Thermal Expansion Valves

Presented by:

Mike Milliman, Standard Motor Products & Gene Dianetti, Parker Hannifin

Introductions

A little information about the presenters.

Mike Milliman:

Senior Product Engineer for Standard Motor Products

Product Responsibilities include OEM & HD A/C components: driers, accumulators, TXV's, switches and other items.

Worked in Refrigeration and Air Conditioning industry for 28 years.

- 20 years with Parker Hannifin
- 4 years with Annex Manufacturing
- 4 years with SMP
- 18 years of exposure within TXV Engineering

Introductions

Gene Dianetti

Global Engineering Manager for Parker Hannifin Corp, Mobile Climate Systems Div.

Worked in Automotive, Refrigeration and Air Conditioning industry for 40 years.

- 36 years with Parker Hannifin
- 40 years of exposure within TXV design and application

Goal

The goal of us being here today is to provide information about Thermal Expansion Valves (TXV or TEV).

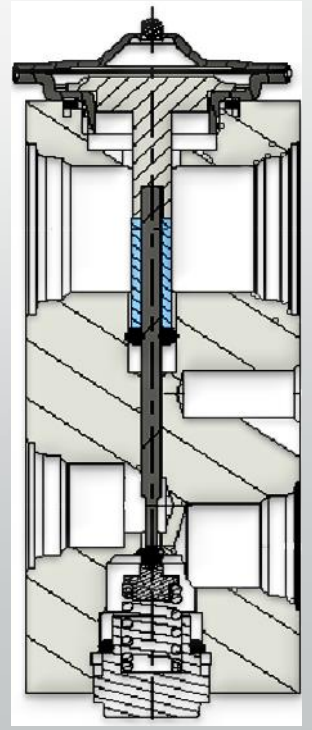
- Provide some Basic Principles
- Understand the Function and Purpose of TXV
- Gain knowledge about operations of a TXV
- Show some Types and Styles of TXV Valves
- Answer some questions about TXV's

Lets start with some basics

- Refrigerant is dependent on a temperature and pressure relationship.
- Refrigerant above its saturation pressure and temperature will change state or boil.
- There is more to an A/C system than just one component.
- All of the A/C components need to work together for better performance.

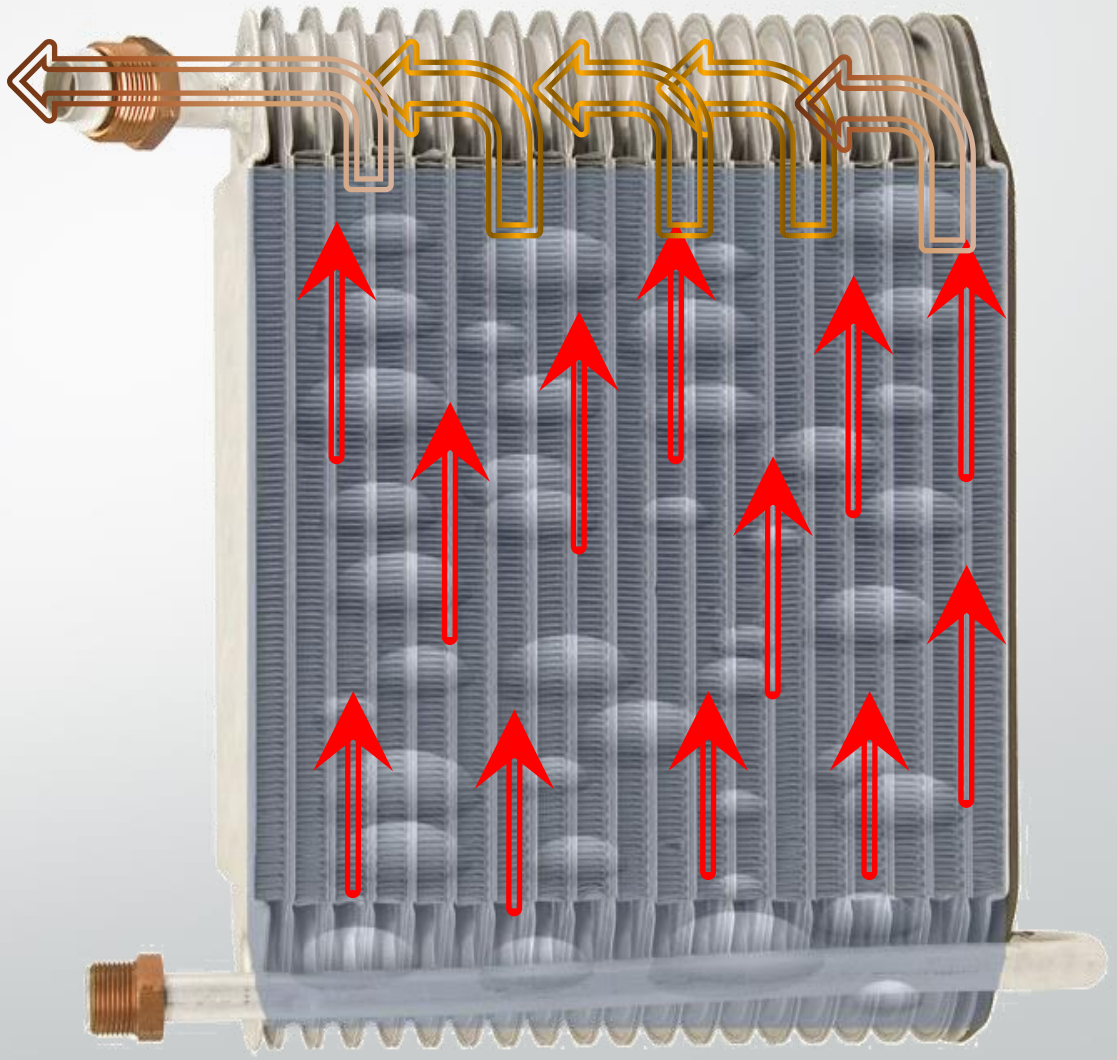
Basics - Expansion Devices

- Separates the high side from the low side of the system.
- Regulates the flow of liquid refrigerant to the evaporator.



Basics - Evaporator

- The TXV is dependent on the evaporator to exchange heat
- The Ideal State in the Evaporator is Full of Refrigerant
  Just Changing State (Boiling)
  32-38° = Maximum Thermal Efficiency



Basics - Compressor

Compressor Slugging Must be Avoided

- Liquid Refrigerant Cannot Exit Evaporator

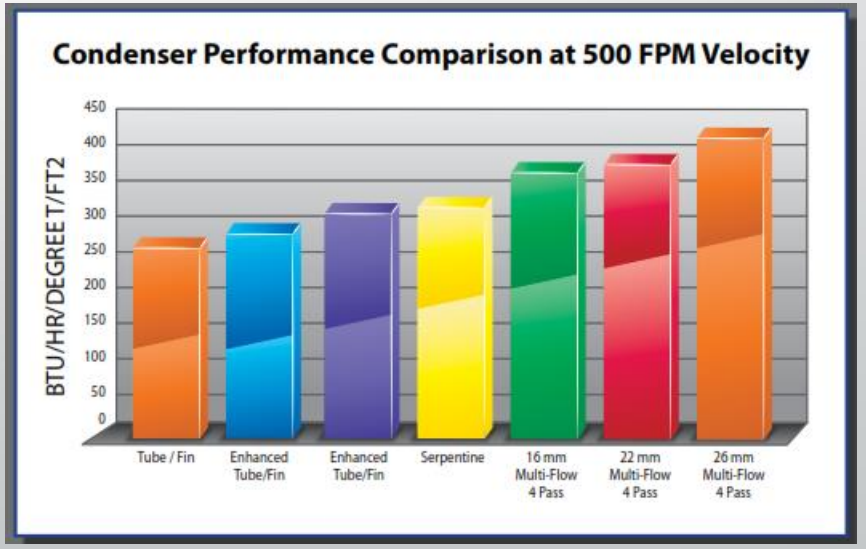
Compressor Lubrication Must be Maintained

- Requires Sufficient Liquid Refrigerant to Carry Oil Up and Out of the Evaporator and Return to Compressor

