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PRINCIPLES OF AIR CONDITIONING

Class Overview

1. Physics of the Refrigeration Cycle
2. Types of Heat
3. Refrigeration Cycle Components
4. The Refrigeration Cycle
5. How Airflow Effects the Cycle
6. Superheat and Subcooling
7. Basic System Charging

Physics of the Refrigeration Cycle

- Refrigeration is based on drastically increasing and decreasing refrigerant pressures.
- Raising or lowering refrigerant pressure directly affects its ability to absorb and reject heat.
- Gas Laws provide answers to how refrigerants work.
- The process of changing the state of the refrigerant in the coils is where the greatest amount of heat transfer takes place.

Boyle's Law

Boyle's law states that with a sudden increase or decrease in pressure, there is a sudden increase or decrease in temperature.

How does this affect the refrigeration cycle?

1. Refrigeration is based on drastically increasing and decreasing refrigerant pressures.
2. Raising and lowering refrigerant pressure assures its ability to adsorb or reject heat in an efficient manner.

Charles' Law

Charles's law states that if we slowly change the pressure of a substance we also change its saturation temperature.

This is the process by which we pull vacuum on a system.

By slowly pulling a line set and/or a system into a vacuum, we then cause the moisture in the system to boil at ambient temperature, so the vapor can be removed through our pumps.

The Laws of Thermodynamics

1. Energy can neither be created nor destroyed, only moved from one place to another.
2. Heat will always transfer from a higher concentration to a lower concentration.

First Law - Energy can neither be created nor destroyed.

How does it apply?

1. In air conditioning we do not create “cold air”, we transfer heat from one space to another.
2. There is no such thing as a substance getting “colder”, we remove heat to lower the temperature.

Second Law - Heat will always transfer from a higher source to a lower source. How does it apply?

1. In the refrigeration cycle we use refrigerant at low temperature and pressure to absorb heat from the air, therefore lowering the temperature of the air inside of the structure.
2. We then raise the pressure and temperature of the refrigerant by compressing it, then reject the heat to the outside air, which is at a lower temperature.

Types of Heat

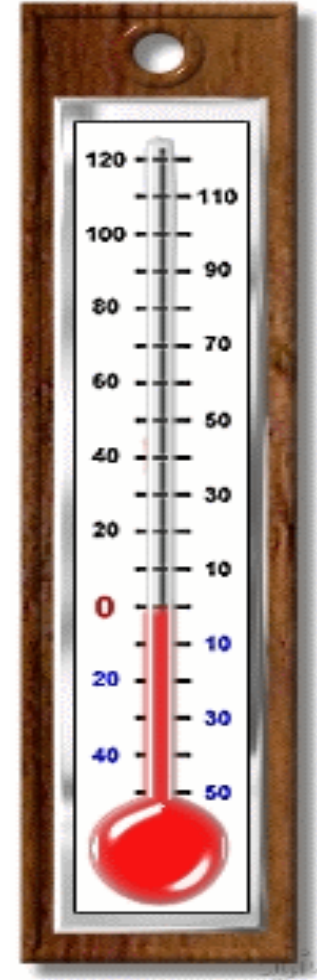
Types of Heat

Sensible and Latent

- Sensible heat is heat added or removed to change actual temperature.
- Latent heat is any heat that is added or removed that doesn't change the actual temperature.

Sensible Heat

- Sensible heat is any heat that directly affects the temperature of a given substance.
- In the refrigeration cycle this is the heat that we add or remove to change temperature.
- Sensible heat can be measured with a thermometer.

