



Heating Ventilation and Air Conditioning (HVAC)



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AGENDA PEMBAHASAN

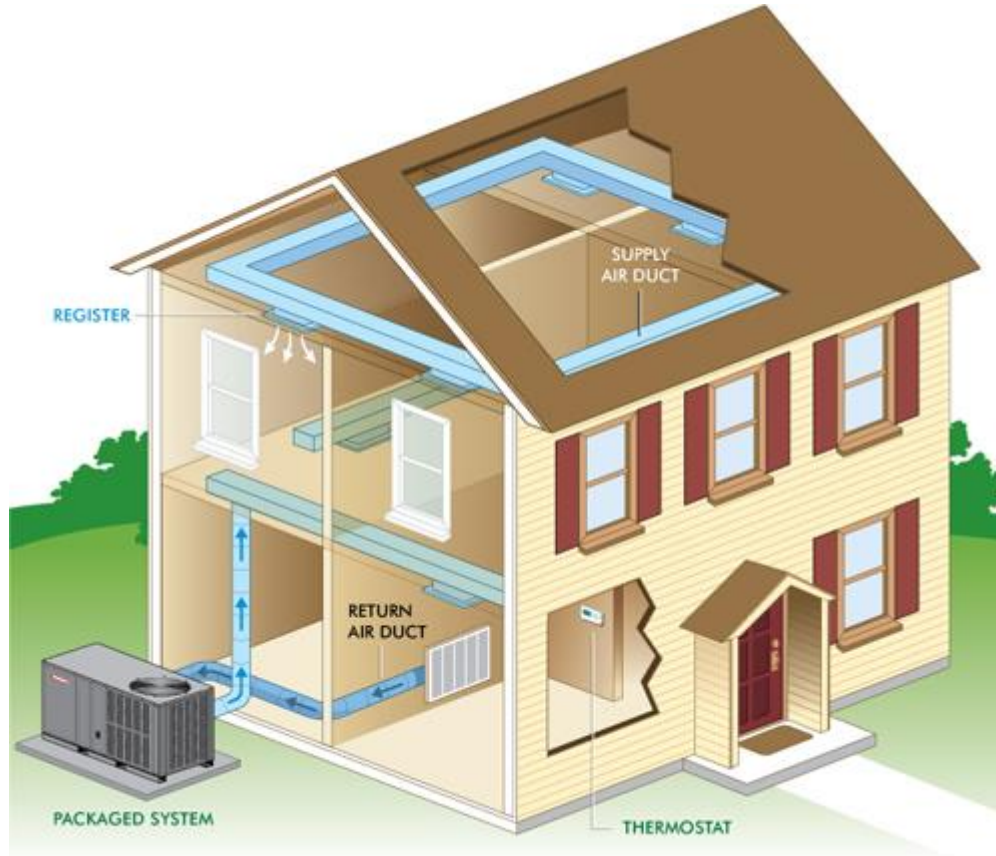


Definisi dan Fungsi dari HVAC

Komponen Dasar dari HVAC

Sistem Kerja dari HVAC

Definisi dan Fungsi dari HVAC



Definition and Function of HVAC

- HVAC = Heating, Ventilation and Air Conditioning
- Goal of HVAC :
 - Provides comfort for people
 - Allows humans to exist under adverse conditions.



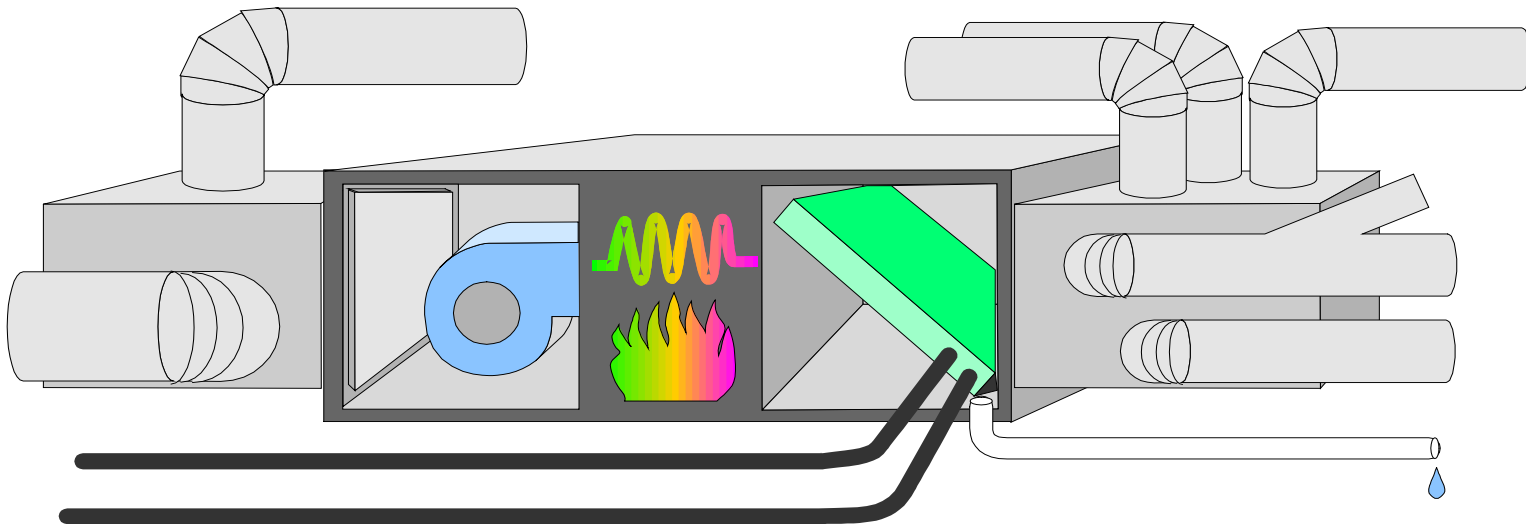
Comfort

- Comfort is primary intent of HVAC systems.
- Productivity
- Building Durability
- Health
- *Mold*



Function of HVAC

1. Control temperature
2. Fresh air circulation
3. Air filtration



Heating

- Engine coolant is routed to heater core
 - Air passes over fins of the heater core

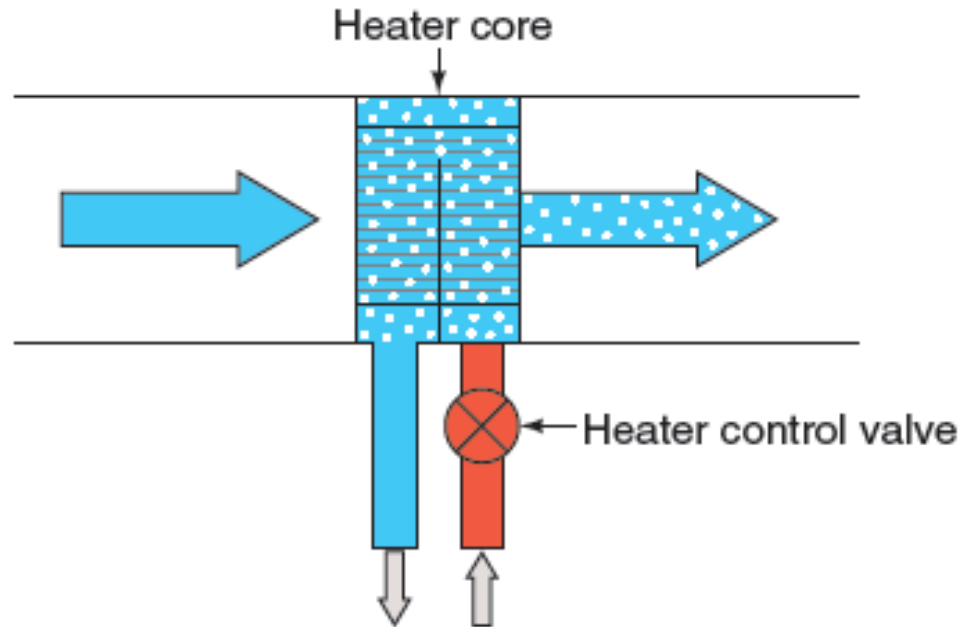


Figure 35.4 Some heaters use a control valve.