This Delicate Balance Requires Precise Flow Control

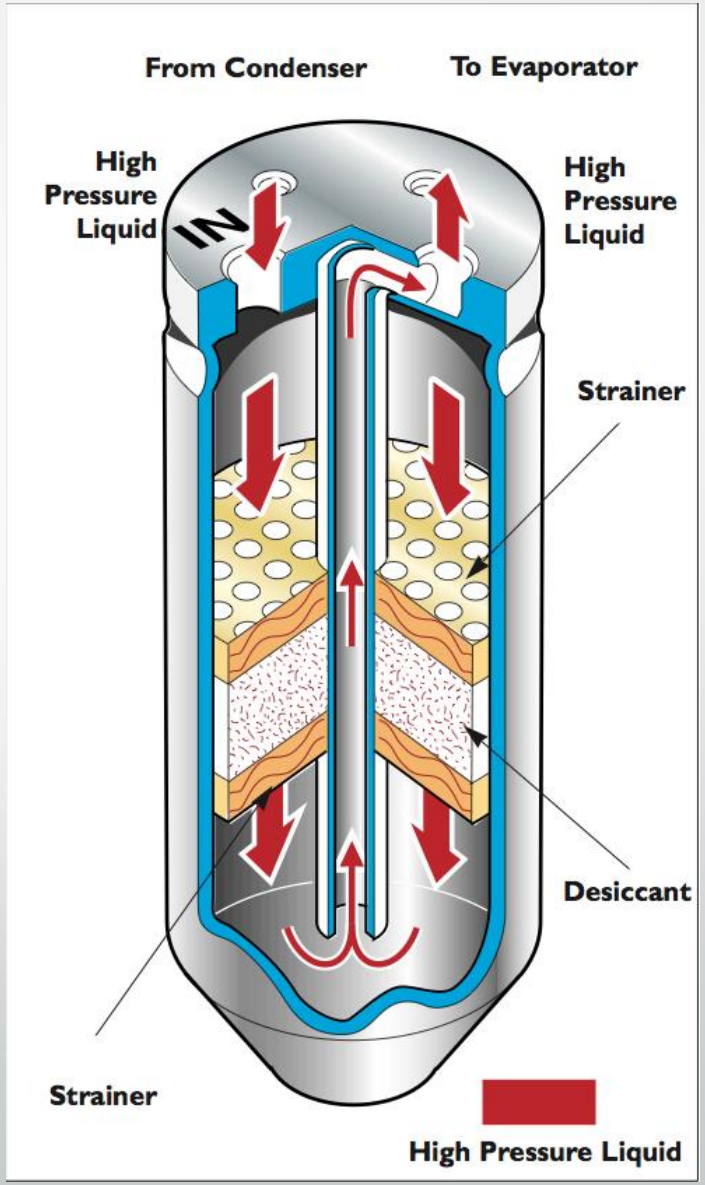
Basics - Condenser

- The TXV is not directly dependent on this heat exchanger but it can have an affect on other components
- The heat exchanger is used to condense refrigerant from its gaseous to its liquid state by cooling it
- Size, style, type and air flow can all be factors in getting good system performance



Basics – Drier

- The TXV is typically going to be the smallest point that refrigerant is going to pass through in the system
- A good receiver filter drier is going to be vital to suppling clean, dry refrigerant to all of the down stream components including the TXV
- Low pressure drop and excellent filtration are beneficial for a long system life

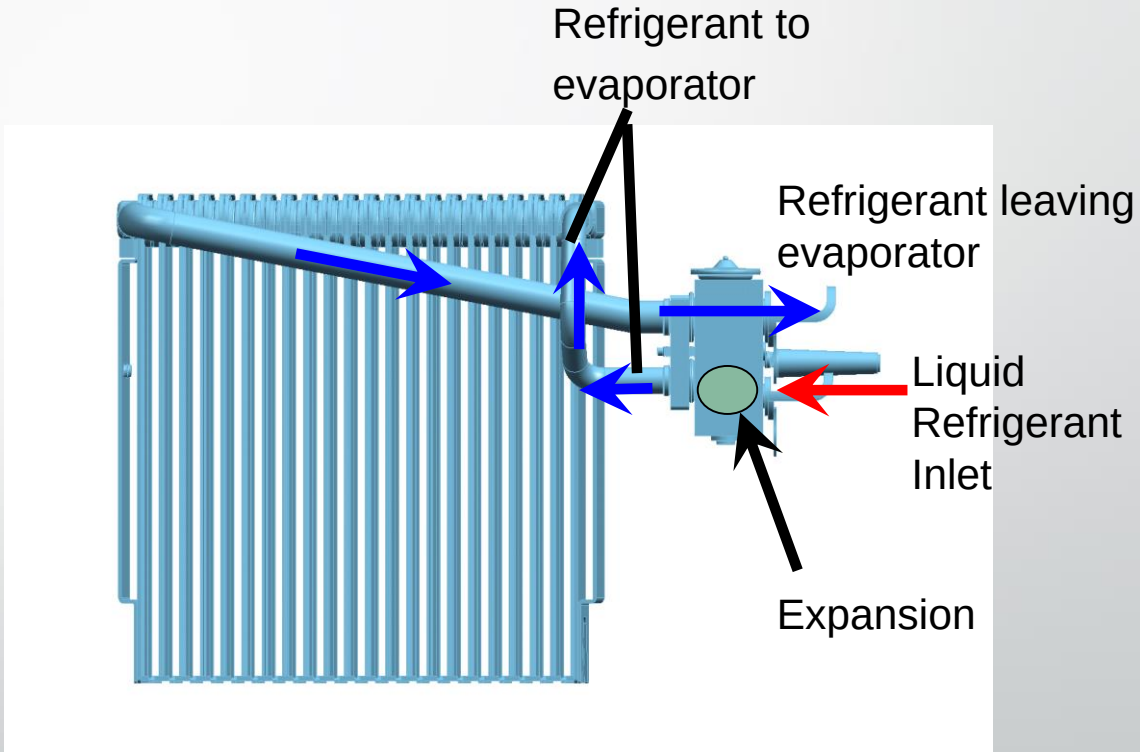


TXV Function and Purpose

- Modulates refrigerant flow into evaporator in proportion to heat load on system WHILE:
  - Maintaining Maximum Thermal Efficiency
  - Preventing Compressor Slugging
  - Ensuring Sufficient Flow to Prevent Oil Drop Out (Maintain Compressor Lubrication)
- This is done by monitoring evaporator "Superheat"
- Superheat is an indicator of heat load on the evaporator

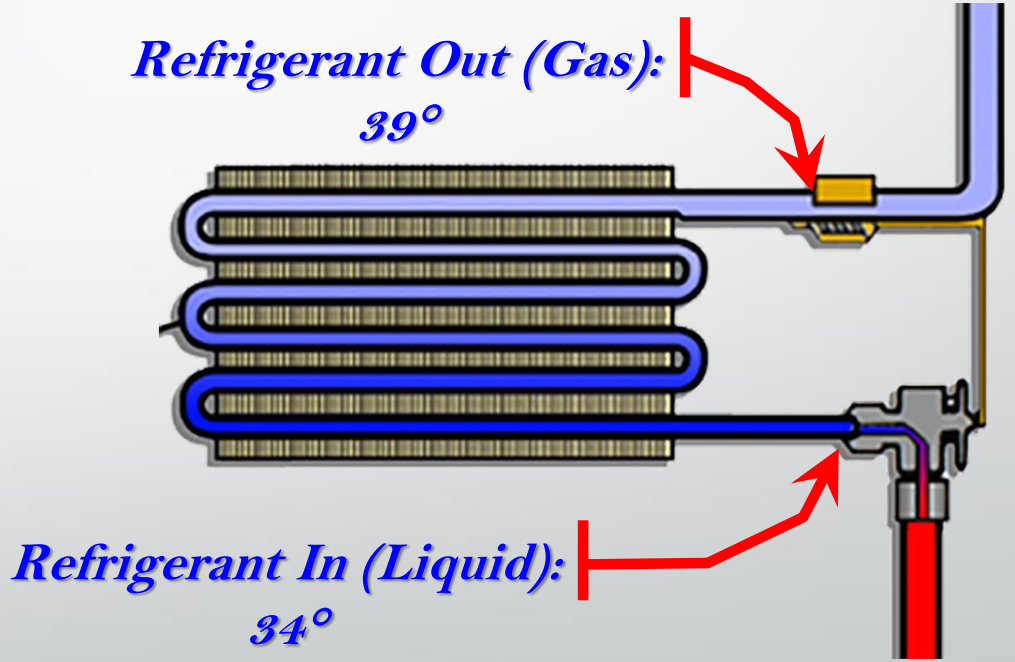
Function & Purpose

- The function of the TXV is to control the mass flow rate being supplied to the evaporator
- The purpose of the TXV responds to the temperature & pressure in the suction line (refrigerant leaving the evaporator)



