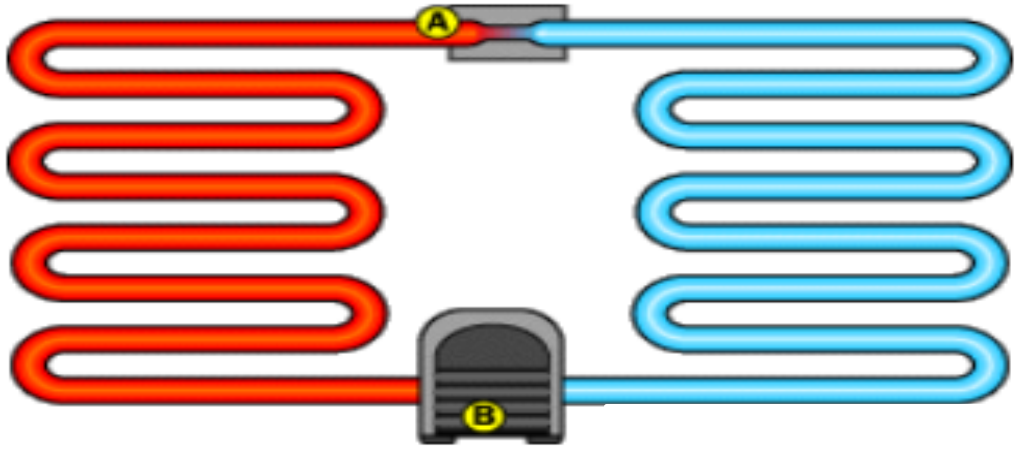
TPC

Welcome

To a Free Public Webinar

Measurement Tools for the HVAC Technician and How to Use Them



Presented by: Bob Robinson, TPC Instructor

Heat Transfer

Air Conditioning and Refrigeration is the transfer of heat from a place it is not wanted to a place that makes little or no difference.

- ***Air Conditioning:***
  Cools people (comfort cooling)

- ***Refrigeration:***
  Cools products

Thermodynamics/Principles of Refrigeration

- Warm moves to cool (2nd law of thermodynamics)
- High Pressure moves to Low Pressure
- Heat must be added or removed from a substance for a change in temperature to take place (Sensible Heat)
- Heat must be added or removed from a substance for a change of state to take place (Latent Heat)

Component Tasks

- **Transfer heat:**
  Heat exchangers, coils, terminal units
- **Move refrigerant (R-11, R-12, etc.):**
  Compressors, refrigerant piping
- **Move or distribute air:**
  Fans, ductwork, air handlers

Thermodynamics

The amount of HEAT in the material

determines the STATE of the matter

- **Heat**

  The amount of energy in the matter

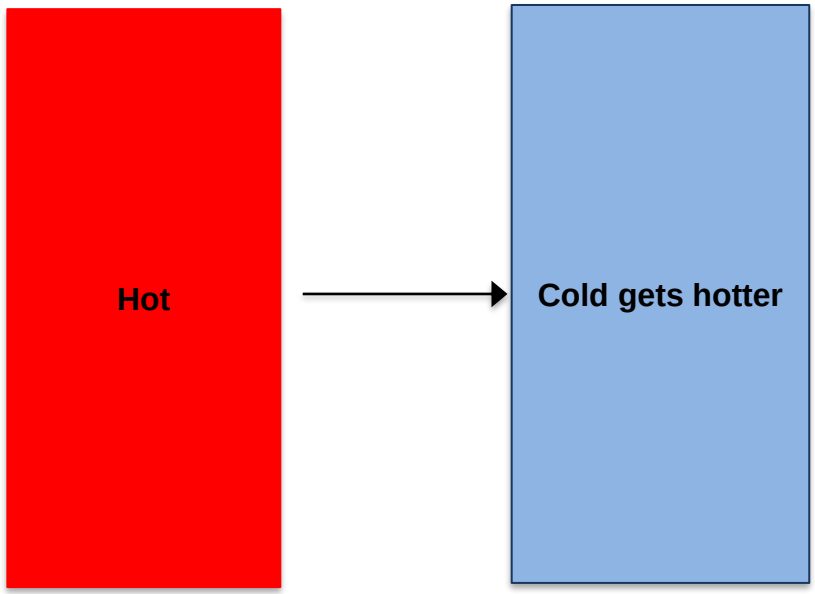
- **Energy**

  The capacity for doing work

Thermodynamics

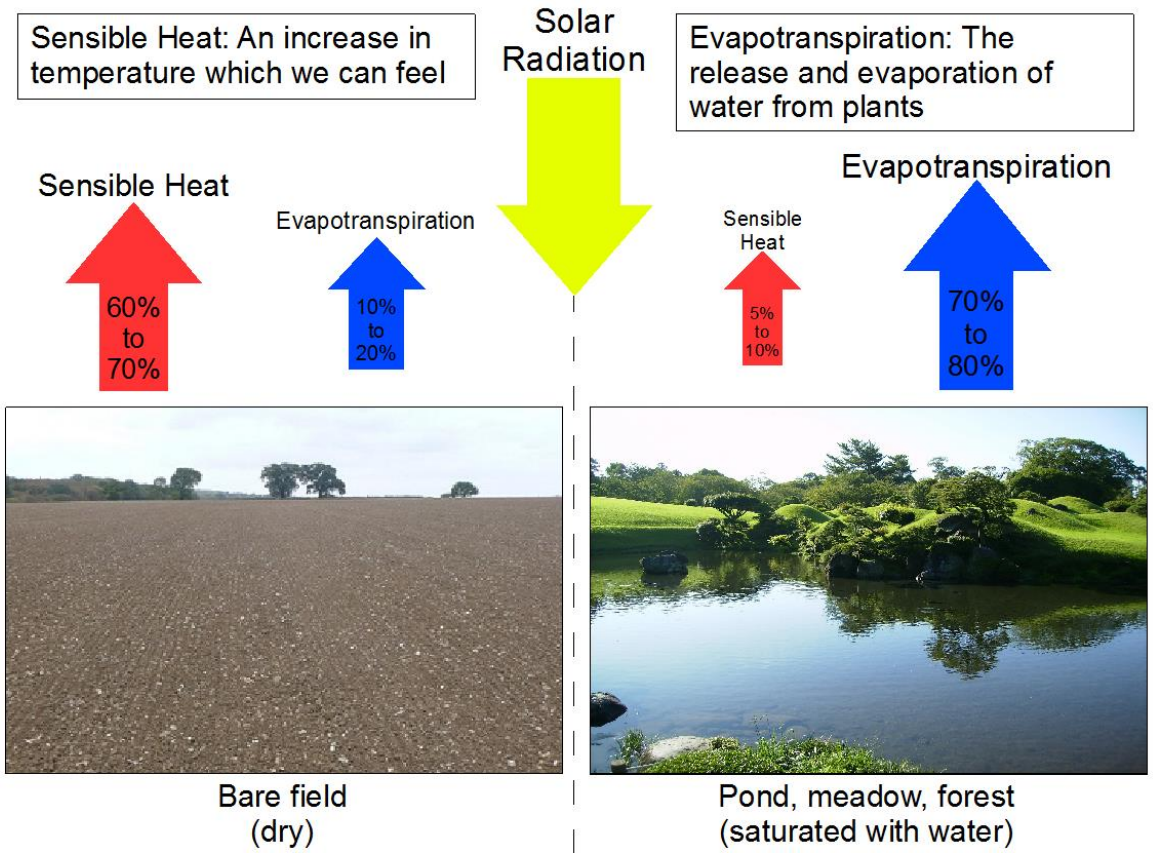
The Second Law of Thermodynamics

“Heat flows from a warmer place to a cooler place”