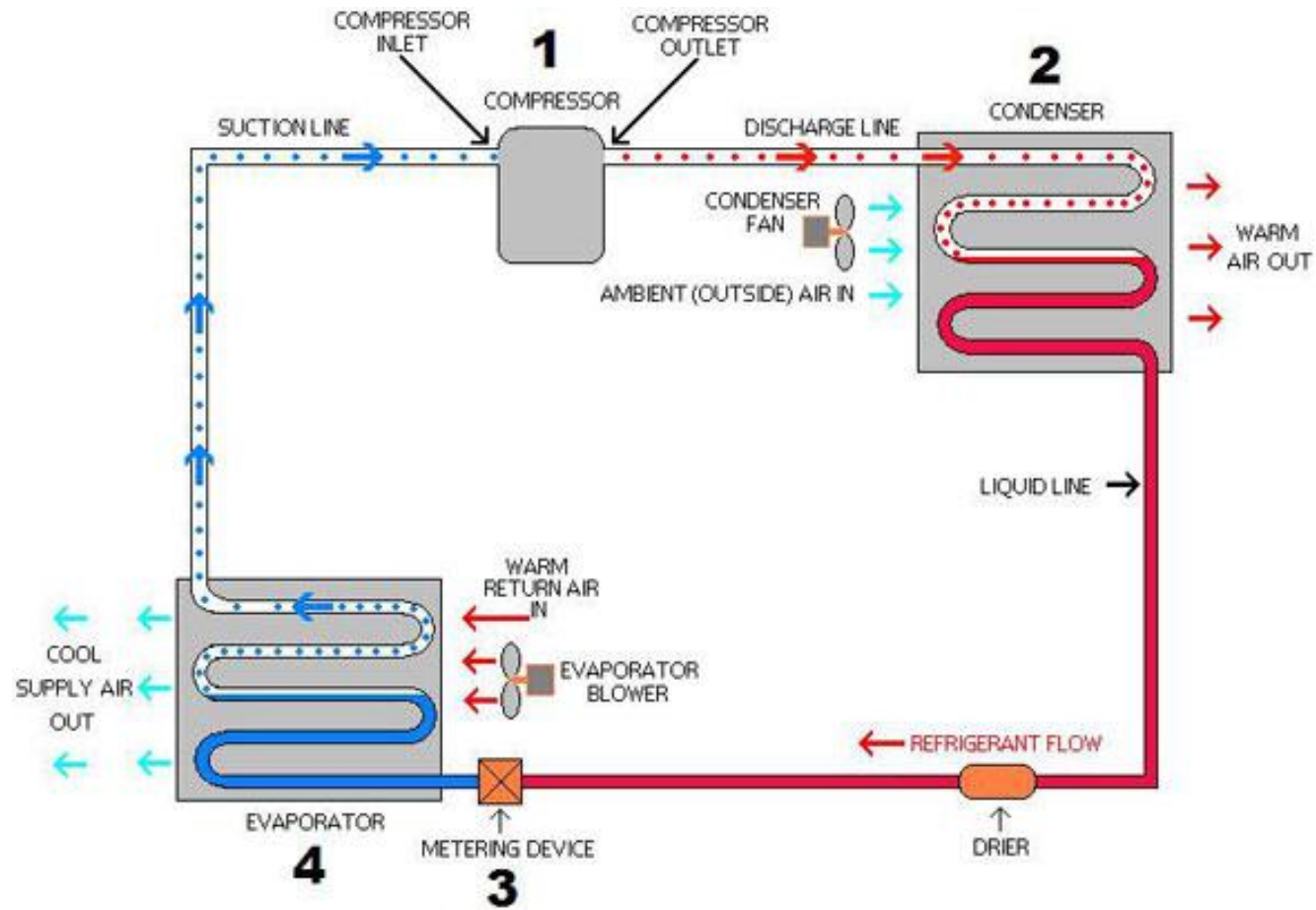


Latent Heat

Latent heat is heat that is added or removed from a substance that does not directly affect temperature.

- The heat absorbed or rejected from a substance to undergo a state change.
- The heat rejected from the moisture in the air, to make it reach dew point temperature, to cause the moisture to condense and be removed from the air.

Refrigeration Cycle Components



The Refrigeration Cycle

Refrigeration Cycle Components (continued)

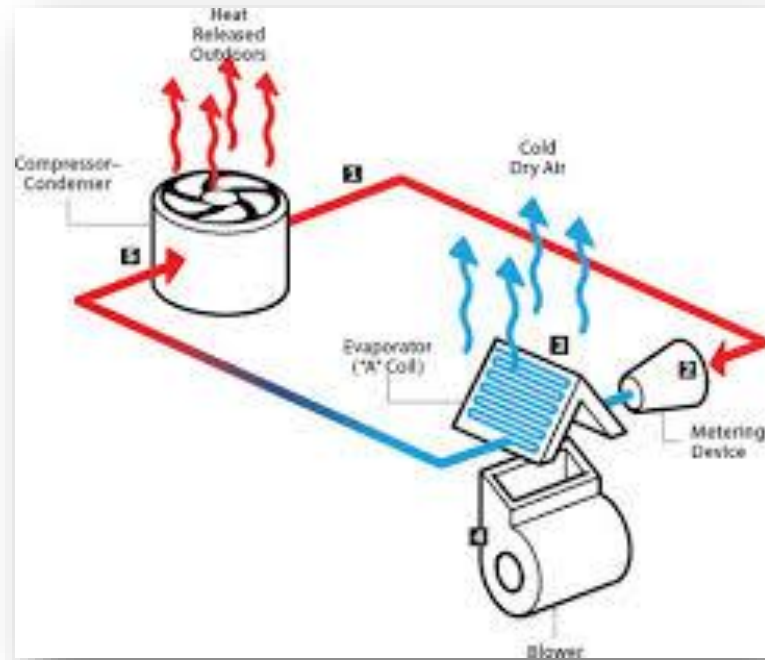
- **Compressor:** Compress refrigerant to raise the temperature and pressure, making it easier to reject heat from the refrigerant.
- **Condenser:** Rejects heat and changes the refrigerant vapor back into liquid.
- **Metering Device:** Regulates the flow of liquid refrigerant and allows evaporation to begin.
- **Evaporator:** Absorbs heat and changes the liquid refrigerant back into a vapor.