Function & Purpose

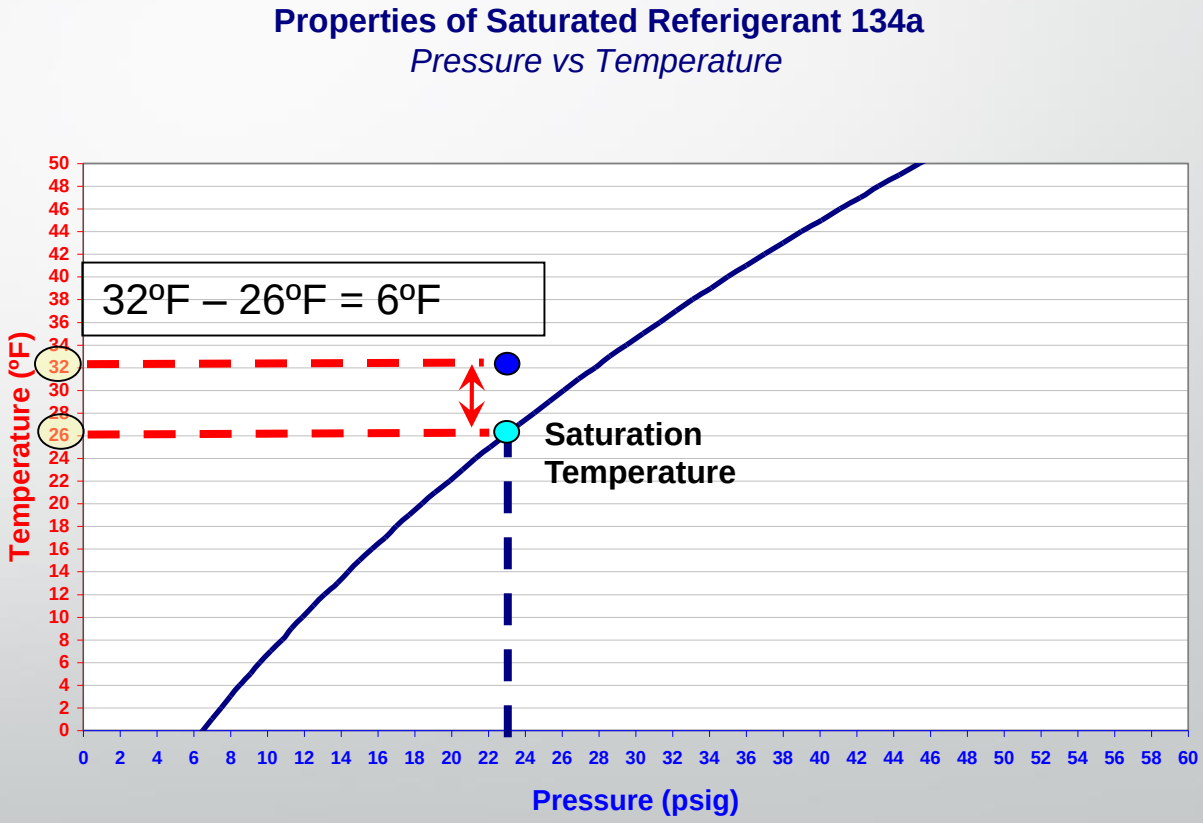
- When discussing expansion valves the term "superheat" is a main topic
- What is superheat?
- Any increase in temperature of the refrigerant gas after change of state from liquid to gas
- In other words, superheat is the temperature of the refrigerant gas above its saturated vapor temperature



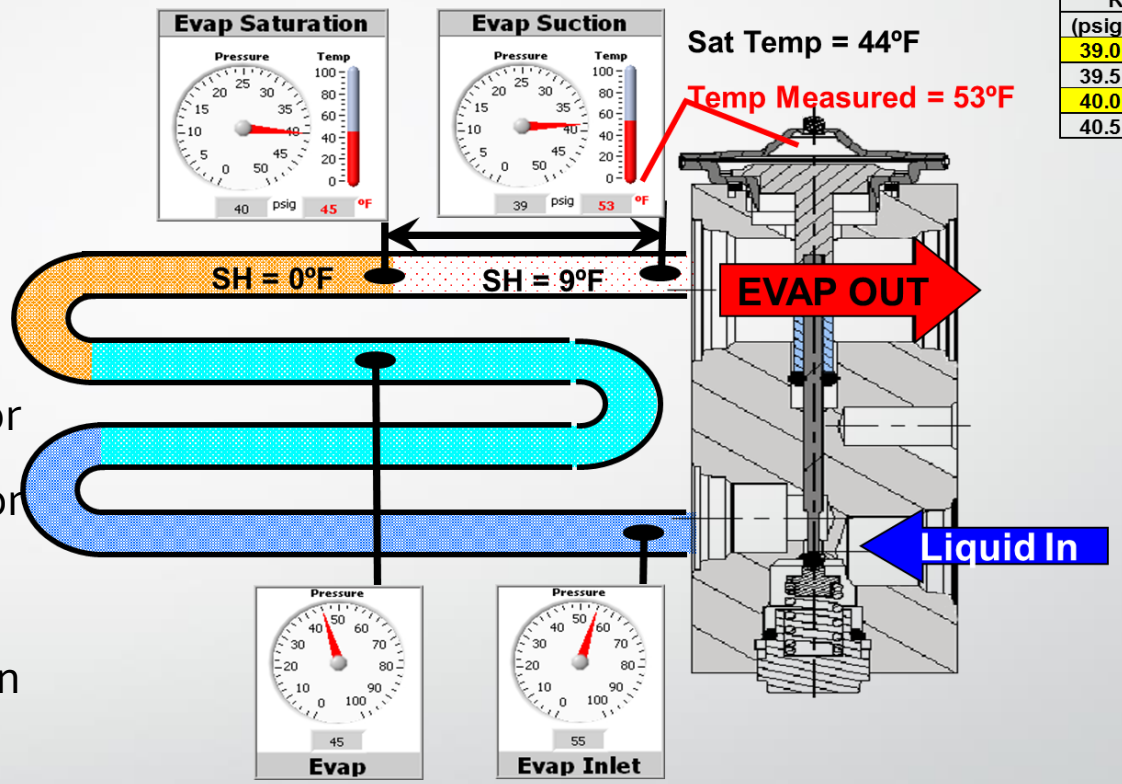
Function & Purpose

Superheat when referring to a TXV as a component is considered static superheat

- Is the amount of superheat needed to overcome the spring force or "crack open point"



Function & Purpose



R134a	
(psig)	(°F)
39.0	44.0
39.5	44.5
40.0	45.0
40.5	45.4

Is superheat necessary?