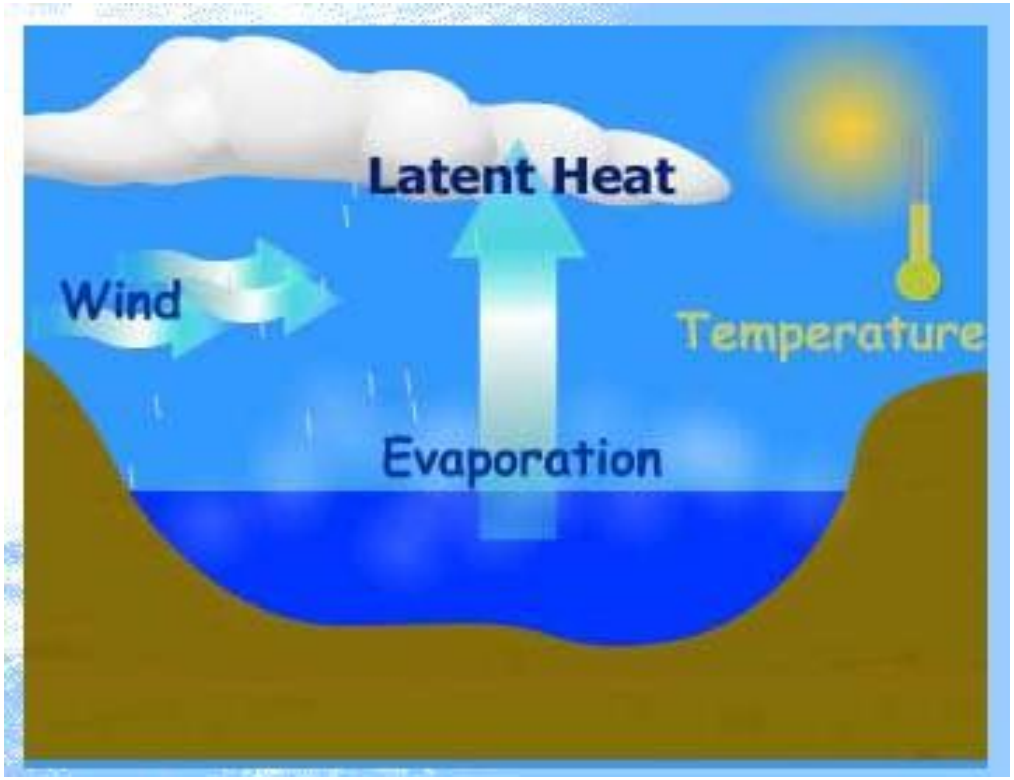
Sensible Heat

Heat added or removed that causes a change in temperature is called sensible heat