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Sources of Heat

- The system adds heat in the winter
 - Removes it in the summer
- Sources of heat
 - Passengers
 - Outside air
 - Road
 - Engine
 - Catalytic converter
 - Sunlight

Heat Transfer

- Heat flows to anything with less heat
 - Convection
 - Heat rises
 - Heat always flows from hot to cold
 - Radiation
 - Example: heat from the sun
 - Evaporation
 - Moisture absorbs heat as it is vaporized
 - Example: perspiration

Ventilation

- Fresh air replaces stale air
 - Prevents carbon monoxide from exhaust
- Air ducts allow outside air into interior
 - Does not work when car is slowed or stopped
 - Electrically driven blower motor and squirrel cage fan brings outside air in
- Blower runs at low speed when ignition key is on
 - Maintains fresh air in car interior
 - Creates positive cabin pressure

Air Distribution System

- Moves heat between different locations
 - Controls air volume, temperature, quality, and location
- Plenum housing: case assembly
 - Combined or split
- Air doors
 - Open and close to control air flow
- Carbon air filter
 - Often replaced with screens
- Control head: relays A/C system demands

Air Conditioning

- Air in passenger compartment is cooled, dried, and circulated
 - Heat is removed from inside to outside
- Modern cars get better freeway fuel economy with windows up and air-conditioning on
 - Above 40 mph: more gas used with windows down

Air-Conditioning Principles

- Must be a transfer of heat for refrigerant to change state
 - Liquid absorbs heat as changes to gas
 - Vapor releases heat as changes to

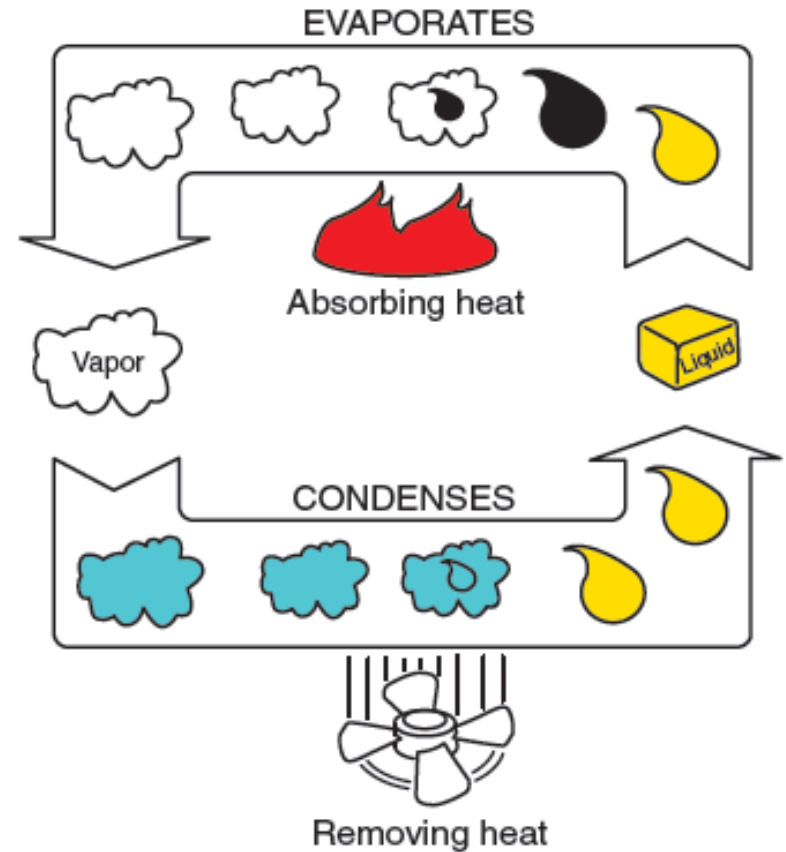


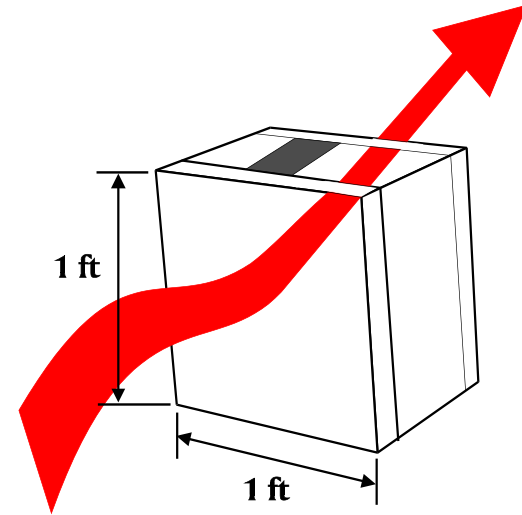
Figure 35.10 The refrigeration process.

Humidity

- Low humidity
 - Permits heat to be taken away from the human body
 - Evaporation and perspiration
- High humidity
 - Makes evaporation difficult
 - People feel as comfortable at 79°F with 30% humidity as at 72°F at 90% humidity

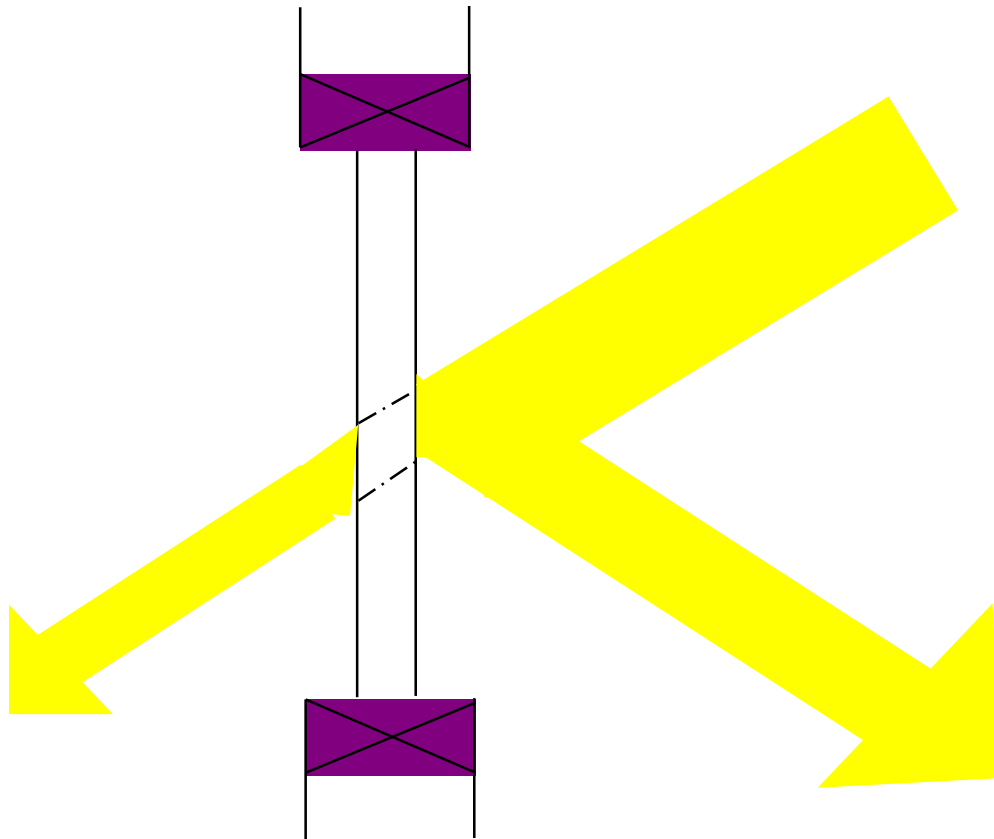
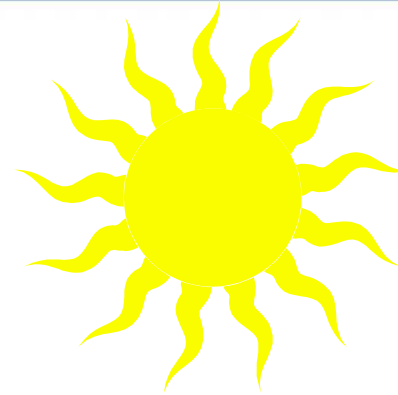
Heat Transfer

- Conduction
- Convection
- Radiation
- Resistance (R-Value)
- $U = 1 / R$
- $Q = U \times A \times \Delta T$



