duct inspection:** Check the ductwork for leaks, blockages, and insulation issues.
- All the techniques stated above contribute to the achievement of the AC Temperature Monitoring with the focus on iidentifying temperature levels based on standards in Server room, Pharmacy, Working places, Data centers room, Shelters, Conference room, Studios, Learning environment.
- Use of temperature remote controllers, Analyse temperature performance indicator statistics

9.6 Inspection of AC cont'd



Split-system air conditioning

(https://www.nachi.org/inspecting-compression-cooling-systems.htm)

9.6 Factors to consider before AC installation

- Building size and layout
- Environments and climate condition
- Maintenance and serviceability
- System type and configuration
- Energy efficiency goals
- British Thermal Unit (BTU) (capacity).
- Future expansion and upgrade
- Brand
- Cost

Thank you for your good attention

Q&A

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