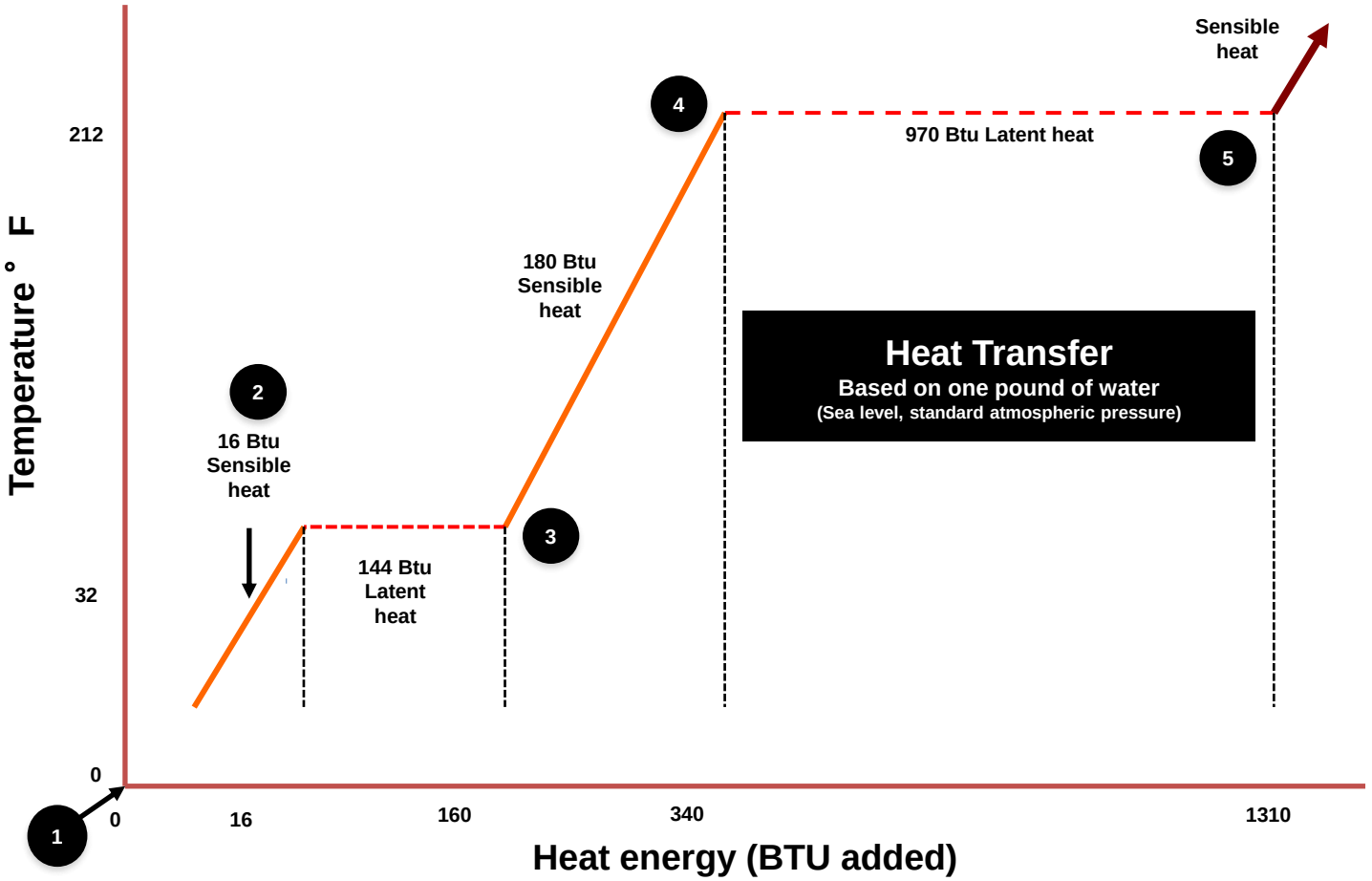


Latent Heat

Heat added or removed that causes a change of state is called latent heat



Heat Transfer



Heat Transfer

- **Superheat**

  Heat added to a vapor, causing an increase in temperature

- **Saturation**

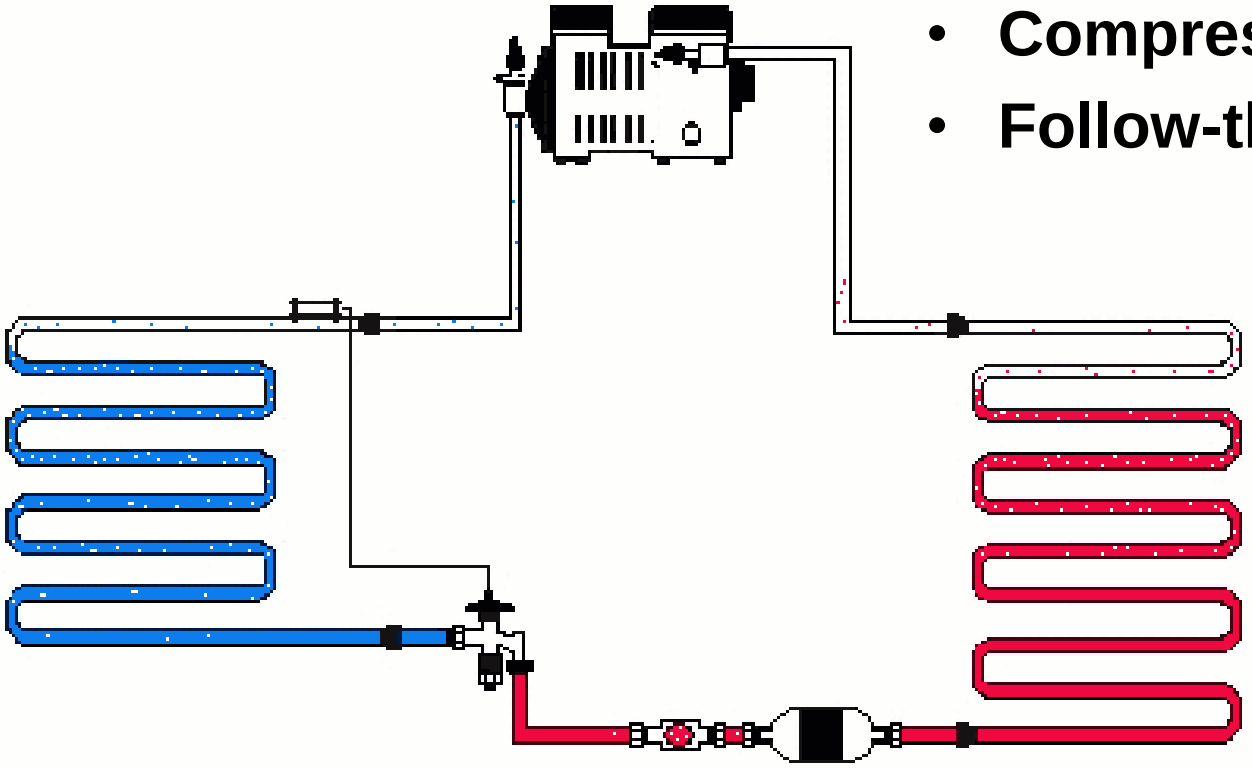
  The point at which a substance can not accept or reject heat without changing state

Pressure - Temperature

- **Pressure / vacuum affects the saturation, vaporization, and condensation temperatures**
- **Pressure increase = saturation (boiling point) increase**
- **Pressure decrease = saturation (boiling point) decrease**