What about heat pumps?
Don't they run on unicorn farts
and pixie dust?!?



How Airflow Affects the Refrigeration Cycle

As air is passed over coils, heat is either absorbed or rejected. When airflow is not adequate, this transfer is negatively affected.



The Refrigeration Cycle

Low Airflow Across the Evaporator Coil

Low Airflow Evaporator Coil

- There is too little heat absorbed by the refrigerant.
- The refrigerant will not undergo a state change from liquid to gas.
- Liquid refrigerant will return to compressor damaging it, because compressors cannot compress liquid!
- The coil temperature will drop below the freezing point of water and any moisture will freeze further restricting airflow.

Causes of Low Airflow Across the Evaporator Coil

Low Airflow Evaporator Coil

- Dirty filter
- Return air too small
- Filter too dense
- Return air too small
- Dirty blower wheel
- Return air too small
- Dirty evaporator
- Return air too small
- Undersized supply air ducts
- Return air too small
- Obstructed grills and registers
- Return air too small

"A buildup of .042(1/20) inches of dirt on the heating or cooling coil can result in a decrease in efficiency of 21%." -**Environmental Protection Agency**

"1/8th of an inch of dirt and dust build-up on the blower wheel can reduce airflow by up to 30%" -**Texas A&M Study**

Low Airflow Across the Condenser

Low Airflow Condenser

- There is too little heat rejected from the refrigerant.
- The refrigerant will have too high of a heat content to properly absorb heat from the inside of the home.
- Pressures on the compressor will rise, causing damage.
- Prolonged operation will cause compressor failure.
- Discharge line temperature should not exceed 225°

Low Airflow Across the Condenser (continued)

Causes of Low Air Flow Across the Condenser

- Dirty condenser coil
- Condenser entering air blocked by debris
- Damaged fins exposed to hail
- Installed too close to the wall or other units
- Fan blade set improperly, too high or too low or wrong direction of rotation
- Replacement fan blade incorrect wrong pitch or direction

Getting the Right Amount of Airflow

Measuring External Static Pressure

- To properly check the air flow, an instrument like a manahelic or manometer is needed to measure the E.S.P. (external static pressure) of the system while it is operating.
- Two readings are necessary; one after the filter in the return air and one before the coil, in gas furnace installations, and between the filter and blower, and in the supply plenum in air handler installations..



Getting the Right Amount of Airflow (continued)