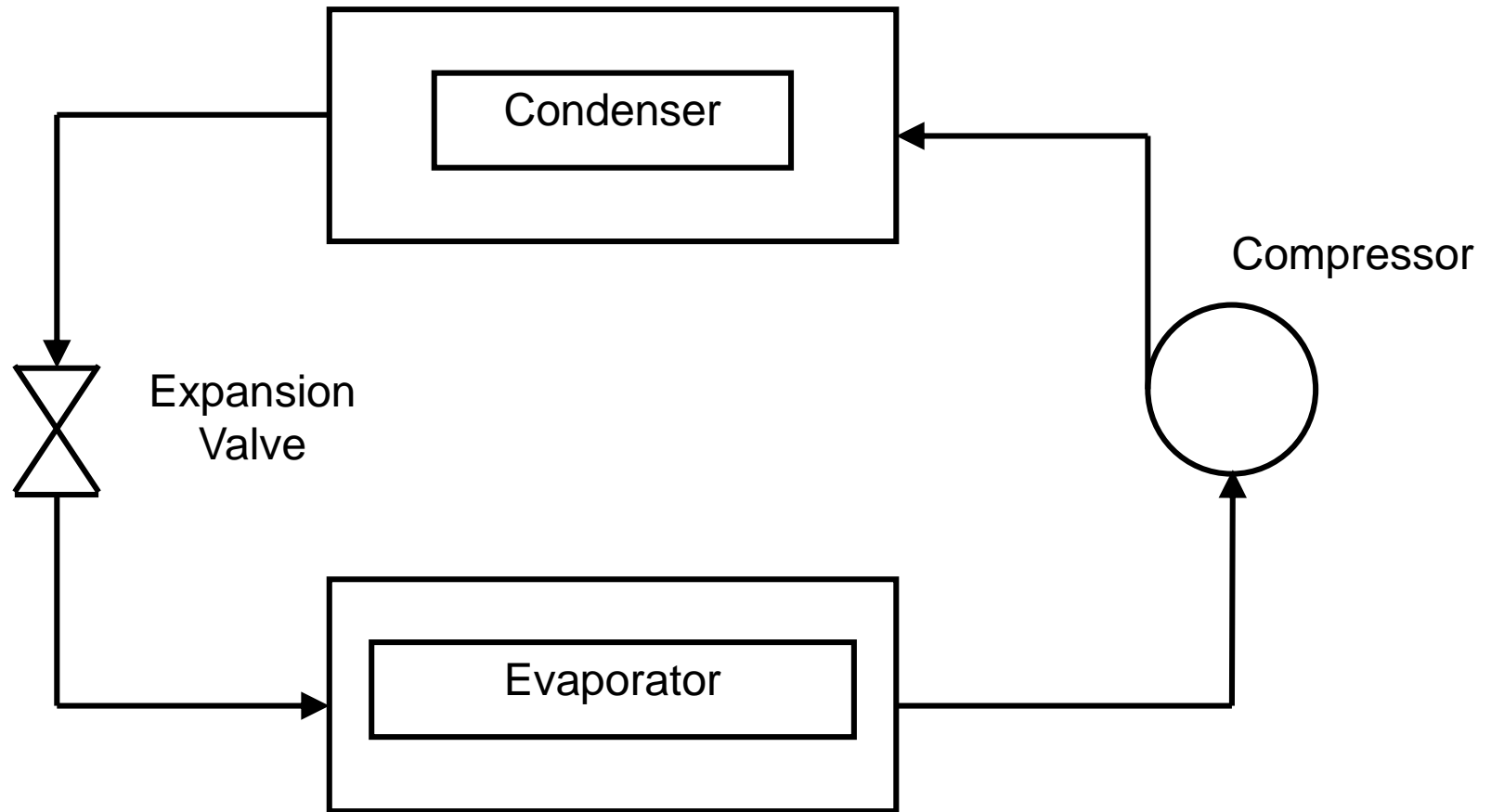
U-Value is the rate of heat flow in Btu/h through a one ft² area when one side is 1°F warmer

Solar Heat Gain Coefficient

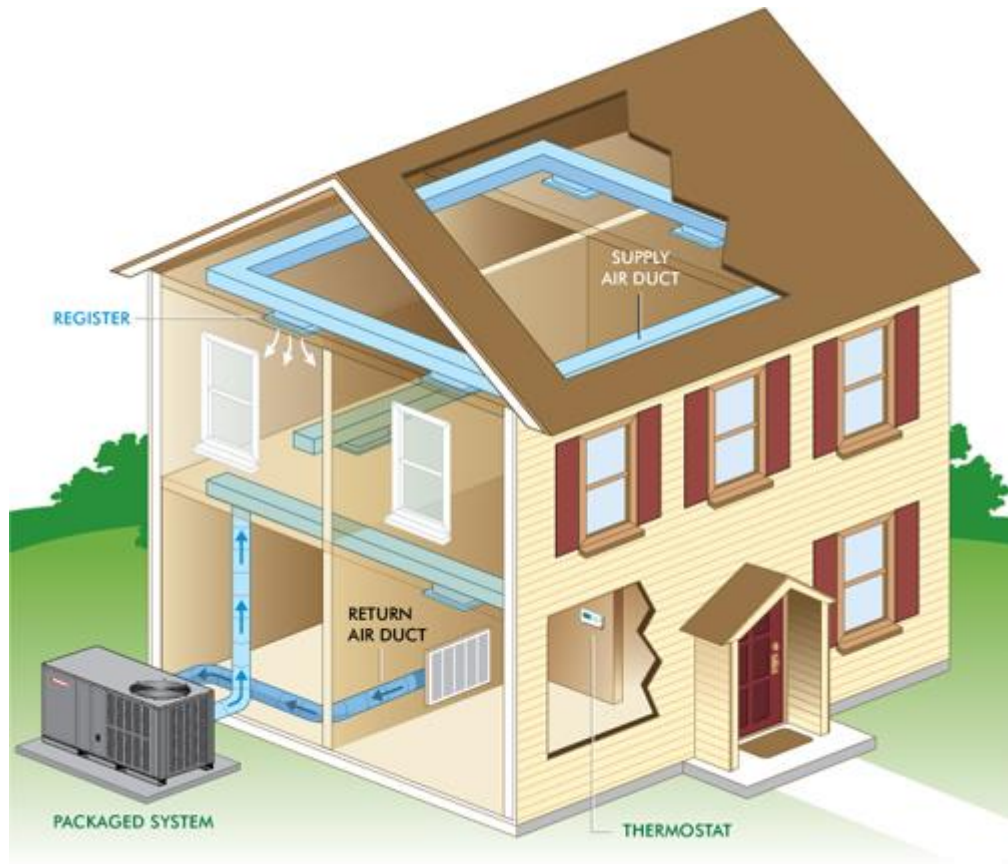


- The amount of solar heat energy allowed to pass through a window
- Example: $SHGC = 0.40$
Allows 40% through and turns 60% away