The pressure of a liquid determines its boiling (saturation) temperature

Compression Refrigeration Cycle

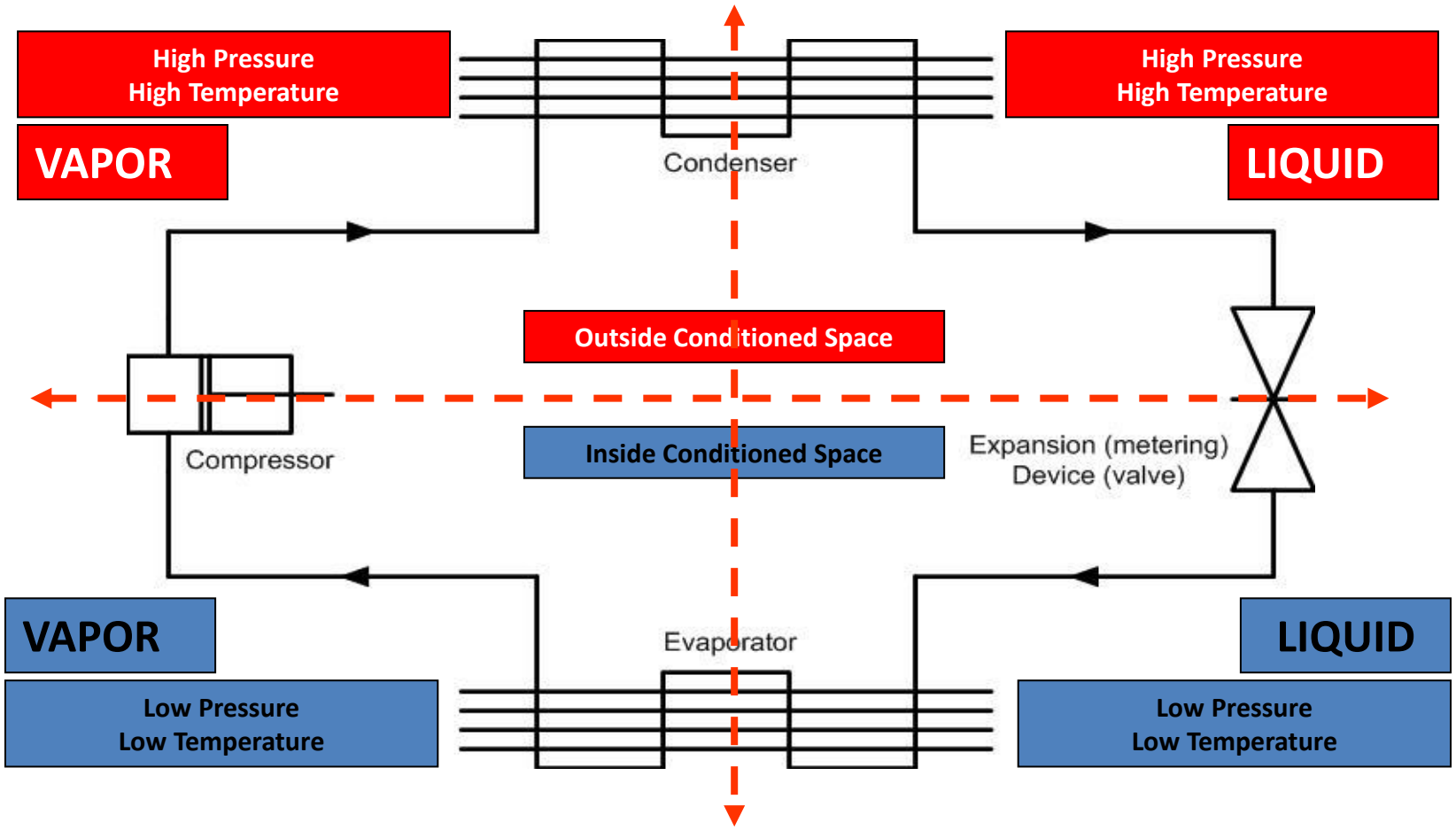


- Refrigeration
- Compression Cycle Theory
- Follow-the-Heat ™

Four Major Components

- **Evaporator – to remove the heat from the conditioned space or process**
- **Compressor – to pump and pressurize the refrigerant**
- **Metering (expansion) device – to change high-pressure refrigerant to low- pressure refrigerant**
- **Condenser– to remove the heat from the conditioned space or process**

Refrigeration Cycle



AC/R System Service Tools

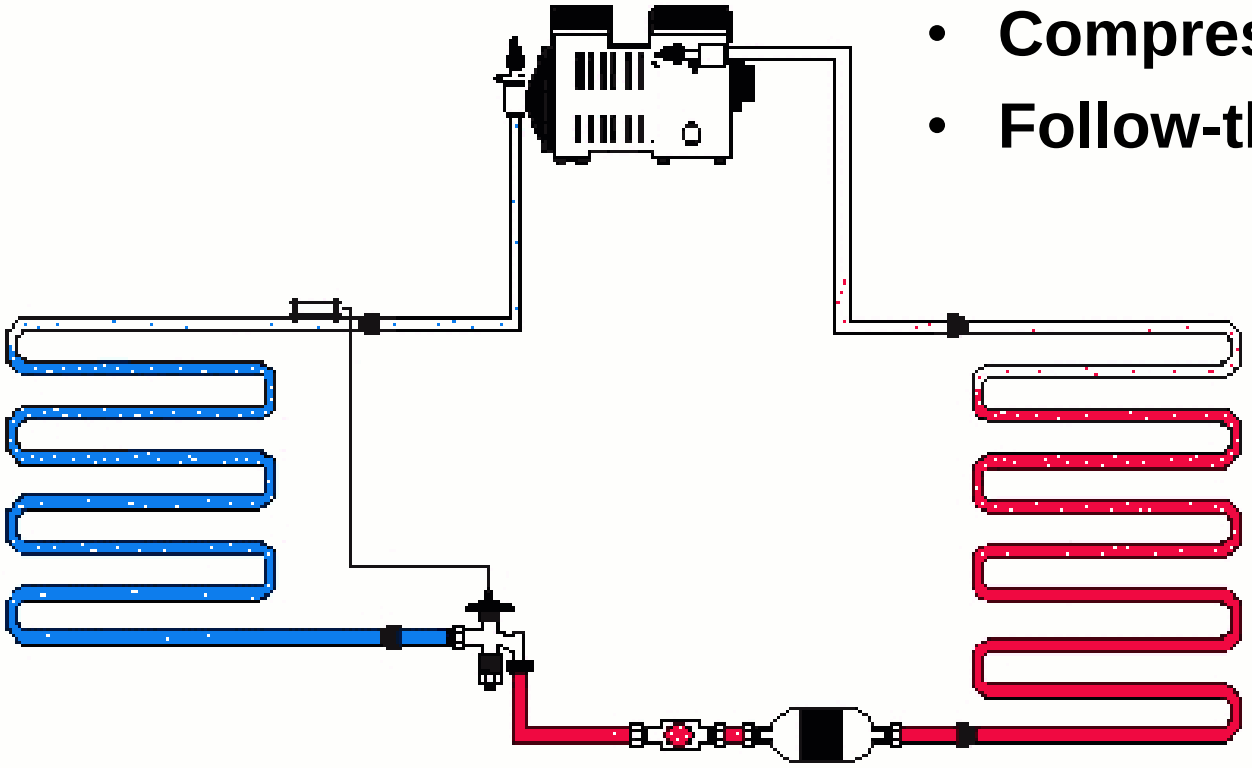
- Manifold Gauge Set (Basic refrigerant circuit)
- Psychrometrics (Study of Air)
- System Pump Down (Recovery Equipment)
- System Evacuation (Vacuum Pump)

Manifold Gauge Set

Digital Gauge Set

- Can read temperatures
- Superheat/Sub-cooling
- Pressures
- Refrigerant Connections
- Temperature clamps

Compression Refrigeration Cycle



- Refrigeration
- Compression Cycle Theory
- Follow-the-Heat ™

Temperature/Pressure Chart

R-22 Temp. & Pressure Chart

TEMP	R22	TEMP	R22	TEMP	R22
-60	12.0 *	17	39.8	46	77.6
-55	9.2 *	18	40.8	47	79.1
-50	6.2 *	19	41.9	48	80.7
-45	2.8 *	20	43.0	49	82.4
-40	0.5	21	44.1	50	84.0
-35	2.6	22	45.3	55	92.5
-30	4.9	23	46.4	60	101.6
-25	7.4	24	47.6	65	111.2
-20	10.1	25	48.7	70	121.4
-15	13.2	26	49.9	75	132.2
-10	16.5	27	51.1	80	143.6
-5	20.0	28	52.4	85	155.6
0	24.0	29	53.6	90	168.4
1	24.8	30	54.9	95	181.7
2	25.6	31	56.2	100	195.9
3	26.4	32	57.5	105	210.7
4	27.3	33	58.8	110	226.3
5	28.2	34	60.1	115	242.7
6	29.1	35	61.5	120	259.8
7	30.0	36	62.8	125	277.9
8	30.9	37	64.2	130	296.7
9	31.8	38	65.6	135	316.5
10	32.8	39	67.0	140	337.2
11	33.7	40	68.5	145	358.8
12	34.7	41	69.9	150	381.4
13	35.7	42	71.4	155	405.0
14	36.7	43	72.9		
15	37.7	44	74.5		
16	38.7	45	76.0		

