Introduction to HVAC
Agenda

- Psychrometrics
- Human Comfort
- Heat Transfer
- Refrigeration Cycle
- HVAC Terminology
- HVAC Systems
Introduction to HVAC

Psychrometrics
Properties of Air

- Dry-bulb temperature
- Wet-bulb temperature
- Dew-point temperature
- Relative humidity
- Enthalpy
Dry-Bulb Thermometer
Wet-Bulb Thermometer
Relative Humidity

Relative Humidity = \frac{\text{Amount of moisture that a given amount of air is holding}}{\text{Amount of moisture that a given amount of air can hold}}
Enthalpy (h):

Definition: A measure of the total heat energy of an air mass in BTU per pound of dry air and associated moisture.
Introduction to HVAC

Human Comfort
Impact of Comfort

Why is air conditioning a “big deal”?
“Home” Economics

Construction Costs
- HVAC
- plumbing
- site work
- electrical
- all other

Operating Costs
- HVAC
- laundry
- lights
- kitchen
- misc
Effects of Comfort

A comfortable indoor environment enhances:

▲ Tenancy
▲ Productivity
▲ Health
▲ Profitability
Factors Affecting Human Comfort

▲ Dry-bulb temperature
▲ Humidity
▲ Air movement
▲ Fresh air
▲ Clean air
▲ Noise level
▲ Adequate lighting
▲ Proper furniture and work surfaces
Cooling Load Components

- roof
- partition wall
- lights
- infiltration
- people
- equipment
- exterior wall
- glass
- solar
- conduction
- floor

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Heat Transfer
What is Refrigeration?

Refrigeration is the process of removing heat from one substance and transferring it to another substance.
Principles of Heat Transfer

▲ Heat energy cannot be destroyed

▲ Heat always flows from a higher temperature substance to a lower temperature substance

▲ Heat can be transferred from one substance to another
Methods of Heat Transfer

- Warm air
- Conduction
- Hot water
- Cool air
Measuring Heat Quantity

1 lb water

60°F

1 Btu

61°F
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Refrigeration Cycle
Basic Refrigeration System
HVAC Terminology
HVAC Terminology

Topics of Discussion:

▲ CFM, ESP, TSP
▲ Enthalpy
▲ Sensible, Latent, Total Heat
▲ BTU, BTUH, MBH, Ton
▲ dB, dBA
HVAC Terminology

CFM:

▲ Definition: Cubic Feet per Minute

▲ Typical values:

➢ 1 cfm/square foot airflow
➢ 400 cfm/ton
➢ 20-cfm per person ventilation air
ESP (External Static Pressure):

▲ Definition: External Static Pressure is the sum of the losses (both straight run frictional & dynamic fitting) that occur outside of the air handling system.

▲ Static Pressure in our industry has a unit of measure equivalent to inches water gauge. Typical values would be in the 1” to 3” range for ESP.
HVAC Terminology
TSP (Total Static Pressure):

Definition: Total Static Pressure is the sum of the ESP and the SP losses of that occur in the air handling system itself. This is the actual SP that the Fan must develop.
HVAC Terminology

Sensible Heat:

▲ Definition: That heat when increased or decreased to a previously steady state environment, will increase or decrease the Dry Bulb temperature of that space.
HVAC Terminology

Latent Heat:

Definition: That heat when increased or decreased to a previously steady state environment, will not change the Dry Bulb temperature of that space. It only effects the amount of moisture in the space.
HVAC Terminology

Total Heat:

▲ Definition: The sum of both the Sensible & Latent heat.
HVAC Terminology

BTU:

Definition: The amount of heat necessary to raise one pound of water one deg F
HVAC Terminology

Ton:

▲ Definition: The rate of heat transfer necessary to melt 1-ton of ice at 32 deg F in 24 hours

= 2,000 lbs x 144 BTU/lb / 24 hrs
= 288,000 BTU / 24 hrs
= 12,000 BTU/hour or BTUH
HVAC Terminology

**dB:**

▲ **Definition:** A measurement used to describe the amplitude of Sound.

▲ **A healthy young human ear can detect sound pressures in the range of:**
  ➢ 20 millionths of a Pascal to
  ➢ 20 Pascals
  ➢ This range is too difficult to manage, so we put it on a logarithmic scale
  ➢ Which works out to: 00-dB to 140-dB
HVAC Terminology

dBA:

▲ Definition: The ‘A’ weighting scale is used to better estimate how the human ear hears sound pressure.

▲ Some acoustical rules of thumb:

➢ 3-dB represents doubling of sound power
➢ 6-dB represents doubling of sound pressure
➢ 10-dB represents perceived doubling of sound to human ear
➢ Average human can’t distinguish a difference less than 3-dB
Introduction to HVAC

HVAC Systems
The Five System Loops

- Airside
- Chilled water
- Refrigeration
- Heat rejection
- Controls
Airside Loop

- **supply air**
- **conditioned space**
- **return air**
- **moisture (latent heat)**
- **sensible heat**
Airside Loop

EA → OA 95°F (35°C)

MA 80°F (26.7°C)

cooling coil

SA 55°F (12.8°C)

RA → EA 75°F (23.9°C)
Chilled-Water Cooling Coil

- Warm, humid air
- Cool, dry air
- Drain pan
- Condensate drain line
Supply-Air Distribution System

- outdoor-air inlet
- sheet-metal supply duct
- VAV terminal
- central air handler
- return-air inlet
- flexible duct
- diffuser
Ceiling Plenum Return

- Roof
- Plenum
- Diffuser
- Supply air
- Ceiling
- Return air
Chilled-Water Loop

80°F (26.7°C) → control valve → 57°F (13.9°C) → evaporator → 42°F (5.6°C) → pump → 55°F (12.8°C) → cooling coil → 55°F (12.8°C)
Refrigeration Loop

- **Air Conditioning Clinic TRG-TRC018-EN**
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1. **Compressor**
   - 120°F (48.9°C)
   - 110°F (43.3°C)

2. **Evaporator**
   - 38°F (3.3°C)
   - 57°F (13.9°C)

3. **Condenser**
   - 50°F (10°C)
   - 120°F (48.9°C)

4. **Expansion Device**
   - 80°F (26.7°C)
   - 55°F (12.8°C)

- **Refrigerant Loop**
  - Flow direction: Compresor → Evaporator → Condenser → Expansion Device → Compressor
Packaged Air-Cooled Chiller

1. Compressor
2. Air-cooled condenser
3. Evaporator
4. Expansion device
Heat-Rejection Loop (water-cooled)
No Chilled-Water Loop (RTU/Split System)
Controls Loop
Introduction to HVAC Systems

Common HVAC System Types
Single Zone, Constant Volume

EA → RA → supply fan → SA

OA → cooling coil

thermostat → zone
Multiple Zones, Variable Volume
multiple zones, variable volume

DX Rooftop VAV System

- Packaged DX rooftop air conditioner
- VAV terminal, diffusers
- Supply
- Return
- System-level controller
multiple zones, variable volume

Central Chilled-Water VAV System

- Cooling tower
- VAV terminal, diffusers
- Air handler
- System-level controller
- Hot-water boiler, pumps
- Water-cooled chiller
## Four-Pipe Versus Two-Pipe System

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<th>4-pipe</th>
<th>2-pipe</th>
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<td>Coils per terminal unit</td>
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<td>Water distribution piping</td>
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<td>1 set</td>
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<td></td>
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<td>(if heating coil</td>
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<td></td>
<td>downstream of cooling</td>
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Questions????