Basic Refrigeration Cycle

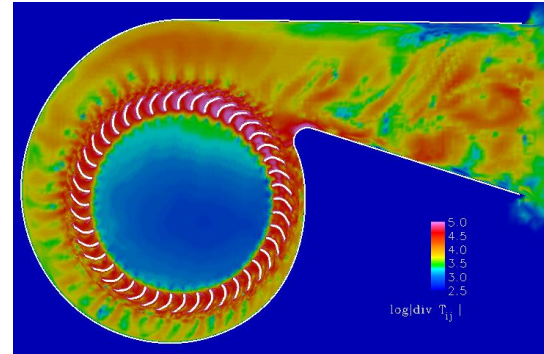


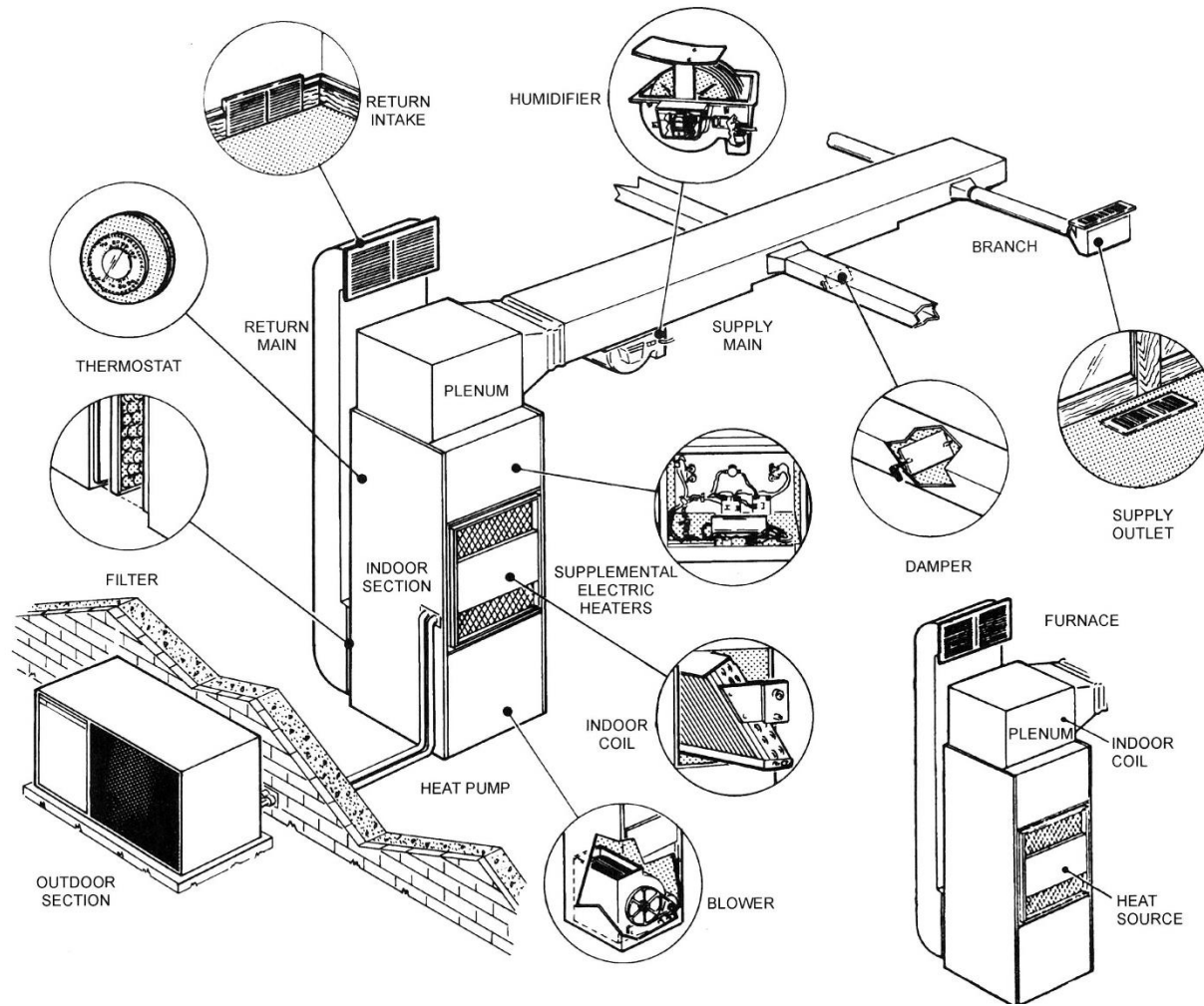
Komponen Dasar dari HVAC



Basic HVAC Equipment

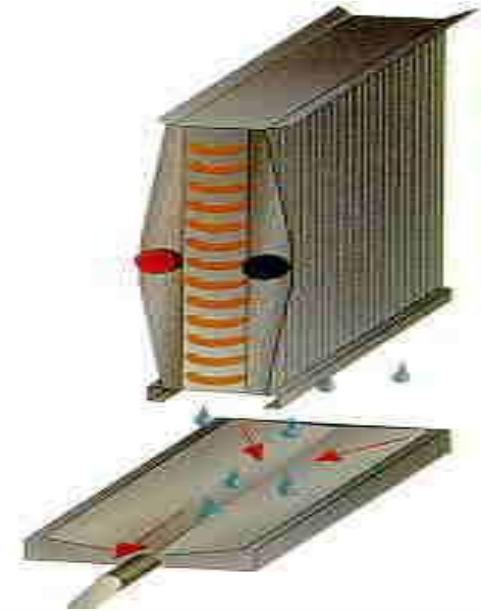
- Fans / Blowers
- Furnace / Heating unit
- Filters
- Compressor
- Condensing units
- Evaporator (cooling coil)
- Control System
- Air Distribution System





System Types and Common Terms

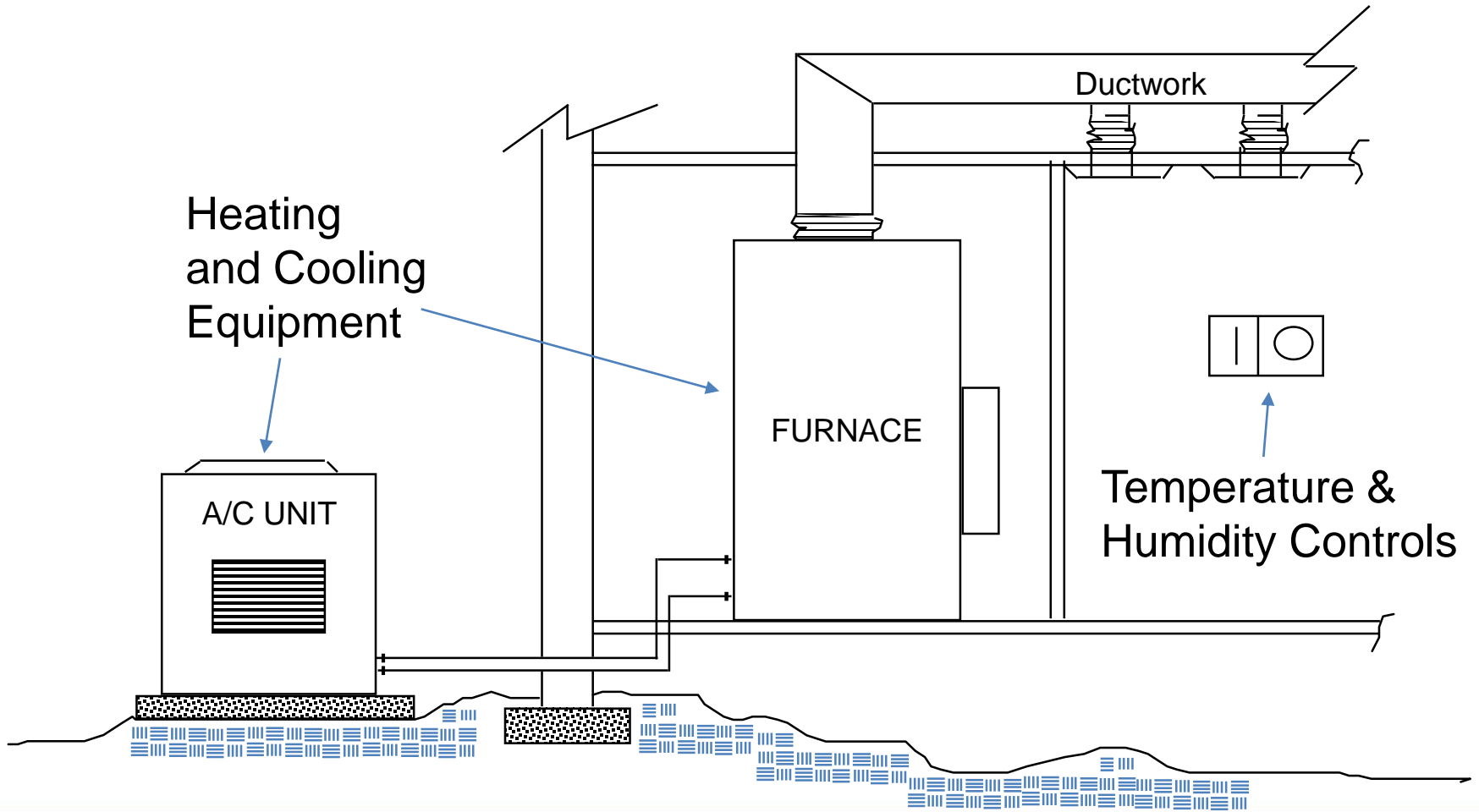
- Packaged Rooftop Unit
 - ◆ Constant Volume
 - ◆ Variable Volume
 - ◆ Indoor Air Quality
 - ◆ Direct Expansion
- Split System
- Heat Pump
- Geothermal
- Air to Air
- Hydronic (water)
- PTAC / PTHP