* = Inches of Vacuum

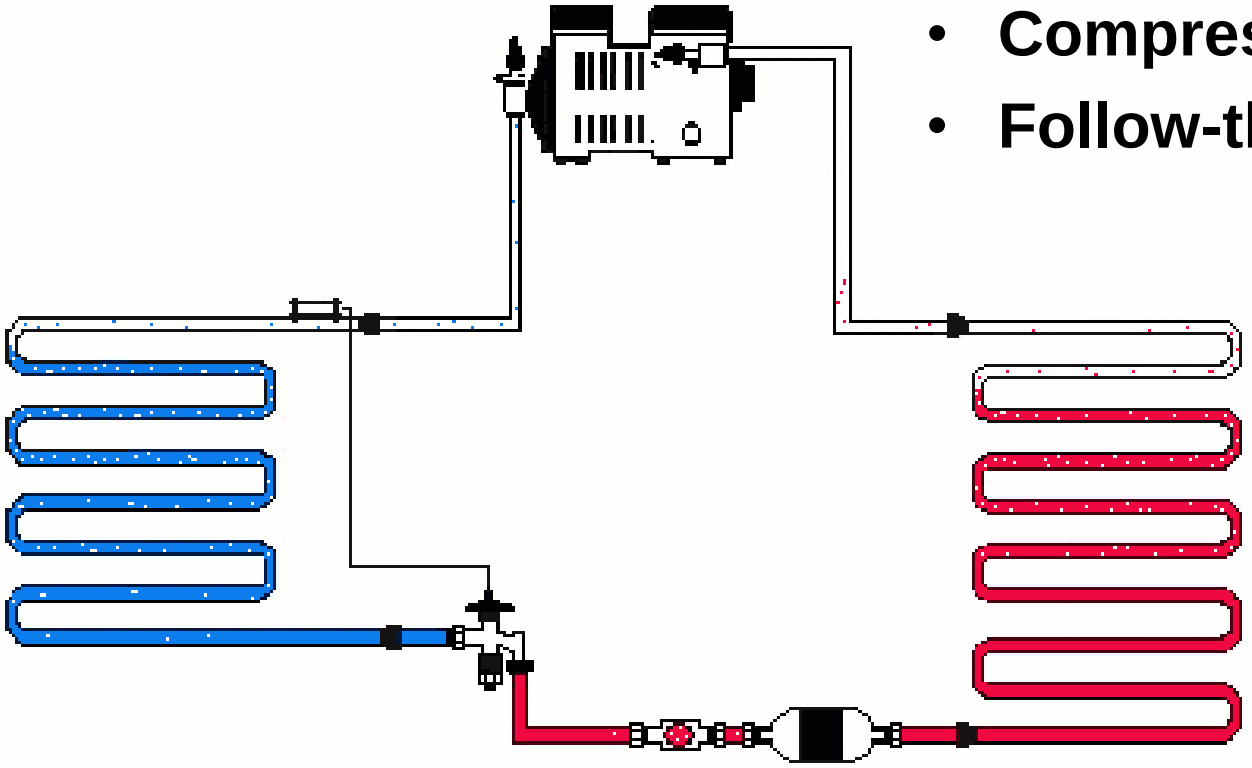
R-410A Temp. & Pressure Chart

TEMP	R410	TEMP	R410	TEMP	R410
-60	1.2	16	71.7	44	127.3
-55	3.4	17	73.3	45	129.7
-50	5.8	18	75.0	46	132.2
-45	8.6	19	76.6	47	134.6
-40	11.6	20	78.3	48	137.1
-35	14.9	21	80.1	49	139.6
-30	18.5	22	81.8	50	142.2
-25	22.5	23	83.6	55	155.5
-20	26.9	24	85.4	60	169.6
-15	31.7	25	87.3	65	184.6
-10	36.8	26	89.1	70	200.6
-5	42.5	27	91.0	75	217.4
0	48.6	28	92.9	80	235.3
1	49.9	29	94.9	85	254.1
2	51.2	30	96.8	90	274.1
3	52.5	31	98.8	95	295.1
4	53.8	32	100.8	100	317.2
5	55.2	33	102.9	105	340.5
6	56.6	34	105.0	110	365.0
7	58.0	35	107.1	115	390.7
8	59.4	36	109.2	120	417.7
9	60.9	37	111.4	125	445.9
10	62.3	38	113.6	130	475.6
11	63.8	39	115.8	135	506.5
12	65.4	40	118.0	140	539.0
13	66.9	41	120.3	145	572.8
14	68.5	42	122.6	150	608.1
15	70.0	43	125.0	155	645.0

Thermometer/Psychrometer

- **Probes**
- **Strap on Sensors**

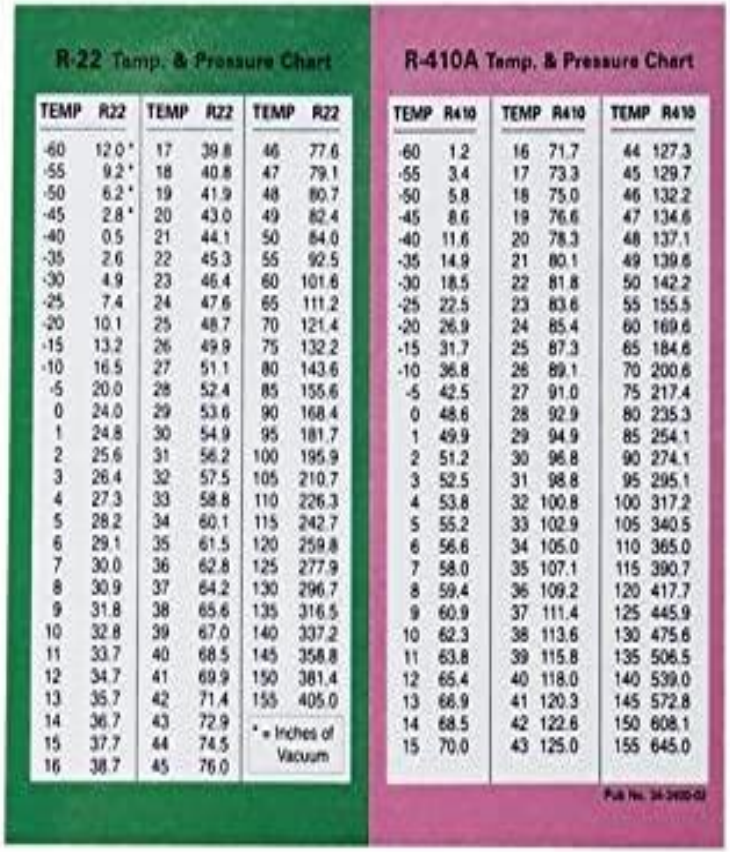
Compression Refrigeration Cycle



- Refrigeration
- Compression Cycle Theory
- Follow-the-Heat ™

Measuring Superheat

- Read and record the suction pressure
- Measure and record temperature with the digital thermometer at suction port
- Subtract the saturation temperature from suction line temperature. This is your Superheat