It ensures all liquid refrigerant is evaporated

- Prevents liquid slugging of the compressor
- Maximum thermal efficiency in evaporator

Excessive Superheat:

- Evaporator liquid level low - No lubrication
- Reduced efficiency (liquid vs gas density)

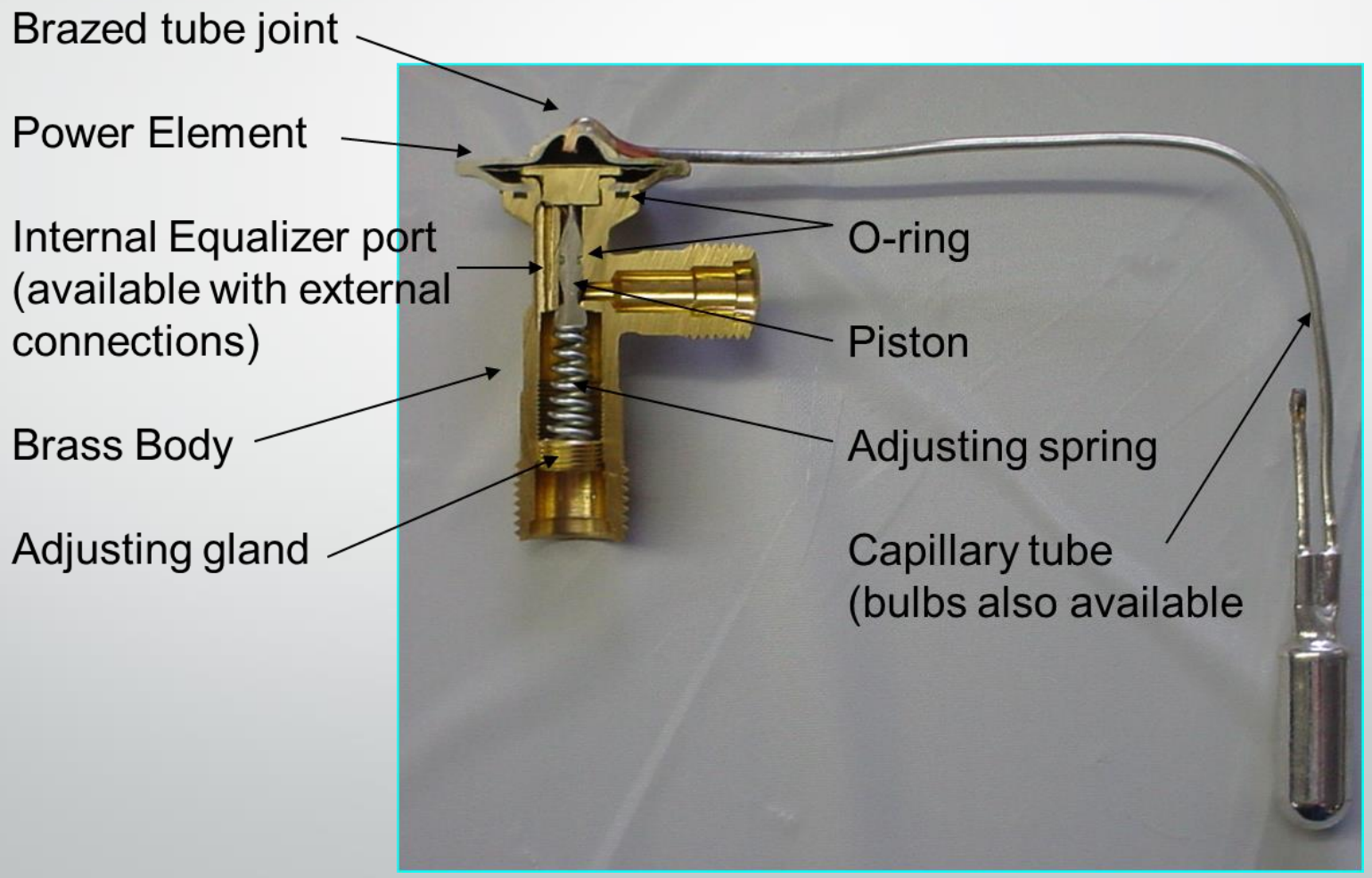
No Superheating:

- Flooded evaporator – No change of state (loss of thermal efficiency)
- Liquid can exit evaporator - Frosted suction line – Possible compressor slugging

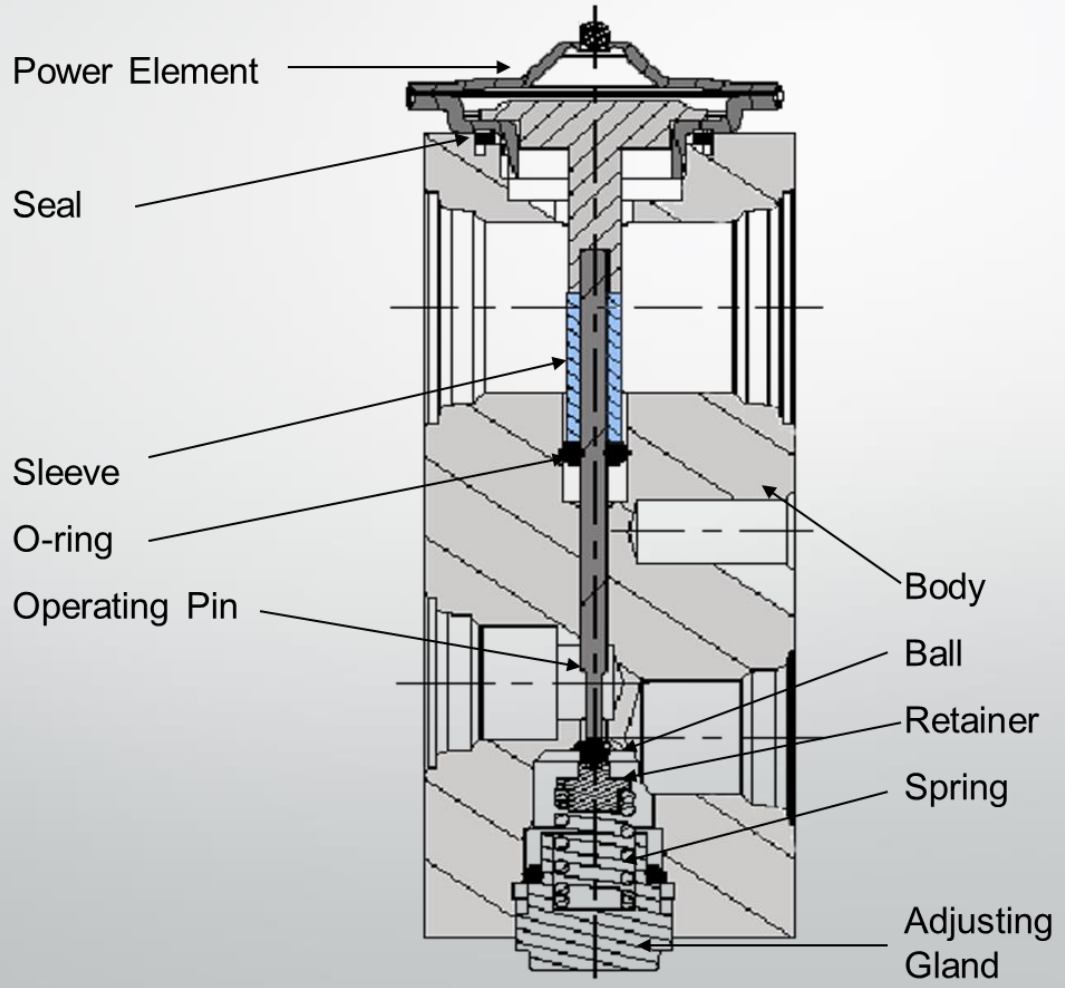
TXV Operation

- TXV Components
- Typical in Operation Conditions
- Sensing and Operating
- MOP
- Charge