Packaged Rooftop Units



Split System

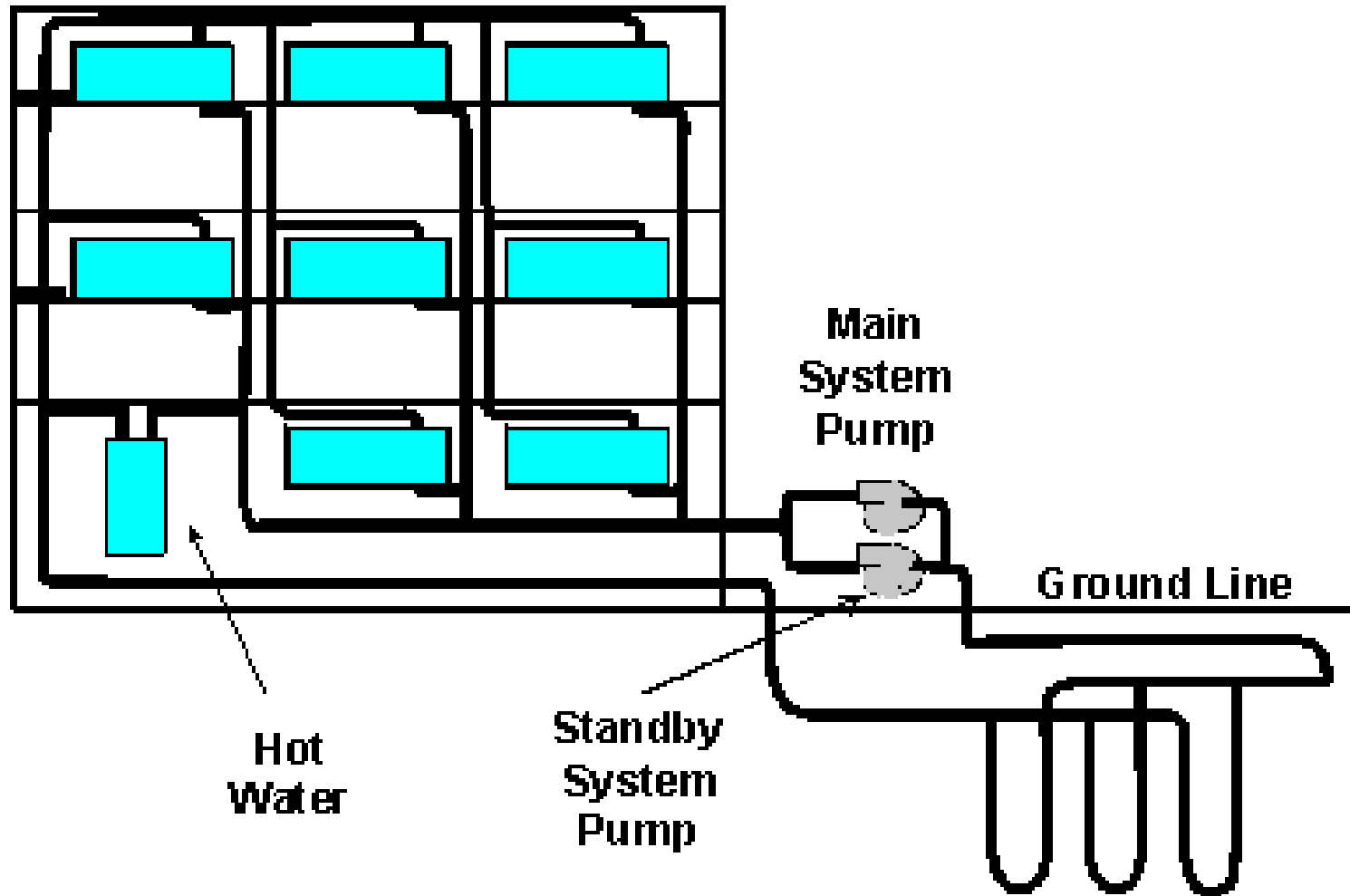


Heat Pump

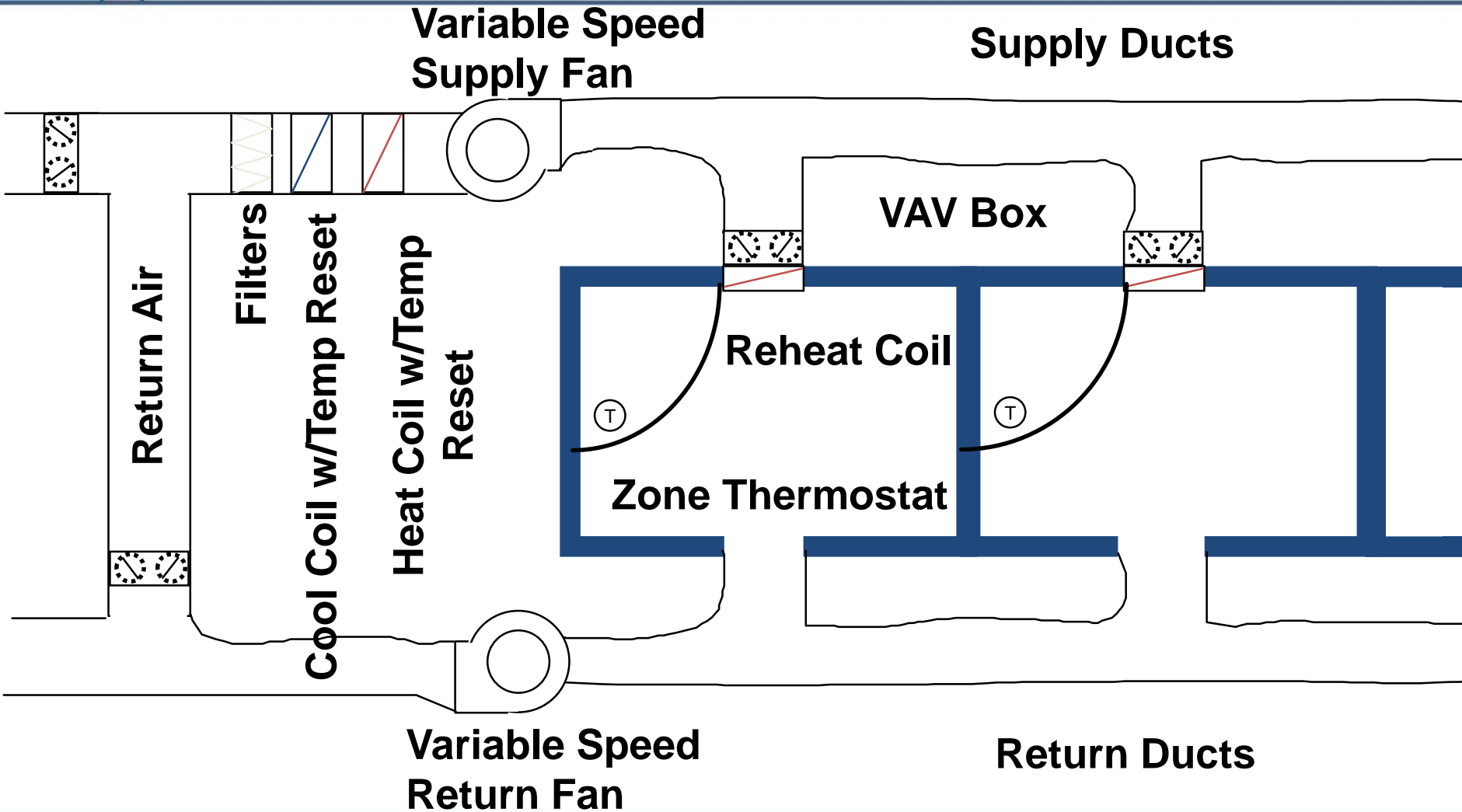
- Operate on simple refrigeration cycle
- Reversing the cycle provides heating
- Temperature limitations
- Air to air
- Water source
- Geothermal
- Lake coupled



Geothermal Heat Pump Systems



Variable Air Volume



Terminal Units

Variable volume:
Parallel

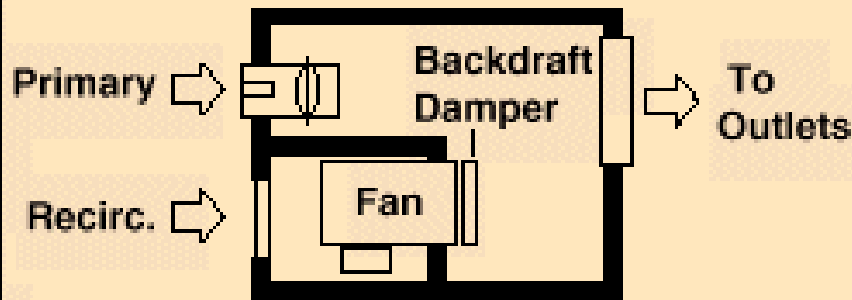


Figure 6. Plan View

Constant volume:
Series

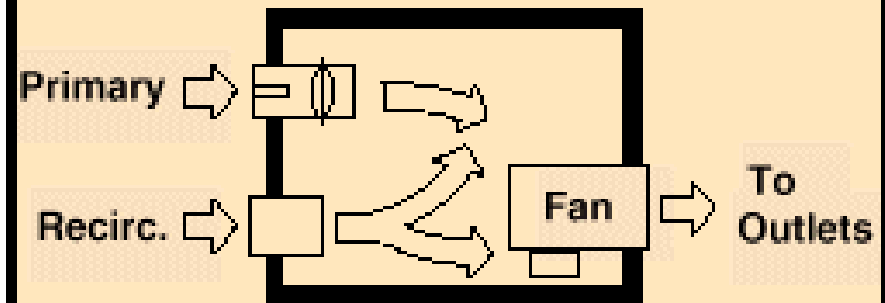


Figure 7. Plan View

Hydronic systems

- Pumps
- Piping
- Valves



Control Devices

- Thermostats
 - Manual
 - Programmable
- Optimum Start
- DDC Systems
- Variable Speed Drives
- Automatic Valves and Dampers
- Outdoor Sensors