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-50	6.2*	19	41.9	48	80.7
-45	2.8*	20	43.0	49	82.4
-40	0.5	21	44.1	50	84.0
-35	2.6	22	45.3	55	92.5
-30	4.9	23	46.4	60	101.6
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10	32.8	39	67.0	140	337.2
11	33.7	40	68.5	145	358.8
12	34.7	41	69.9	150	381.4
13	35.7	42	71.4	155	405.0
14	36.7	43	72.9		
15	37.7	44	74.5	* = Inches of Vacuum	
16	38.7	45	76.0		

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-40	11.6	20	78.3	48	137.1
-35	14.9	21	80.1	49	139.6
-30	18.5	22	81.8	50	142.2
-25	22.5	23	83.6	55	155.5
-20	26.9	24	85.4	60	169.6
-15	31.7	25	87.3	65	184.6
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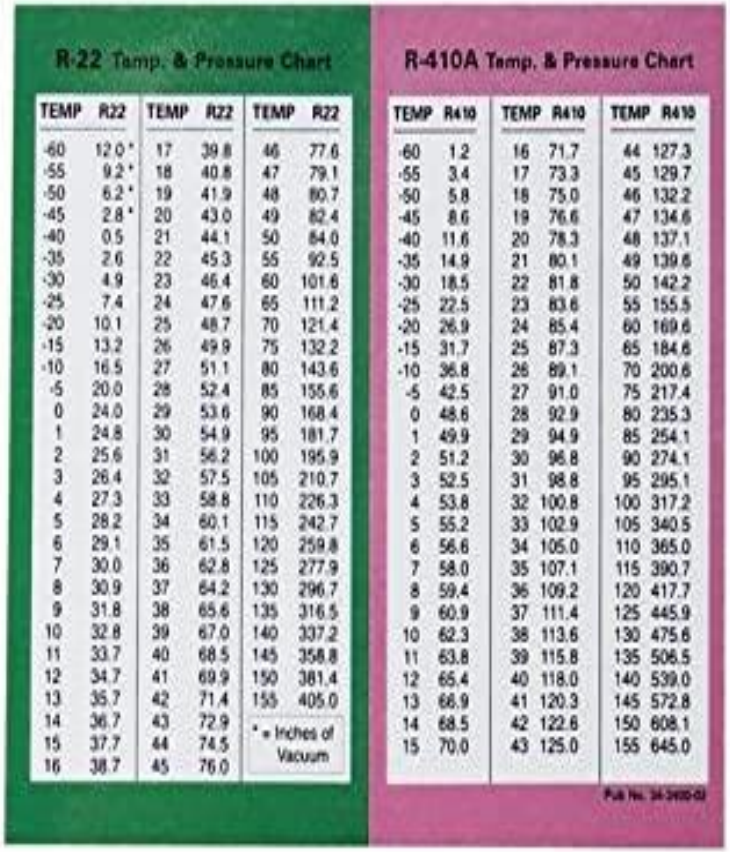
15	70.0	43	125.0	155	645.0

Measuring Subcooling

- Read and record the liquid pressure
- Measure and record temperature with the digital thermometer at liquid port
- Subtract the measured liquid line temperature from the saturation temperature. This is your Subcooling



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Psychrometrics

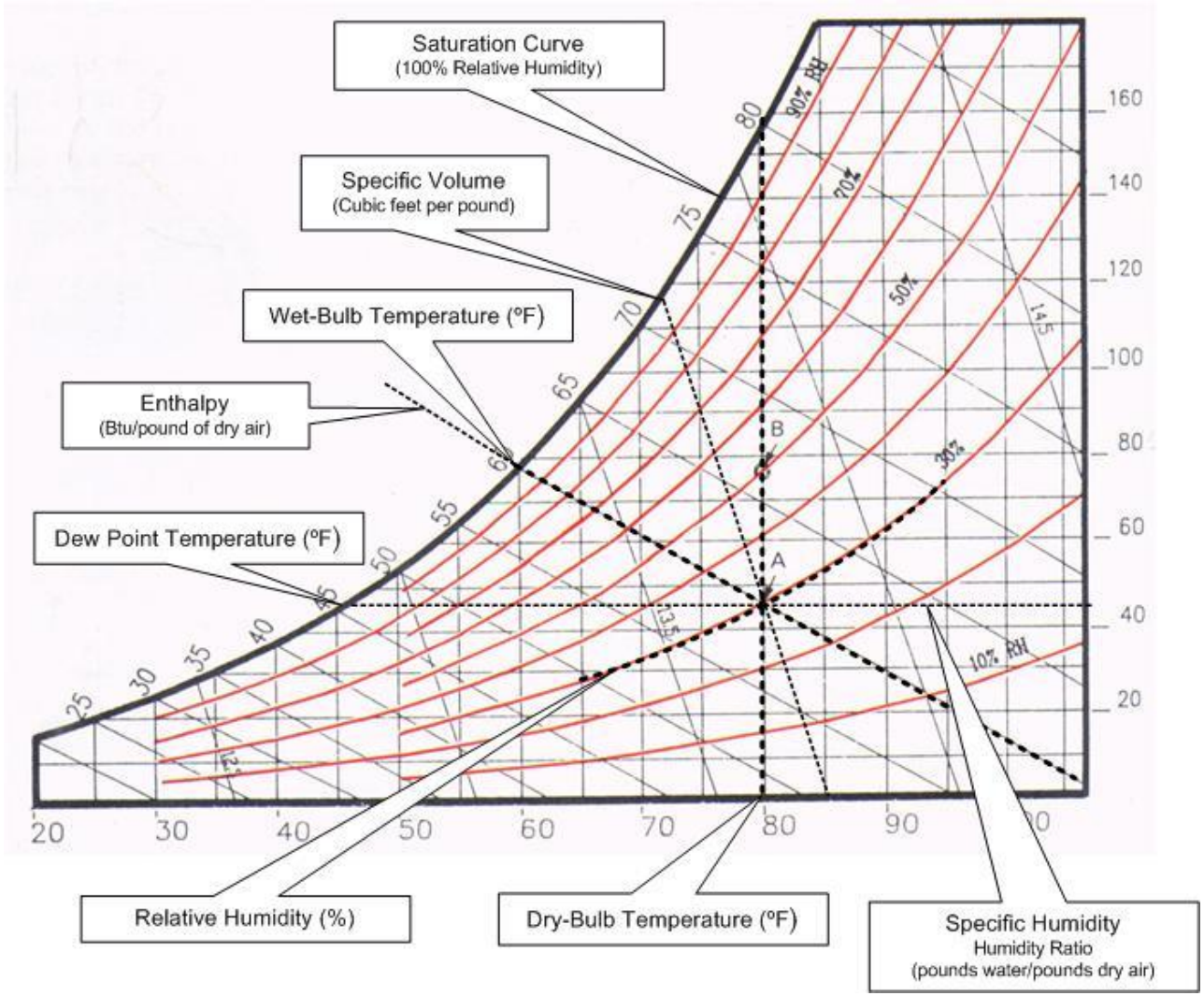
- **Dry-bulb temperature**
  - **The measured ambient air temperature without taking into consideration the moisture content of the air.**
- **Wet-bulb temperature**
  - **The measured ambient temperature taking into consideration the moisture content of the air. The wet-bulb thermometer is a standard thermometer with a cotton wick attached to the bulb.**