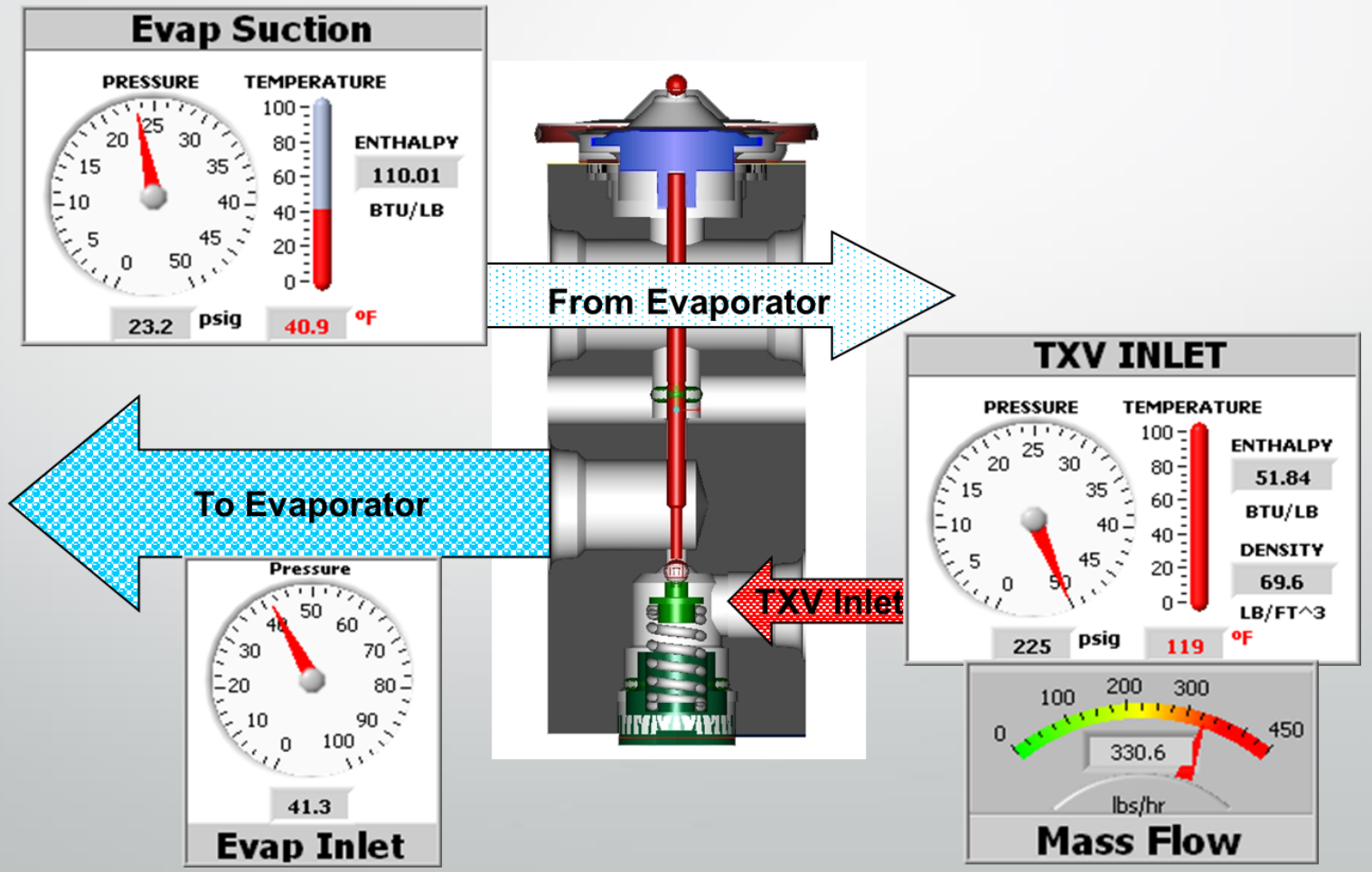
TXV Operation: Right Angle Valve Components



TXV Operation: Block Valve Components

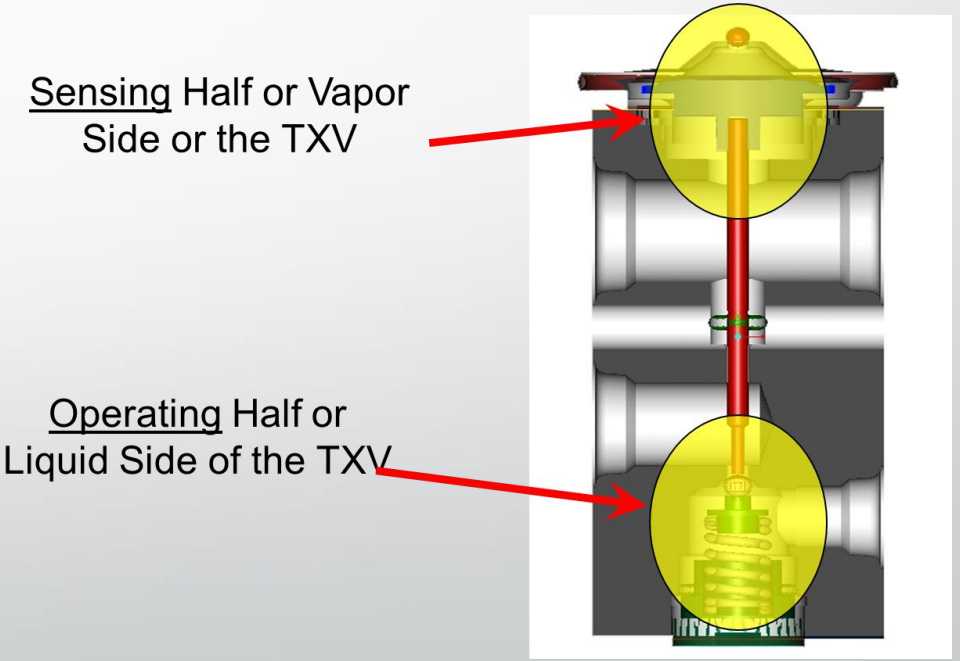


TXV in Operation



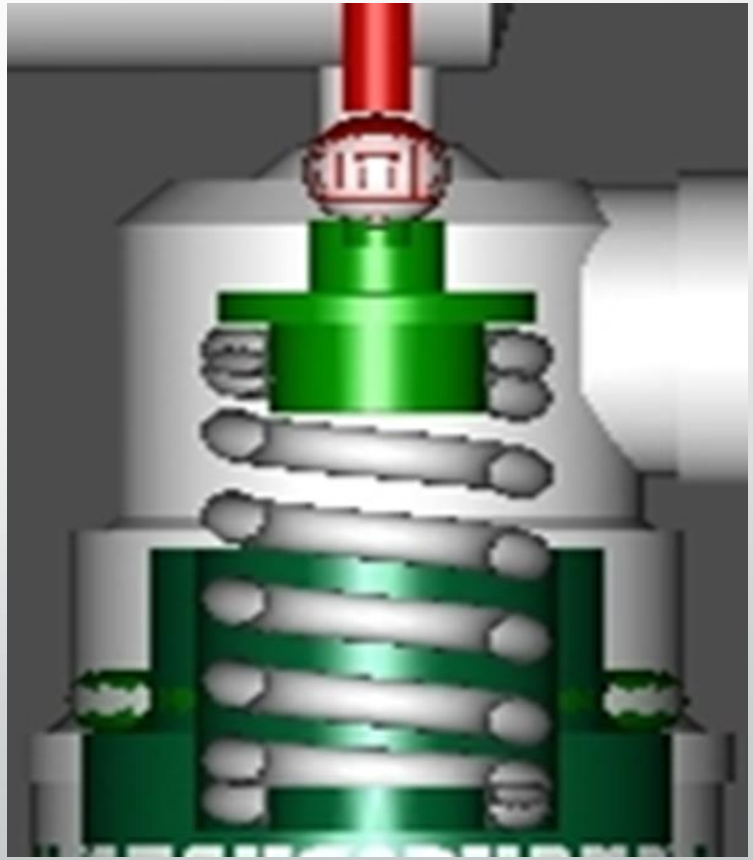
TXV Operation

- How does the TXV control refrigerant mass flow with respect to temperature and pressure?
- How does the TXV maintain superheat?
- How does the TXV maximize the thermal efficiency of the evaporator?
- We will use the block valve as an example and divide it into it's simplest form