Major Equipment

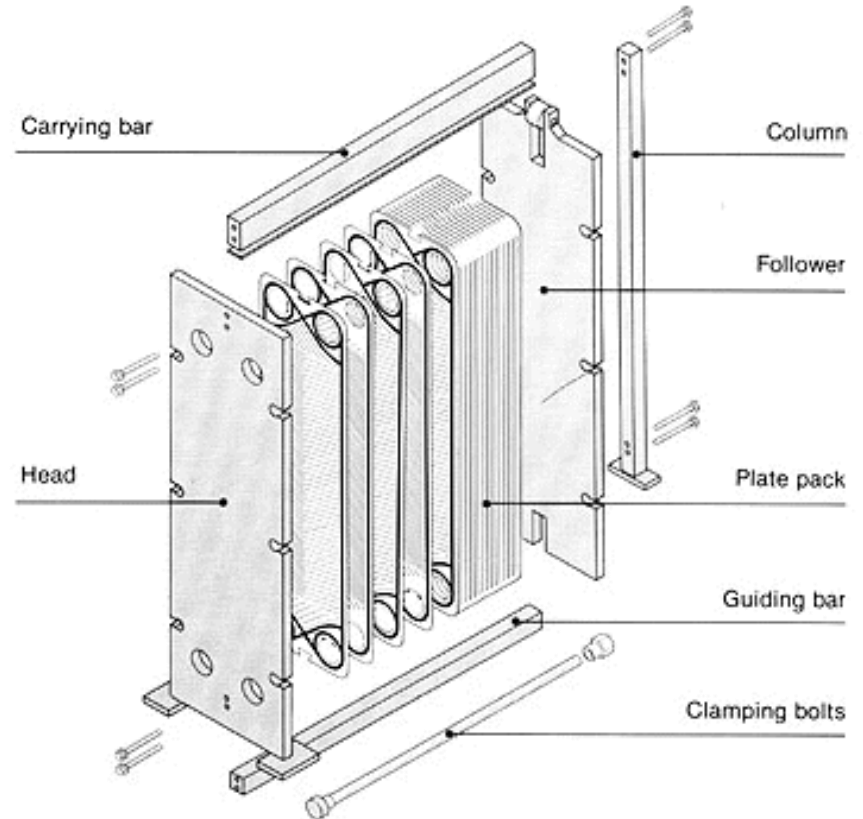
- Chillers
- Boilers
- Cooling Towers



Economizers



Air Side

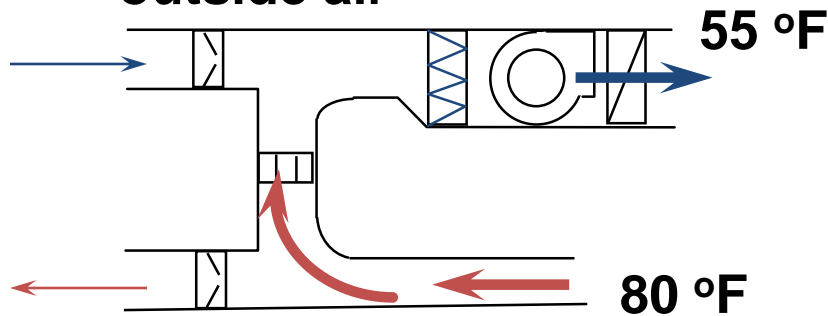


Water Side

Economizers

Free cooling source: When available, use cool outdoor air instead of mechanically cooled air.

Minimum supply of outside air



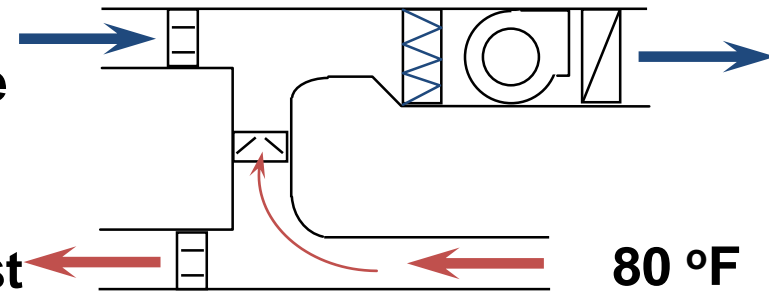
Normal Operation

Outside air dampers are positioned to provide the minimum outside air

55 °F and up

85% outside air

85% exhaust

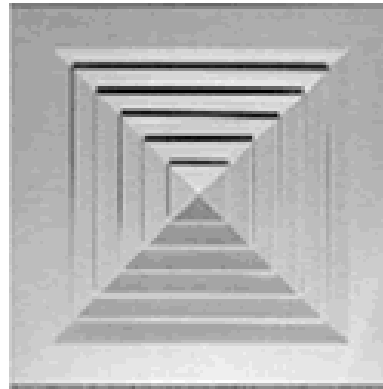


Economizer Operation

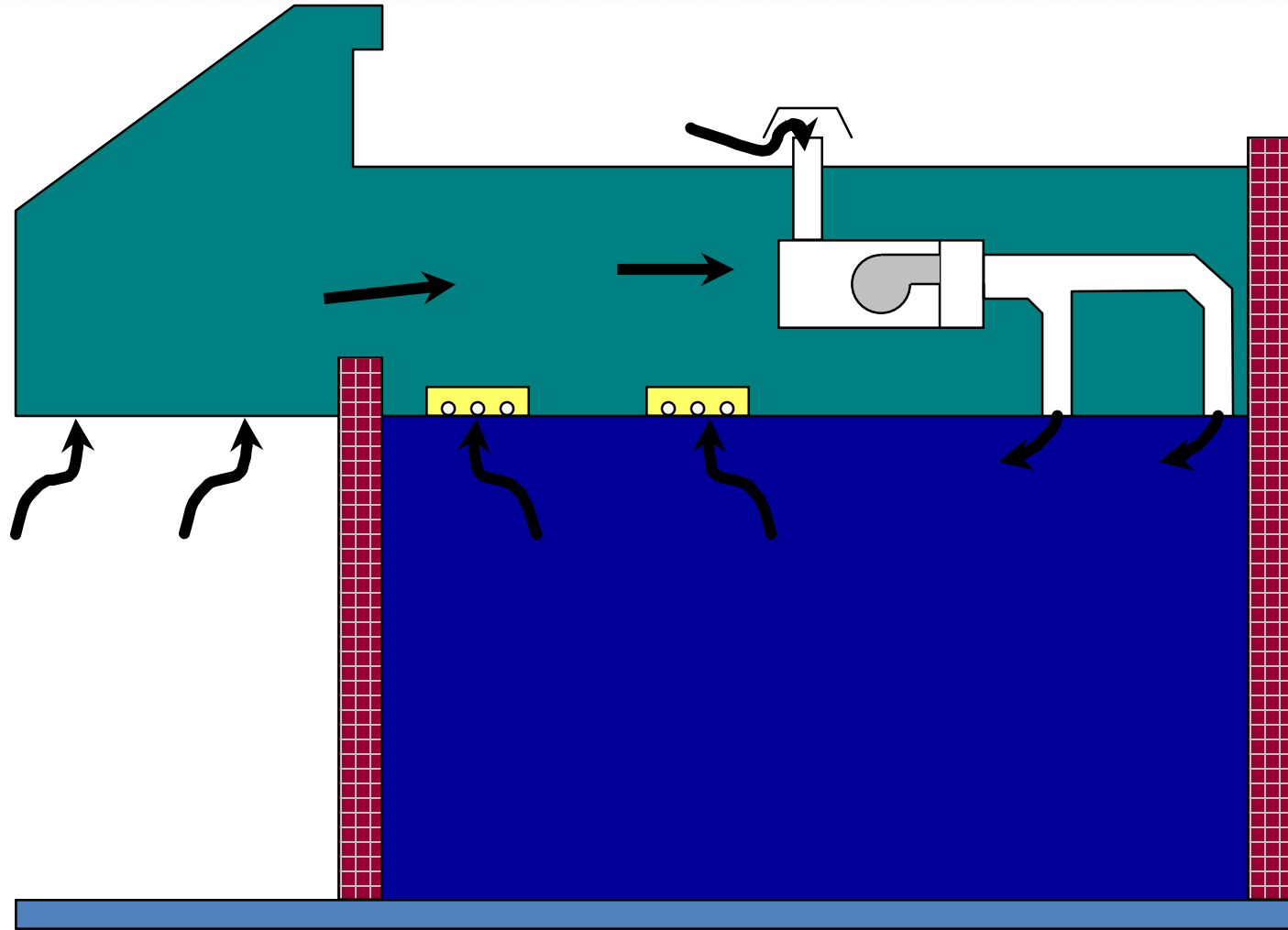
Outside air dampers are fully open. Maximum outside air is provided

Air Distribution

- Ductwork
 - Metal
 - Flexible
 - Duct board
- Grilles, Louvers, & Registers
- Dampers
 - Shut off
 - Fire
 - Smoke
- Sealants
- Supports



Return Plenum Problems



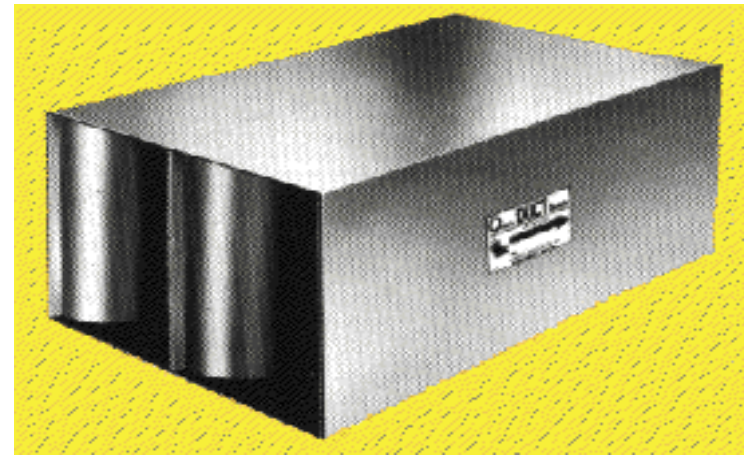
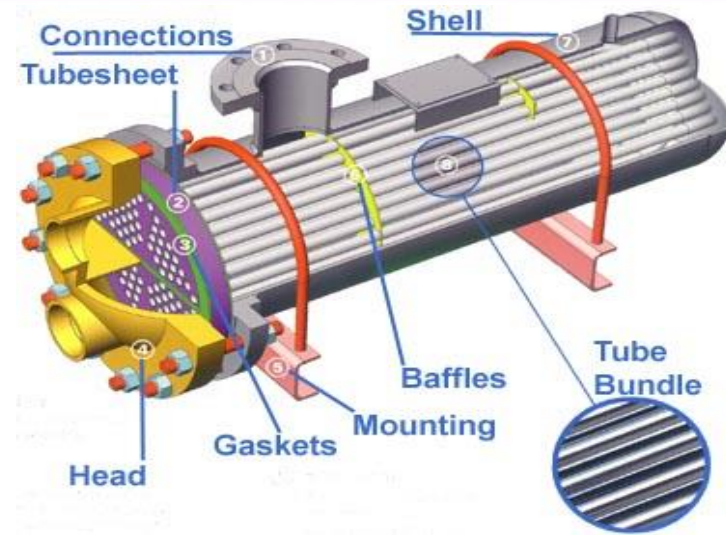
Additional Equipment