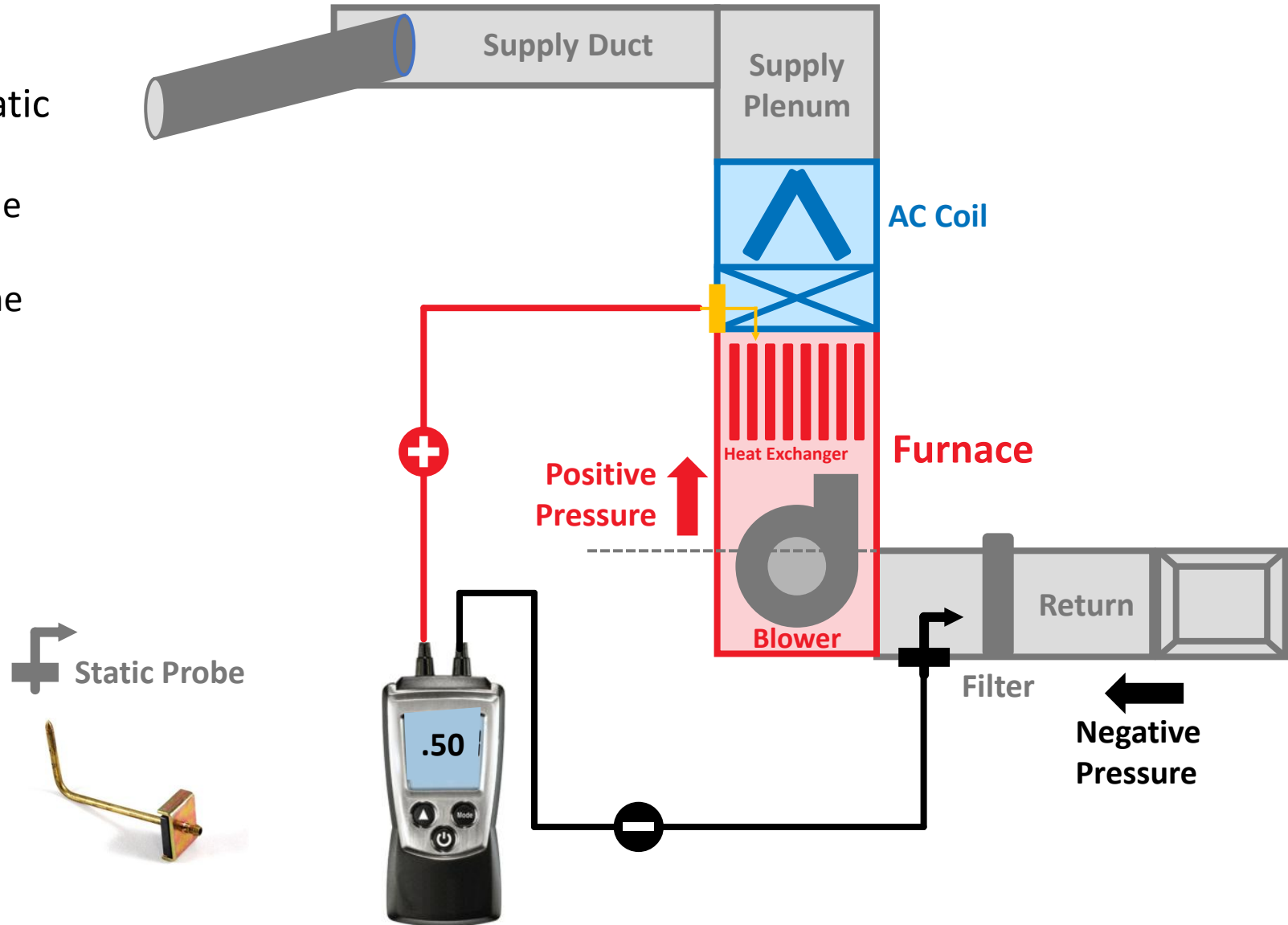
Measuring External Static Pressure

- The difference between the two numbers is the E.S. P. The measured E.S.P needs to be close to what the manufacturer recommends on their Blower Performance Chart for that particular unit.
- Most manufacturers size the CFM capacity of the blower based on one half (0.5 IWC) inches of water column.



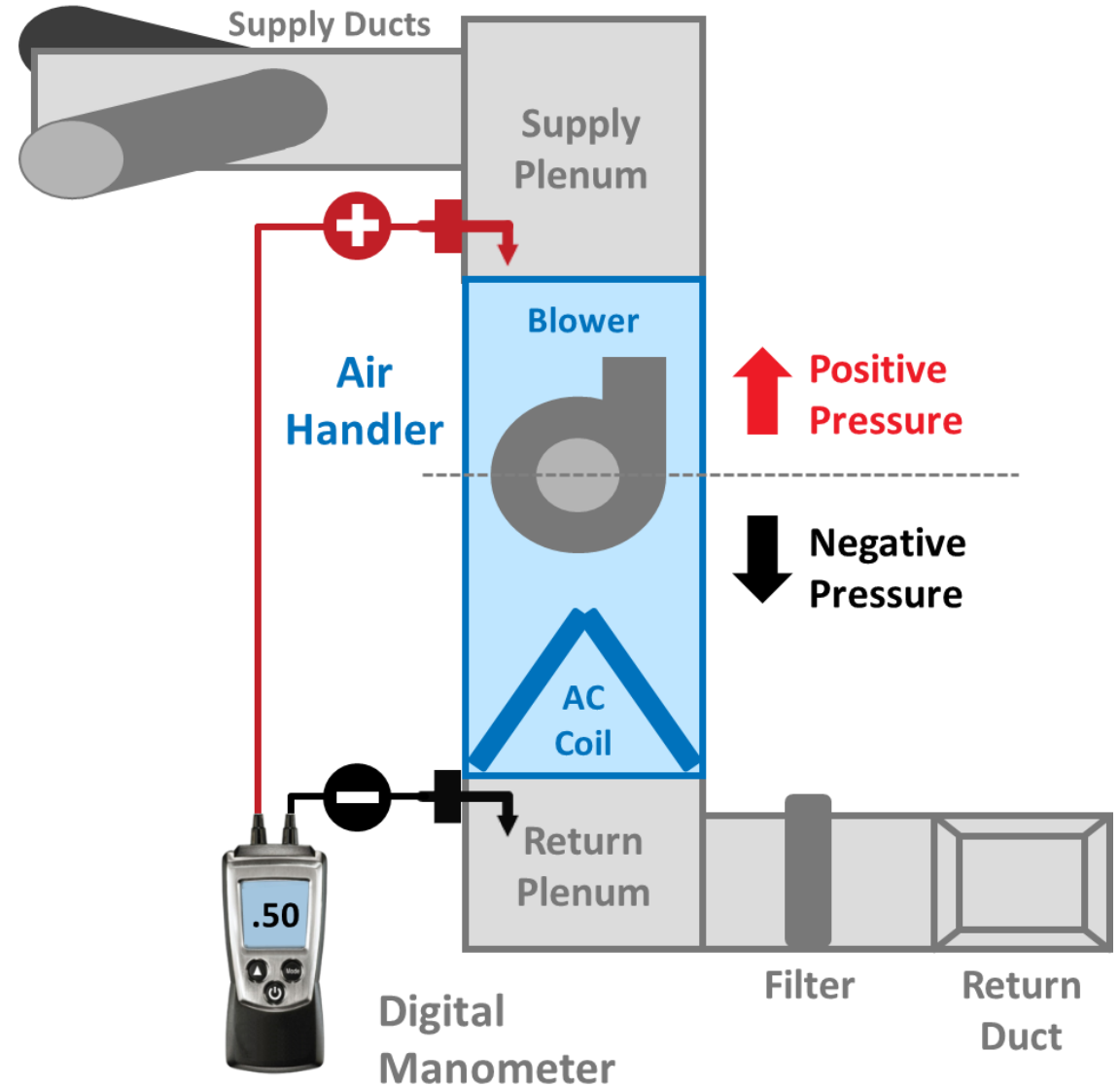
Static Pressure | Gas Furnace and AC Coil