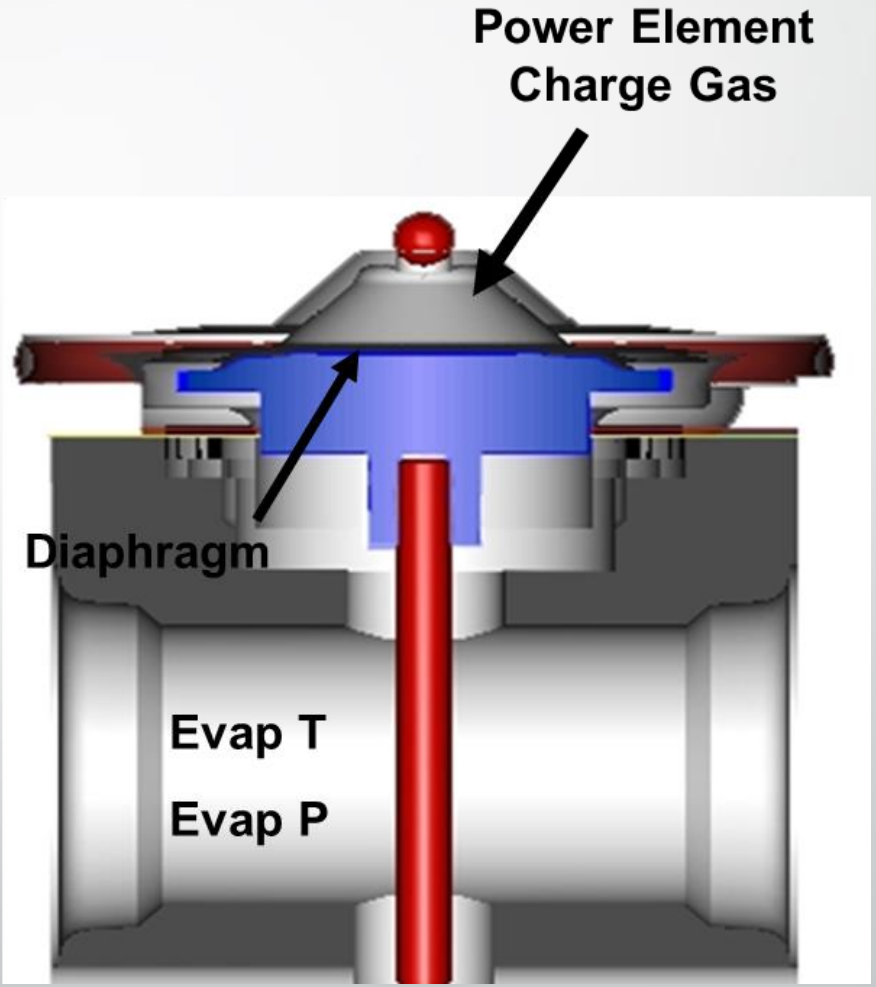
TXV Operating Side

- Provides an infinitely variable orifice to meter refrigerant flow into the evaporator
- Orifice opening (stroke) is controlled by the sensing side of the TXV
- This is how the refrigerant mass flow thru the valve is done

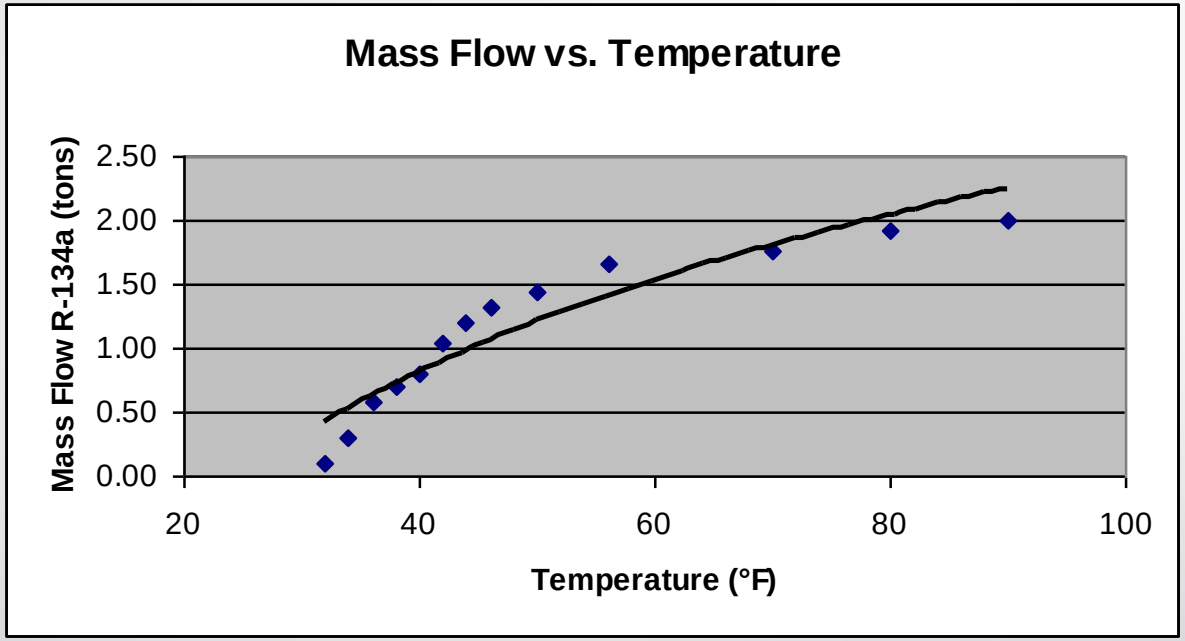


TXV Sensing Side

- The net effect of the forces (Evap T & Evap P) on the sensing side regulates the operating side to the desired evaporator superheat
- The sensing side will try to maintain a given superheat in the evaporator by adjusting the flow orifice on the operating side
- This is how the TXV maintains superheat and maximizes evaporator efficiency



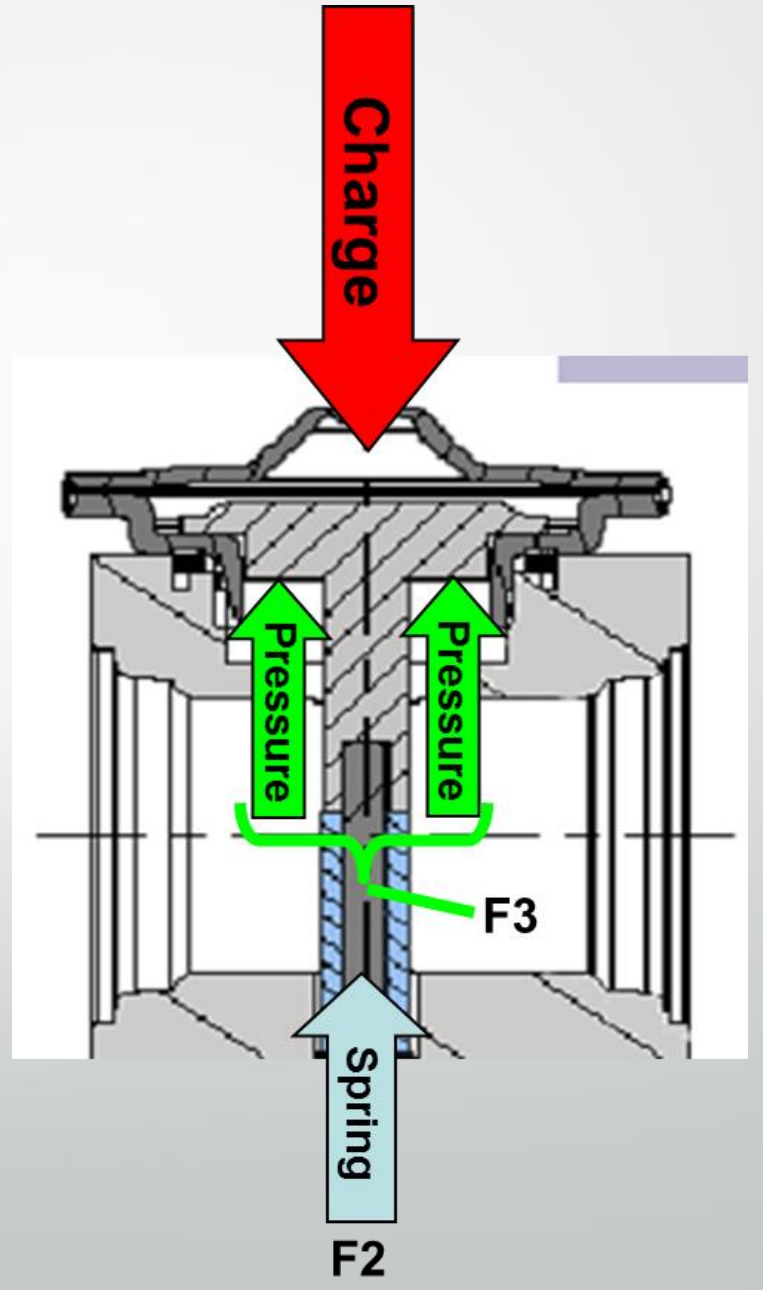
TXV Operation



- The sensing side responds to evaporator outlet conditions (temperature & pressure) to adjust the flow orifice on the operating side from essentially zero to the rated capacity

TXV in Balance

- In order to achieve precise flow while operating the TXV must maintain a delicate balance of forces



TXV Operation

- Can you have negative superheat?