Psychrometrics

- **Enthalpy**
  - **Often referred to as heat content or total heat, enthalpy is the sum of the internal energy of a system and the product of its pressure and volume.**
  - **The enthalpy formula is h=u + pv where h is enthalpy, u is internal energy per unit mass, p is pressure, and v is volume.**

Sling Psychrometer

Psychrometric Chart



Fan Performance

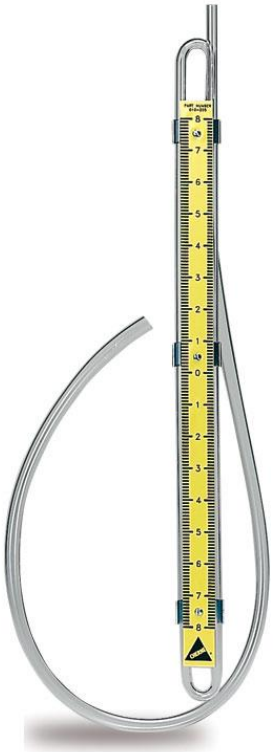
Pressure

- **Static pressure**
  pressure outward against duct walls
- **Velocity pressure**
  pressure moving through duct
- **Total pressure**
  sum of static and velocity pressures

Fan Performance

Pressure

- Measured in inches of water column (in wc)
- Varies by position of measurement in duct
- Use traversing procedure