- The design static of most furnaces is 0.5 inches water column.
- Use a manometer to measure the static pressure of the furnace only.
 - Supply side is measured between the heat exchanger and evaporator coil.
 - Return side is measured between the blower wheel and filter.



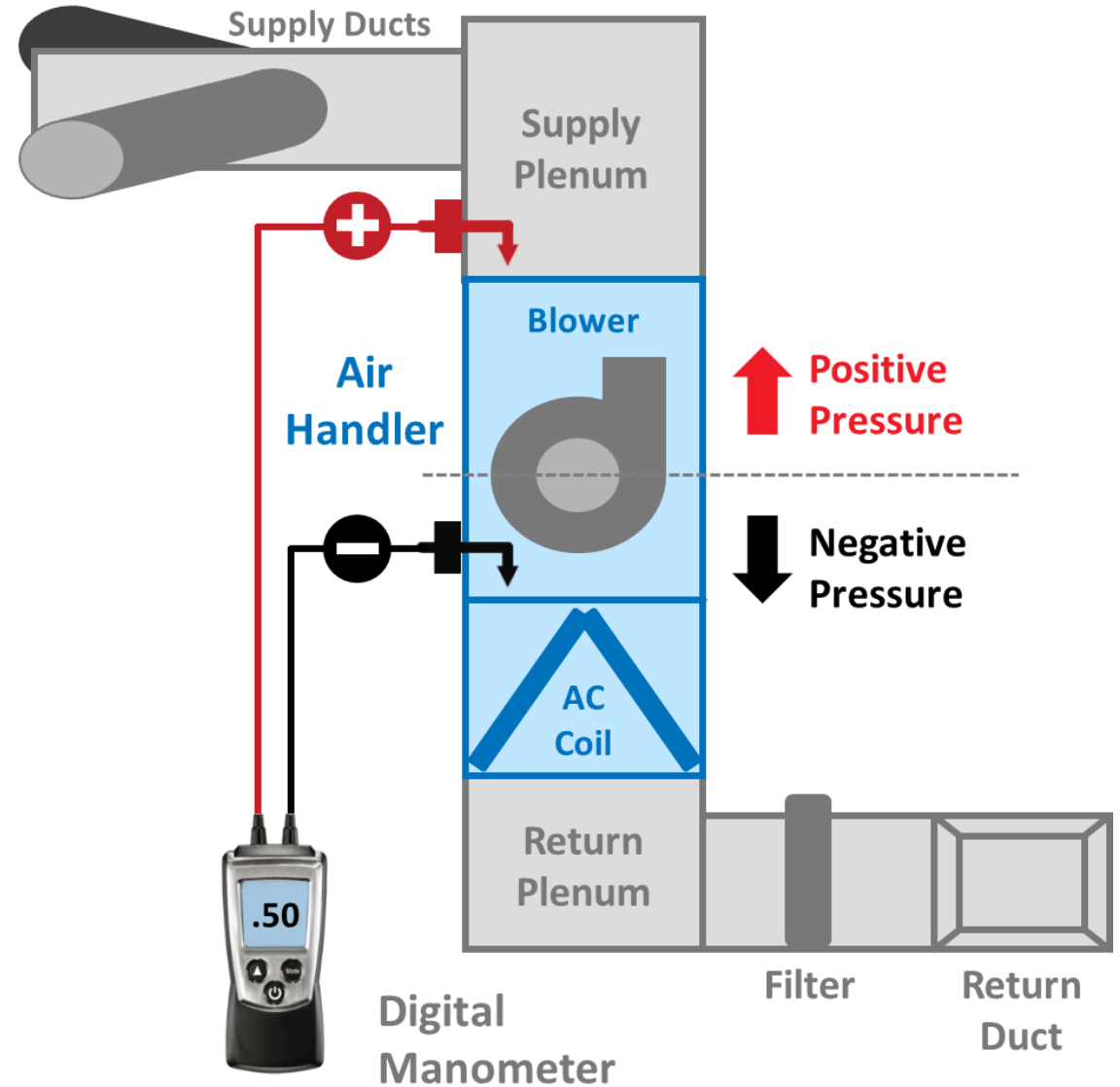
Static Pressure | Single Piece Air Handler