- Energy Recovery Units
- Desiccant Systems



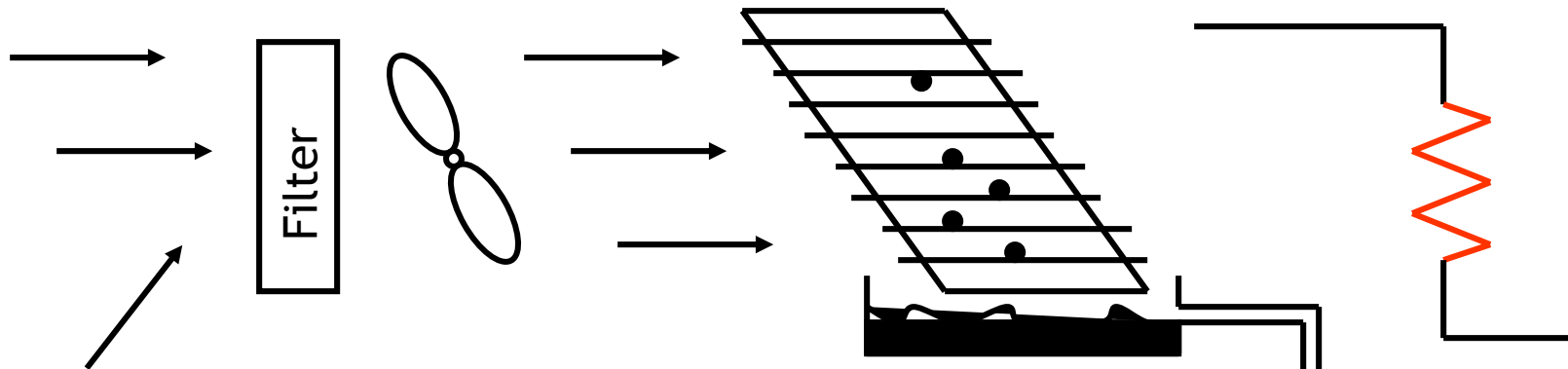
Additional Equipment

- Heat Exchangers
- Humidifiers
- Silencers

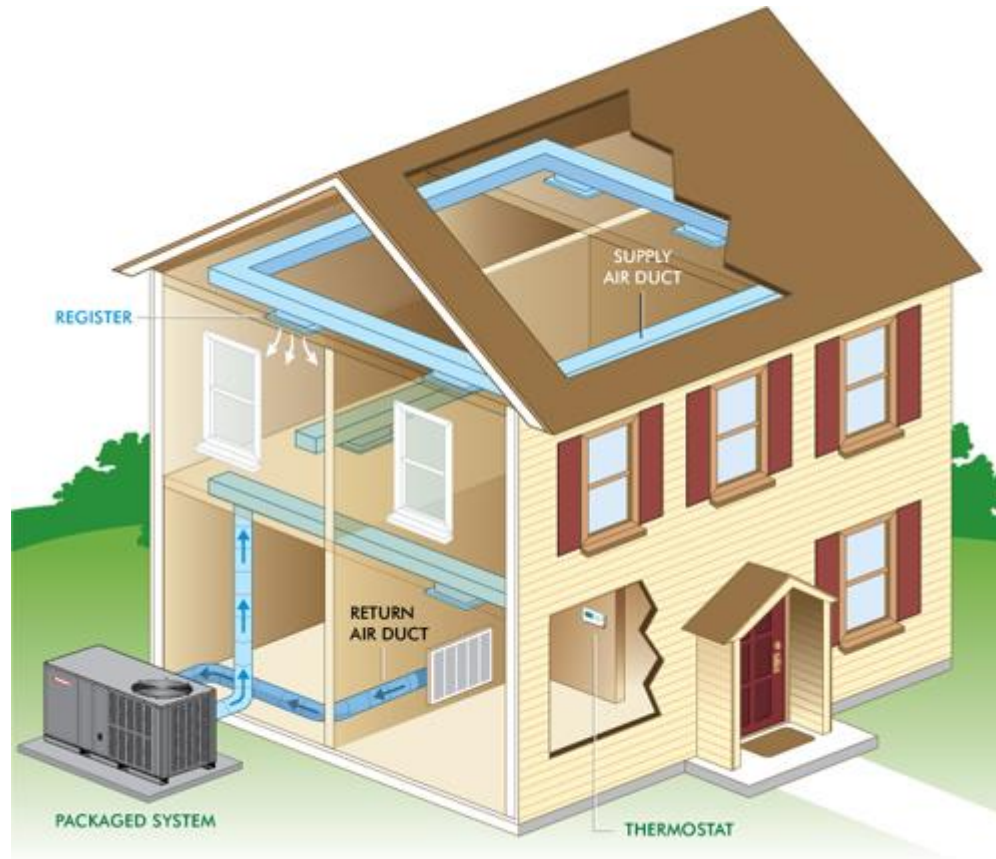


Mechanical Dehumidification

- ◆ Return air is mixed with ventilation air
- ◆ Cold coil condenses moisture
- ◆ Heat is added back (electric or gas) so that room air is not over cooled- *Reheat*



Sistem Kerja dari HVAC



Air-Conditioning System Operation

- Closed system
 - Four major devices
 - Compressor
 - Condenser
 - Evaporator
 - Metering device
 - Refrigerant circulates among devices
 - Changing pressure and state of refrigerant regulates cooling cycle operation
 - Four stages: compression, condensation, expansion, and vaporization

Absorbing Heat

- Process
 - Liquid refrigerant is circulated to the evaporator
 - Loses pressure as it exits the metering device
 - Absorbs heat from inside of car
 - Boils and vaporizes
 - Pressurized again
 - Gives off heat to outside air
 - Each cycle through evaporator absorbs at least 25° of heat from air blowing across it

Reducing Humidity

- Sources
 - Outside air
 - Breathing of passengers
- Moisture in the air condenses on evaporator fins
 - Drained off through the floor as water
- System does not cool air as much when humidity is high
- Defroster operation
 - Dried cool air moves through heater core before it is blown onto the windshield

Compressing the Refrigerant

- Vaporized refrigerant pulled from evaporator to compressor
 - Compressors are driven by a belt from the crankshaft
 - Pressurizes heated refrigerant, increasing its temperature
- Compressor clutch
 - Electromagnetic clutch connects and disconnects from the crankshaft pulley

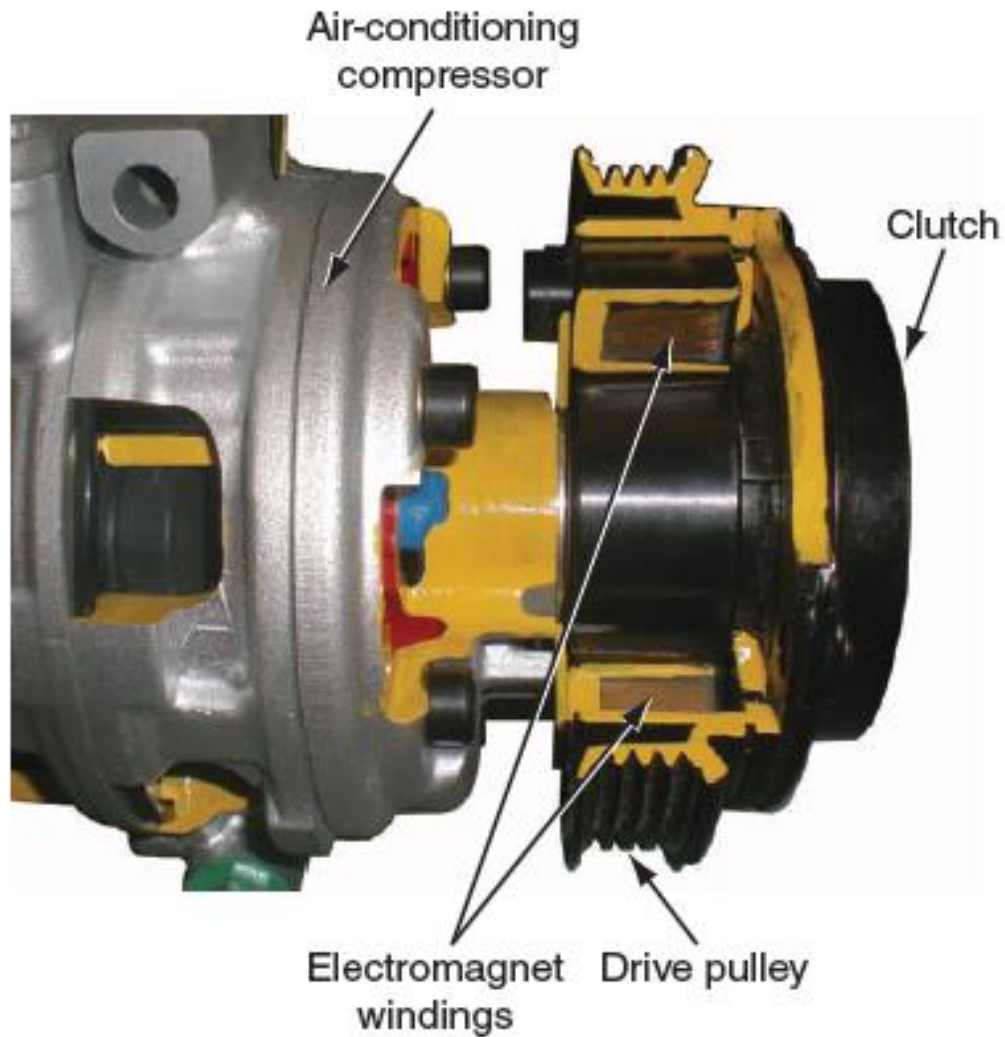
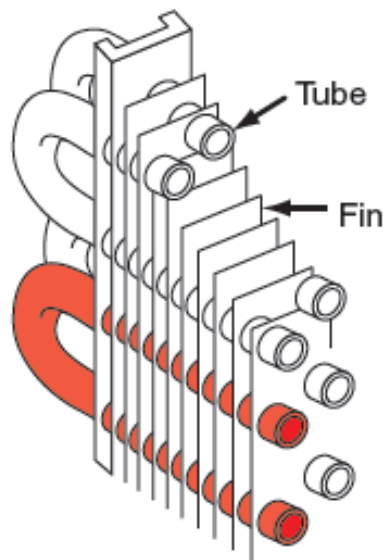