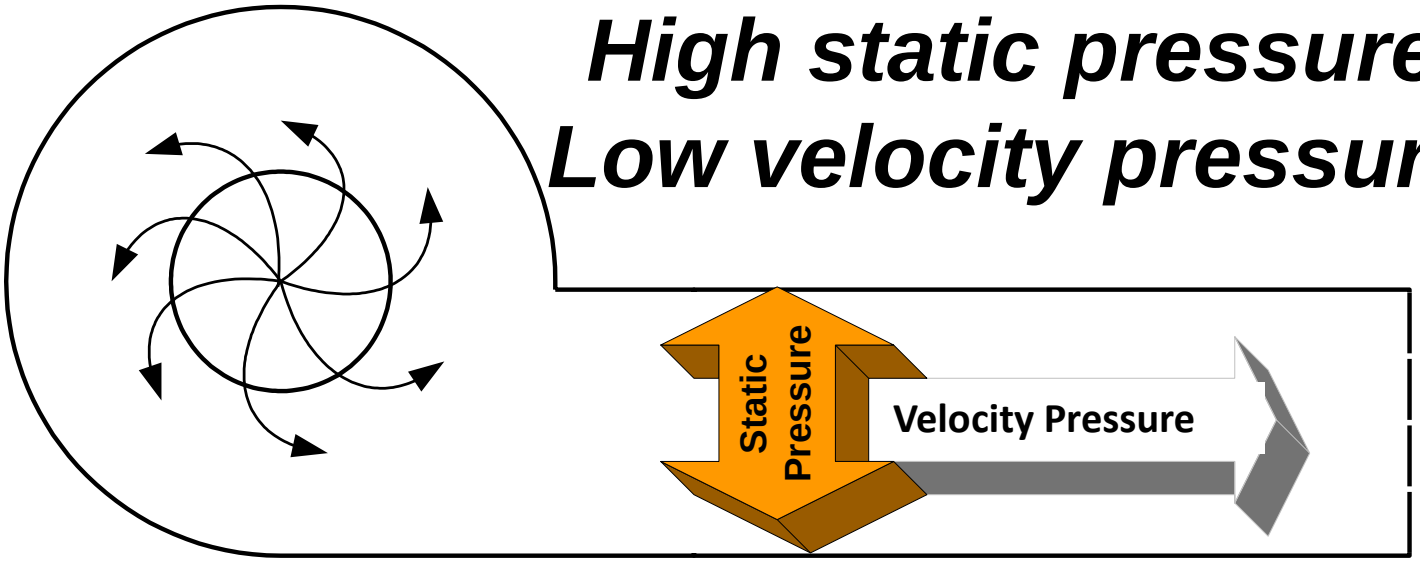


Air Flow Measurements

- **Measuring air-flow**
- **Static Pressure**

Fan Performance

Dampers Closed
High static pressure
Low velocity pressure



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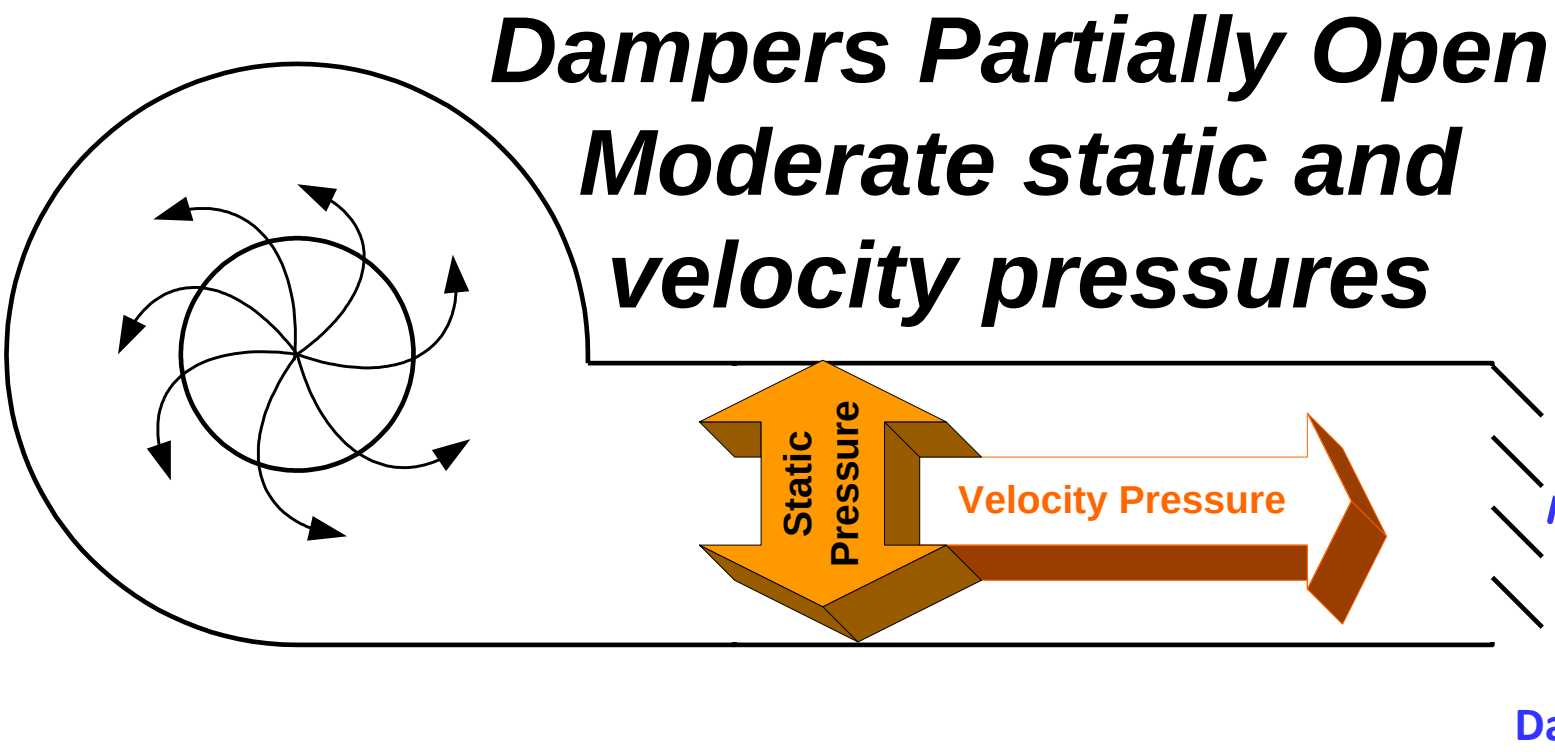

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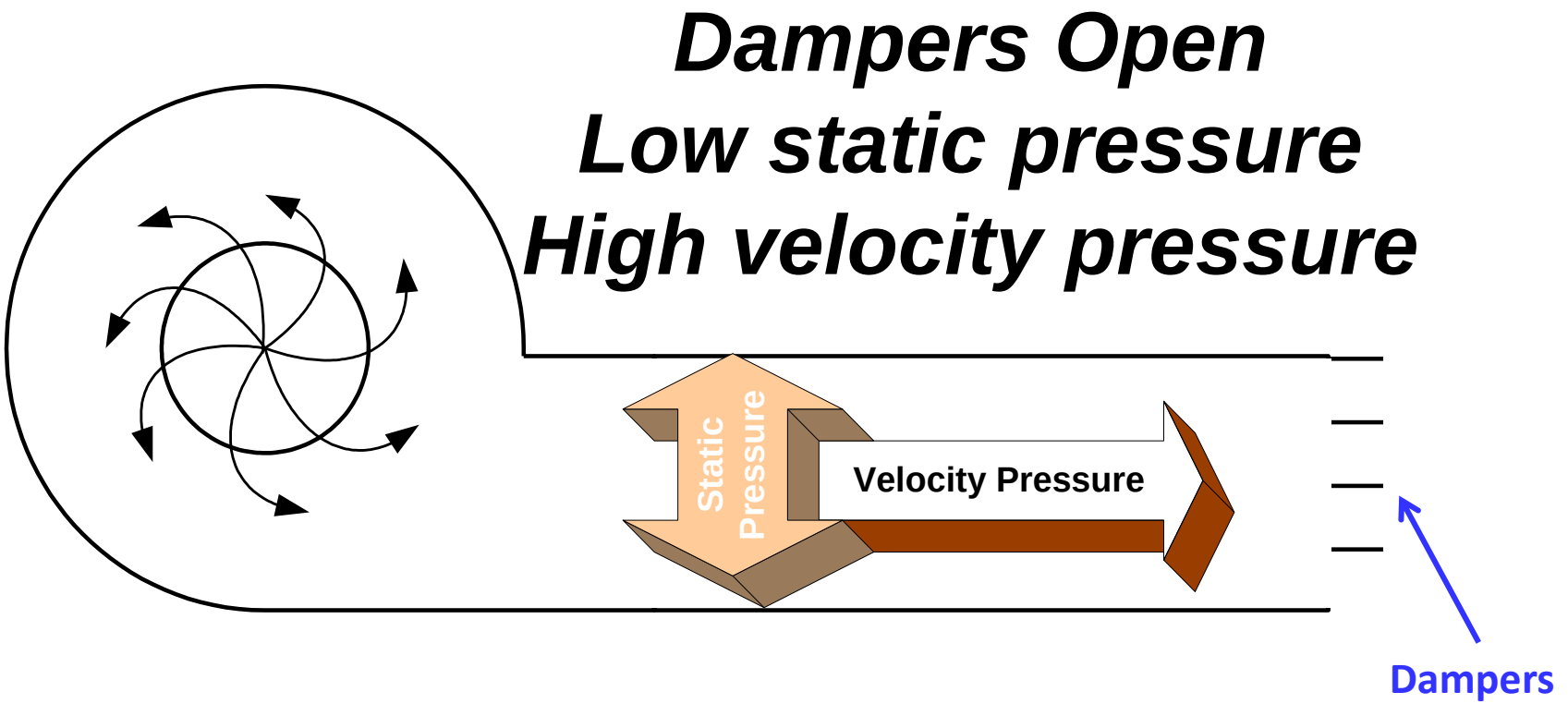

AC/R System Service

Pump Down

- Stores refrigerant charge in receiver
- System must still be recovered to remove any remaining vapor

AC/R System Service

System Evacuation

- Removes non-condensables
  - Air and moisture
- Dehydration
- Desired level is 500 microns

AC/R System Service

Vacuum Pump

- Single stage
- Two stage
- Piston pump
- Rotary vane pump

AC/R System Service

Vacuum Techniques

- Use short hoses
- Remove Schrader cores
- Use two vacuum pumps
- Use 3/8” hoses and fittings
- Use heat lamps
- Strike the compressor to dislodge moisture
- Deep vacuum is considered 500 microns
- Use micron gauge
- Triple evacuation method

AC/R System Service

Micron Gauge

Analog micron gauge

Electronic LED micron gauge

Digital micron gauge

Digital Micron Gauge

- A micron gauge is a must when vacuuming a system
- A deep vacuum, 500 microns or less is required on most new systems

AC/R System Service

Electronic Scale

Questions?

If you'd like to learn more about HVAC tools of the trade, TPC is here to help!

Phone: (847) 808-4000

Email: sales@tpctraining.com

Thank You & Work Safely!