- On a single piece air handler, the evaporator coil has been installed at the factory and is already considered in static pressure calculation.
- Use a manometer to measure the static pressure of the air handler only.
 - Measure static pressure of the supply duct at the outlet of the air handler.
 - Measure the static pressure of the return duct at the inlet of the air handler.



Static Pressure | Two Piece Air Handler

- On a two-piece air handler, the evaporator coil is not part of the air handler so it must be not considered in calculating the static pressure.
- Use a manometer to measure the static pressure of the air handler's blower assembly only.
 - Measure the static pressure of the supply duct at the outlet of the unit.
 - Measure the static pressure between the outlet of the evaporator coil and the inlet of the air handler.



Airflow Must be Correct Before Checking Refrigerant Pressures to Determine if the Charge is Correct!

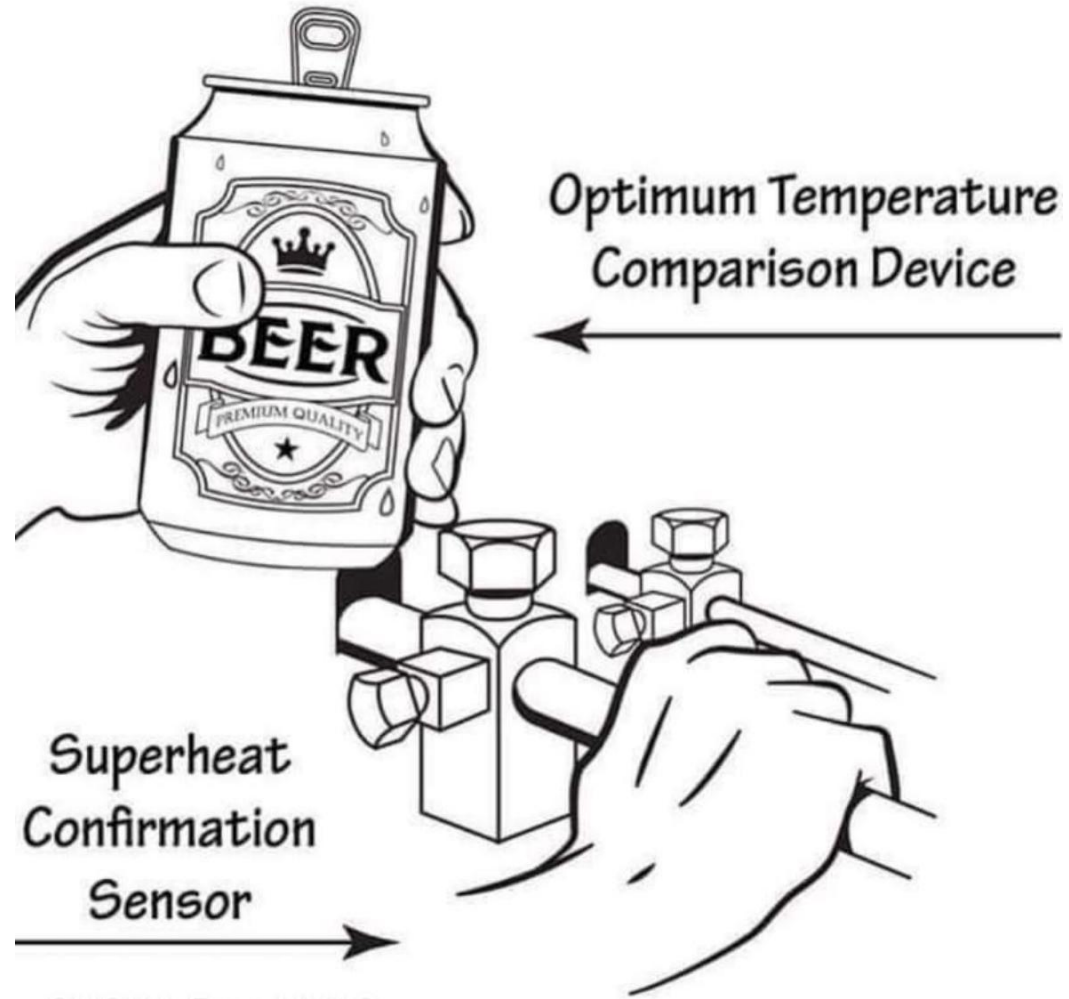
Make sure return air grille is large enough to move 400 CFM/Ton