Figure 35.16 Cutaway of a magnetic air conditioner clutch.

Transferring Refrigerant Heat to Outside Air

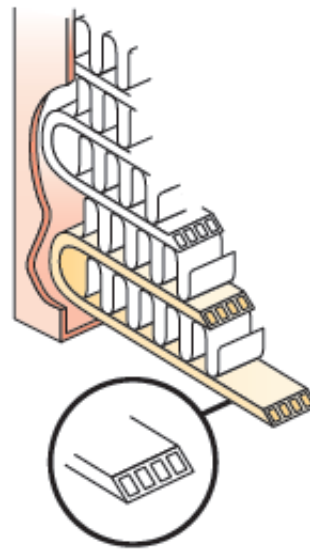
- Refrigerant is pumped from compressor to condenser
 - Condenser is a radiator for refrigerant
 - Transfers heat to cooler air blowing through it
 - Pressurized refrigerant is cooled from gas to warm liquid
 - Refrigerant must be hotter than the air coming across the condenser
 - Condenser design
 - Several designs



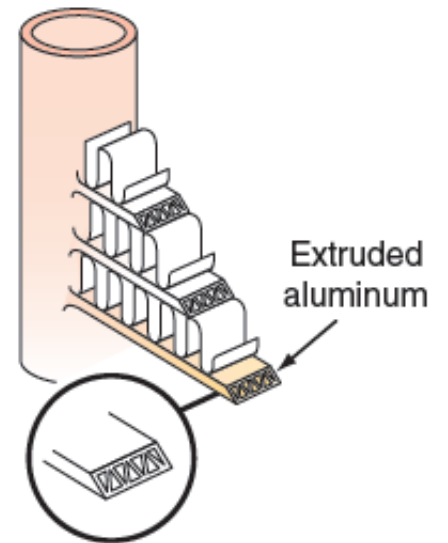
Tube and fin

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Figure 35.18 Earlier condensers, called tube and fin, had round tubes.



Serpentine flow



Parallel flow

Figure 35.20 Two flat tube condenser designs.

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Flow Control Devices

- Systems to control refrigerant flow
 - Thermostatic expansion valve
 - Orifice tube
- Restriction raises pressure in system
 - Flow control device lets the pressure off refrigerant as it flows to the evaporator
- TXV controls amount of refrigerant flowing to evaporator
- Orifice tube cycles the compressor clutch

Air-Conditioning Compressors

- Compressor designs
 - Several types
- Axial compressor has four or more cylinders
 - Swash plate: axial plate connected to drive shaft
 - Wobble plate: wobbles in place
- Variable displacement compressors: no clutch cycling
- Radial compressor: multiple cylinders with pistons and a scotch yoke

Air-Conditioner Compressors (cont'd.)

- Scroll compressor
 - Moveable scroll oscillates around a fixed scroll
- Rotary vane
 - Blades like power steering pump
- Electric compressors
 - Pressurize the air-conditioning system so the engine does not have to be run
 - Used in hybrids

Heating and Air-Conditioning Controls

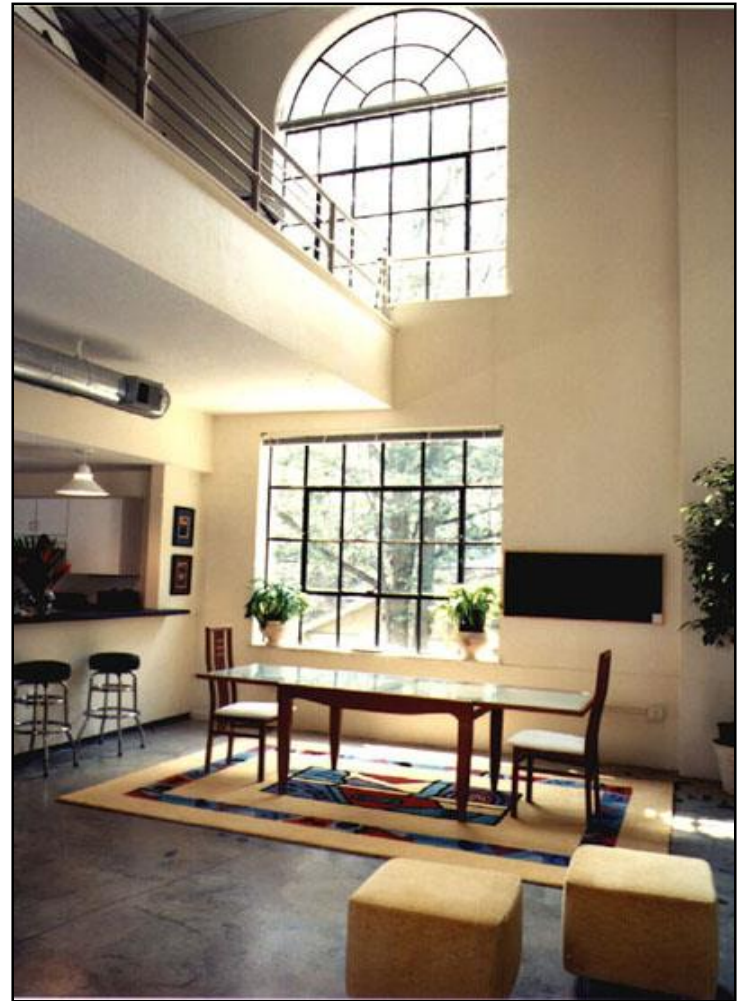
- Manually controlled air conditioning
 - Manual control system controlled by the driver
- Semiautomatic temperature control systems
 - Discharge temperature is automatically controlled
- Automatic temperature control systems
 - Driver sets desired temperature
- Automatic blower control
 - Blower is pulse-width modulated
 - Interval determined by the programmer

Automatic Air-Conditioning Sensors

- Sensor inputs maximize system performance
 - Outside air temperature (OAT) sensor denies compressor operation between 35°F and 45°F
 - Sunload sensor opens blend door and spins the blower faster in response to sunlight intensity
 - Discharge duct temperature sensor senses the temperature of air leaving the duct
 - Interior temperature sensor is sometimes used for the first few minutes of vehicle operation

Improved Ventilation Effectiveness

- Mechanically provide filtered and dehumidified outdoor air to the breathing space
- Vary ventilation based on the number of occupants and process loads - changes in occupancy can be measured by CO₂ sensors
- Consider designs that separate ventilation and space conditioning
- Utilize heat recovery systems to reduce system size and ventilation energy costs



Improved Ventilation Effectiveness

- Effective mixing of ventilation air within space
- Net positive pressure in the southeast; exhaust from appropriate spaces
- Provide clean outdoor air, avoid:
 - loading docks
 - exhaust vents
 - plumbing stacks
 - waste collection
 - stagnant water



Additional Information / Resources

- ASHRAE – The American Society of Heating, Refrigerating and Air-Conditioning Engineers
– www.ashrae.org
- Geothermal heat pump consortium
www.geoexchange.org
- www.buildingscience.com
- www.energycodes.gov

Terima kasih & Sampai Jumpa di Pertemuan Selanjutnya