HOW TO SIZE RETURN GRILLES

Filter Grilles
Width x Height x 2

Flat Grilles
Width x Height x 2.5

Superheat and Subcooling



SUCKA Free HVAC

Superheat

- Superheat is defined as the temperature of refrigerant vapor above its saturation temperature. Superheat takes place in the evaporator and is determined by subtracting the saturation temperature (gauge temperature) from the actual suction line temperature. Superheat is measured at the suction line.

$$\begin{array}{r} \text{Suction Line Temperature} \\ - \text{Saturation Temperature (of Suction Line)} \\ \hline \text{Superheat} \end{array}$$

Superheat (continued)

What happens with the wrong amount of Suction Line Superheat?

- Too little or too much superheat upsets the balance of a system and prevents it from performing as it should.
- The correct amount of superheat means that all of the liquid refrigerant has evaporated in the evaporator.
- Not enough superheat means the refrigerant returning to the compressor through the suction line may allow liquid refrigerant to enter the compressor and cause damage.

Subcooling

- Subcooling is defined as the temperature of refrigerant liquid below its saturation temperature. Subcooling takes place in the condenser and liquid line and is determined by subtracting the saturation temperature (gauge temperature) from the actual liquid line temperature. Subcooling is measured at the Liquid Line.

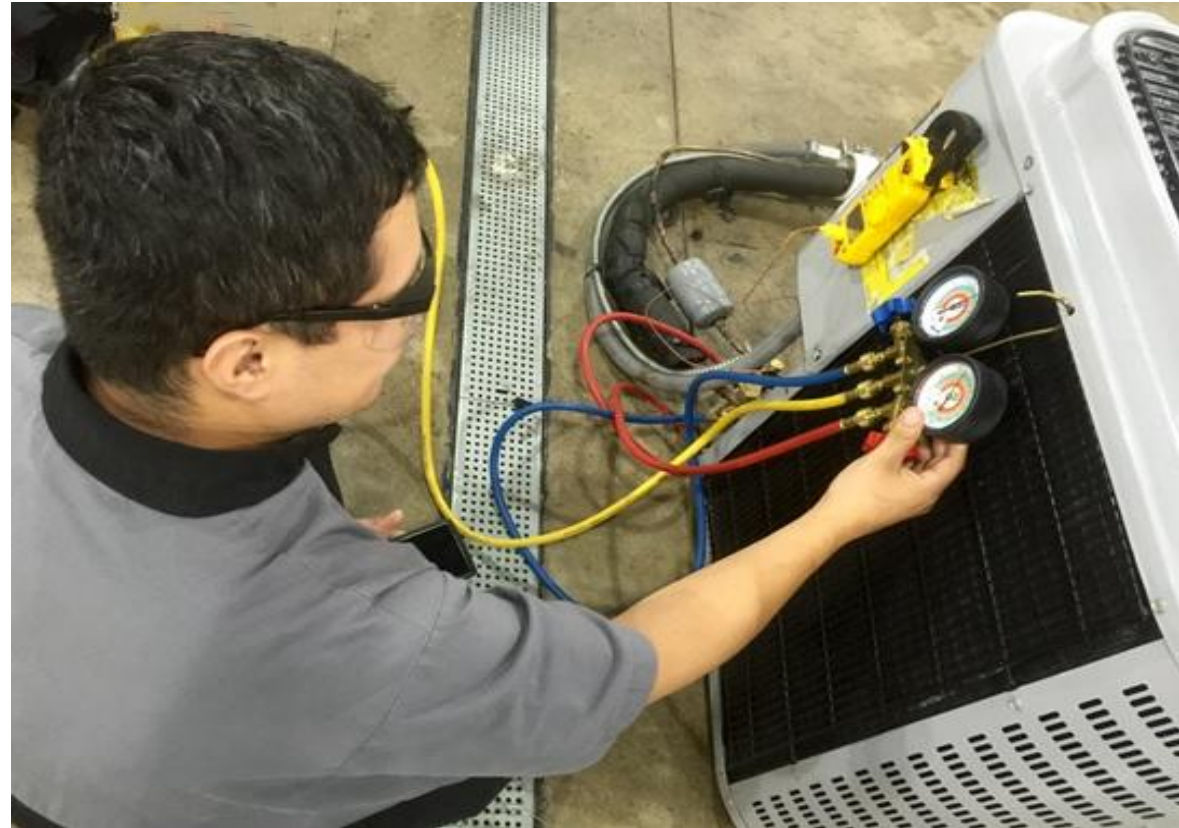
$$\begin{array}{r} \text{Liquid Line Temperature} \\ - \text{Saturation Temperature (of Liquid Line)} \\ \hline \text{Subcooling} \end{array}$$

Subcooling (continued)

What is Subcooling and why do we need it?

- A properly operating condenser will convert the superheated vapor into a liquid and will cool it a few degrees more before it enters the liquid line.
- All air conditioning systems require 100% liquid entering their metering device.

Basic System Charging



Superheat and Subcooling

Charging Different Refrigerant Types and Systems

1. When charging a system, the first thing you must ascertain is what type of refrigerant does your system use.
2. There are many types of refrigerants, the refrigerant type will generally be identified on the data plate or on the body of the compressor.

Air Flow Must be Correct Before Charging

Basics...

- Correctly sized returns!
- Filters clean and not too restrictive?
- Evaporator coil clean?
- Blower wheel clean?
- Registers open?
- Correct airflow setup?



Poor Air Flow



Dirty Evaporator



Dirty Blower Wheel



Leave them open

Superheat and Subcooling

Refrigerant Charging Methods

- Installer's Weighing Method
- Technician's Superheat Method
- Technician's Subcooling Method

Refrigerant Charging Methods (continued)

Weighing Method

This method is used during installation of all types of systems.

- 1. Check manufacturers information for proper amount of refrigerant trim charge per/ft of additional line length.*
- 2. Using a digital refrigerant scale, add or recover refrigerant based on your calculations.*



Superheat and Subcooling

Refrigerant Charging Methods (continued)

Weighing Method

Example:

How much additional charge is needed on a system with 3/8" liquid line that has a total length of 50 feet?

50 minus 15 = 35 feet

35 feet X .6 ounces = 21 ounces



Superheat and Subcooling

Identifying Whether to Use Superheat or Subcooling

Superheat

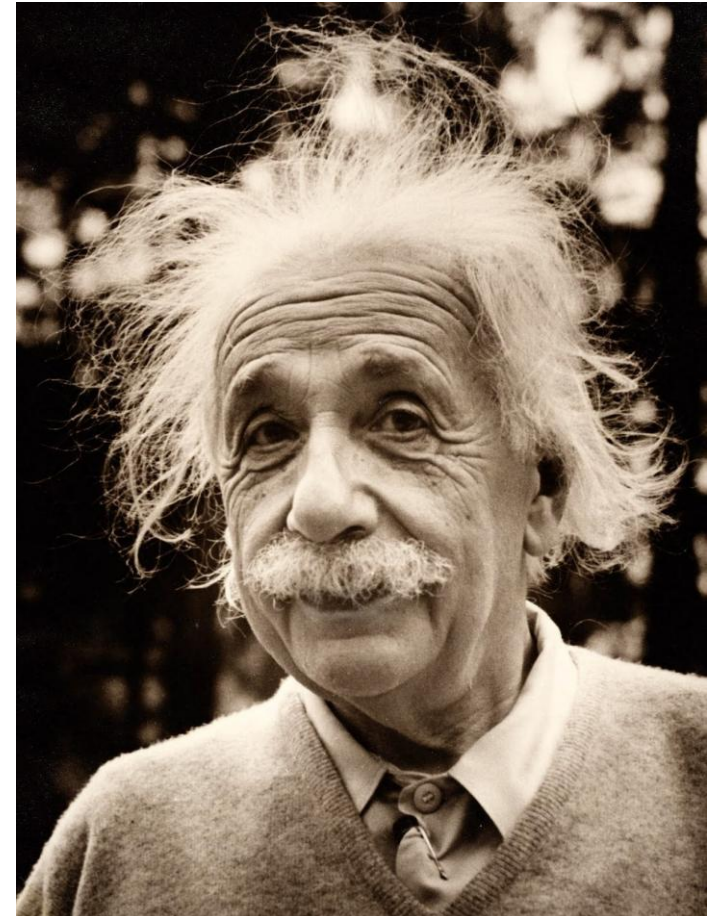
- Units that have fixed orifice metering devices.
- You should always check superheat even when the unit is required to be charged with subcooling.

Subcooling

- Units with TXV or EEV must be charged with subcooling.
- You should always check superheat even when the unit is required to be charged with subcooling.

You are a scientist!

Start acting like it!



**YOUR NANA IN HEAVEN
WATCHING YOU DUMP
REFRIGERANT ON EVERY INSTALL**



Thank You For Attending

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