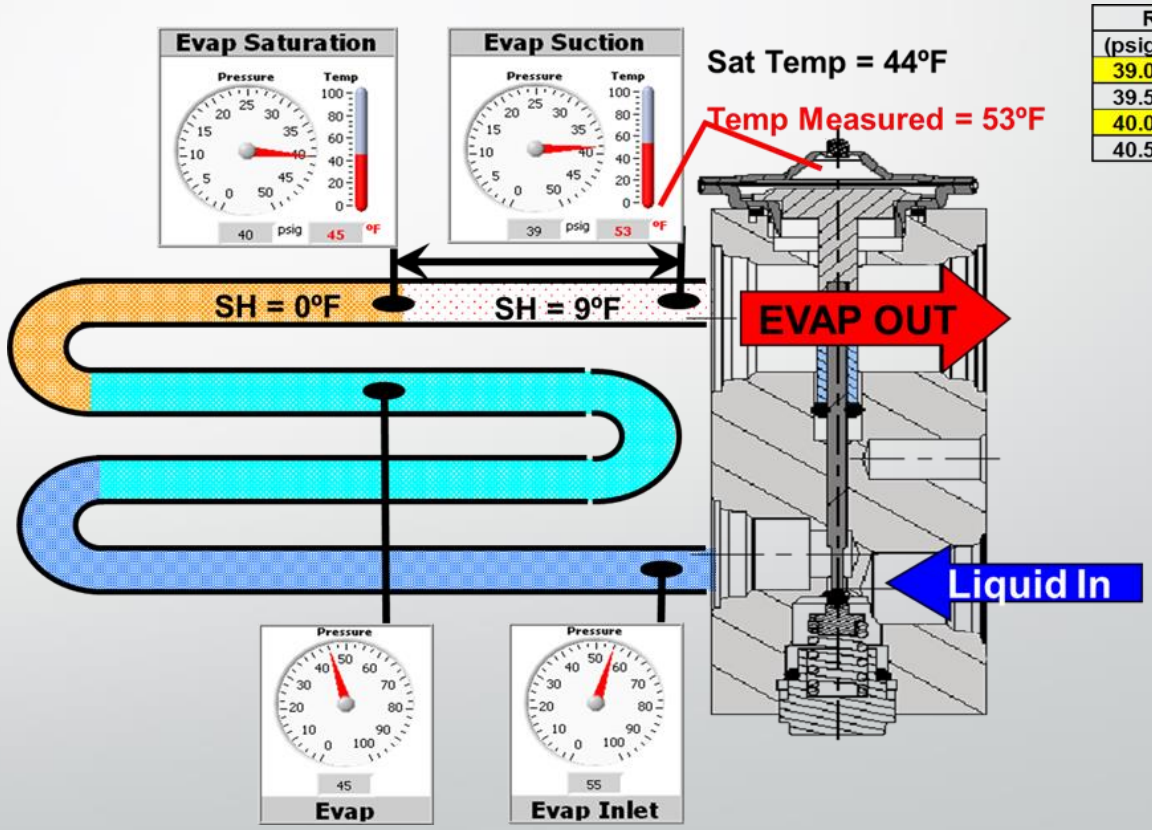
  Yes, the TXV can be set to produce
  A negative static SH but in reality
  This is considered subcooling and not
  a normal condition

- Can you have no superheat?

  Yes but it can result in flooding evap
  Which will reduce thermal efficiency,
  not to mention it could damage the
  compressor

- Is no superheat the same as zero degrees superheat?

  Yes, zero degrees of superheat
  Is the point of saturation….meaning
  no superheat



R134a	
(psig)	(°F)
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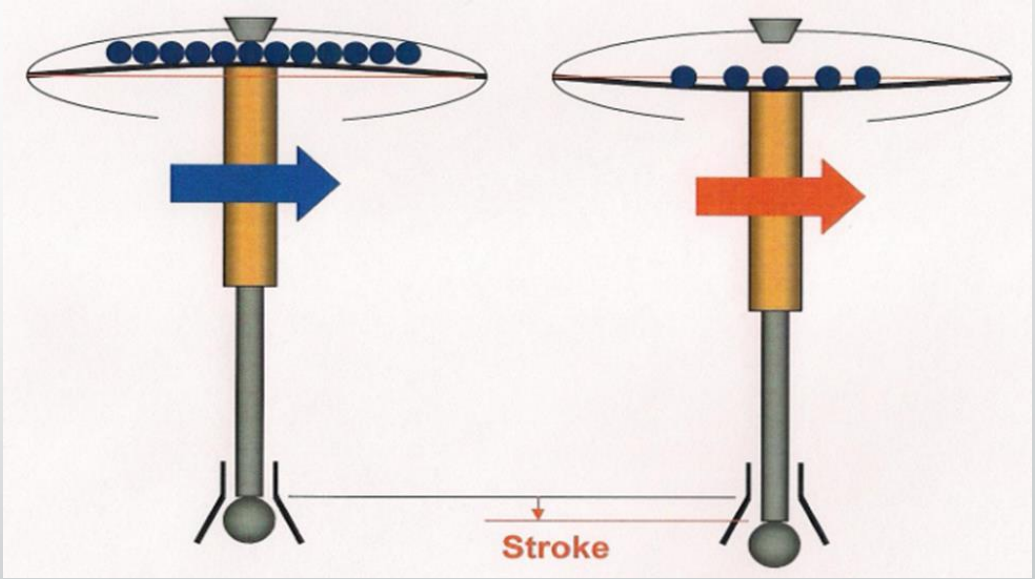
TXV Operation

- MOP = Maximum Operating Pressure or Pressure Limit
- The charge pressure in the power element is directly related to MOP
- The charge pressure in the power element is the pressure that the evaporator needs to reach before the valve starts to meter the refrigerant



TXV Operation

The underside of power element diaphragm is exposed to the evaporator pressure

If the pressure exceeds designed threshold, the TXV closes

- This limits the pressure of the refrigerant supplied to compressor to maximum value
- Helps in pull down (lower MOP's help pulldown performance)
- This gives better performance at high loading conditions (higher MOP improved idle performance)
- Must balance pulldown and idle performance when determining proper TXV pressure limit

TXV Operation

- The power element contains a charge
- The charge is held in by a thin metal diaphragm
- Types of charges:

  Cross Charge

  A refrigerant mixed with another gas to produce a desired system condition

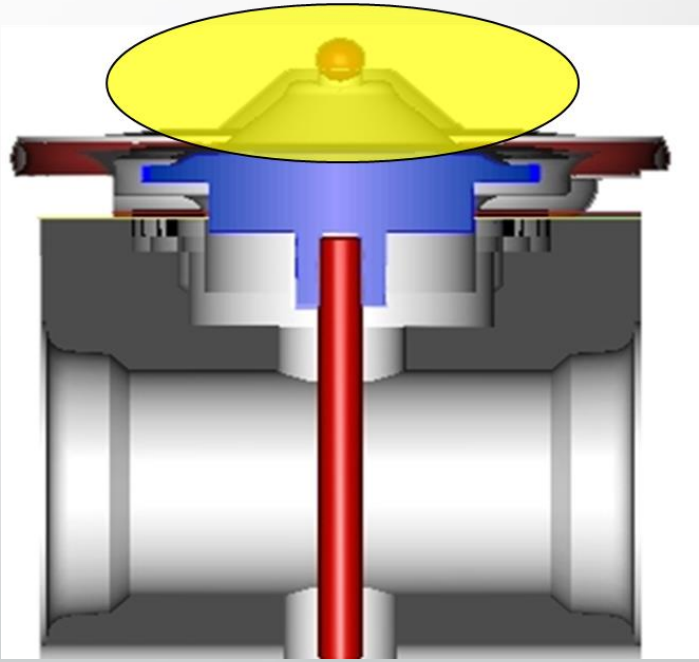
  System Charge

  Typically the same charge that is in the system

- Charge amounts:

  These are related to the maximum operating pressure of the system

  This can be altered to achieve a desired system but there are limitation



TXV Types and Styles

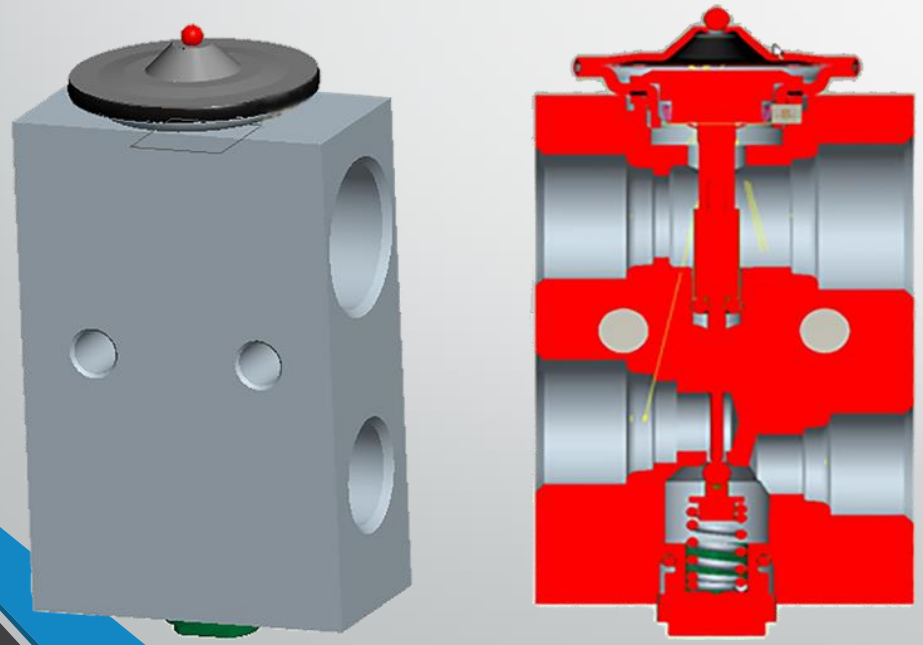
- Block Valves
- Right Angle Valves
- Specialty Valves
- System Types
- Trouble Shooting

Block Valve Configurations

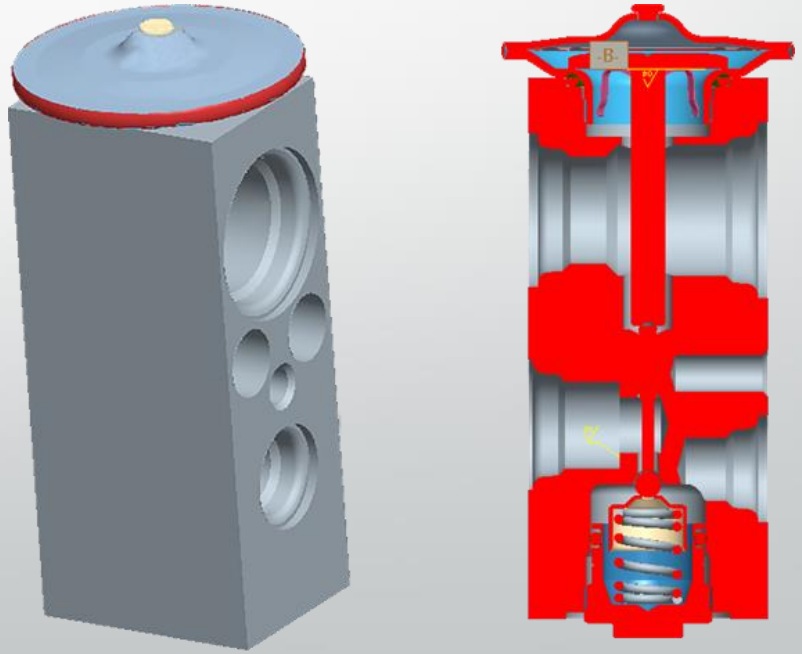
- Optimized orifice sizing
- Single / multiple component control charges optimized for specific compressor & system configurations
- Optional nicked / drilled bypass bleed
- O-ring / Slimline seal connections
- Ambient / Position Insensitive designs
- Pre-assembly of other components
  - Switches, Fittings, Studs, Kits….Etc.

Block Valve Families

- Threaded tube-o port style
- Lines are connected individually

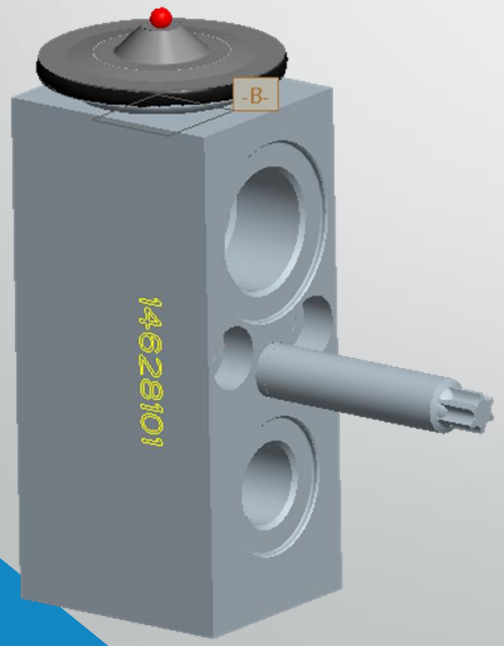


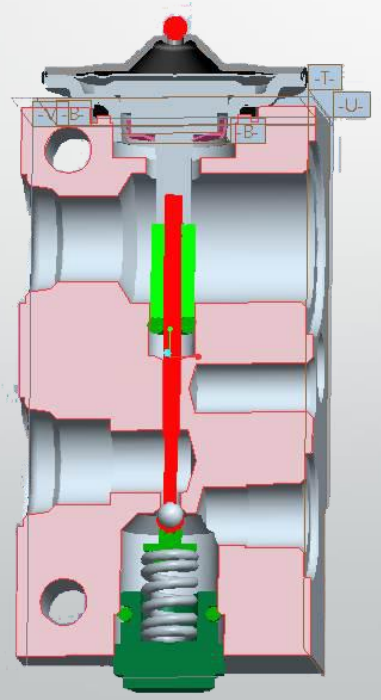
- Mini-block style
- Standard tube-o ports
- Lines are connected with plates



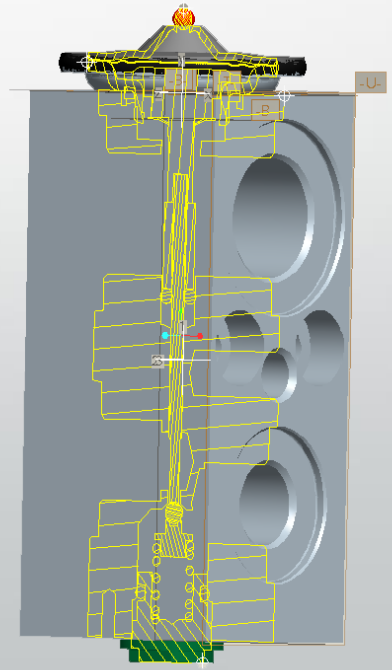
Block Valve Families

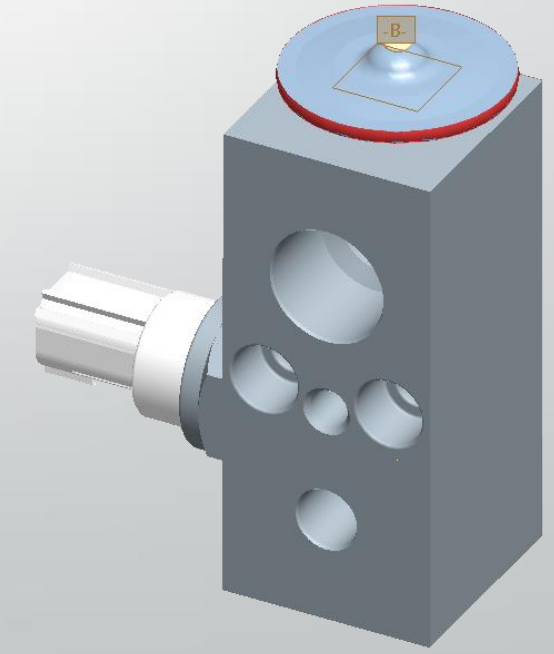
- Slim-line ports (GM, F-liner)
- Dual seal ports (CAT)





- Combination blocks
- Non mini-block tube-o ports





Right Angle Valve Configurations

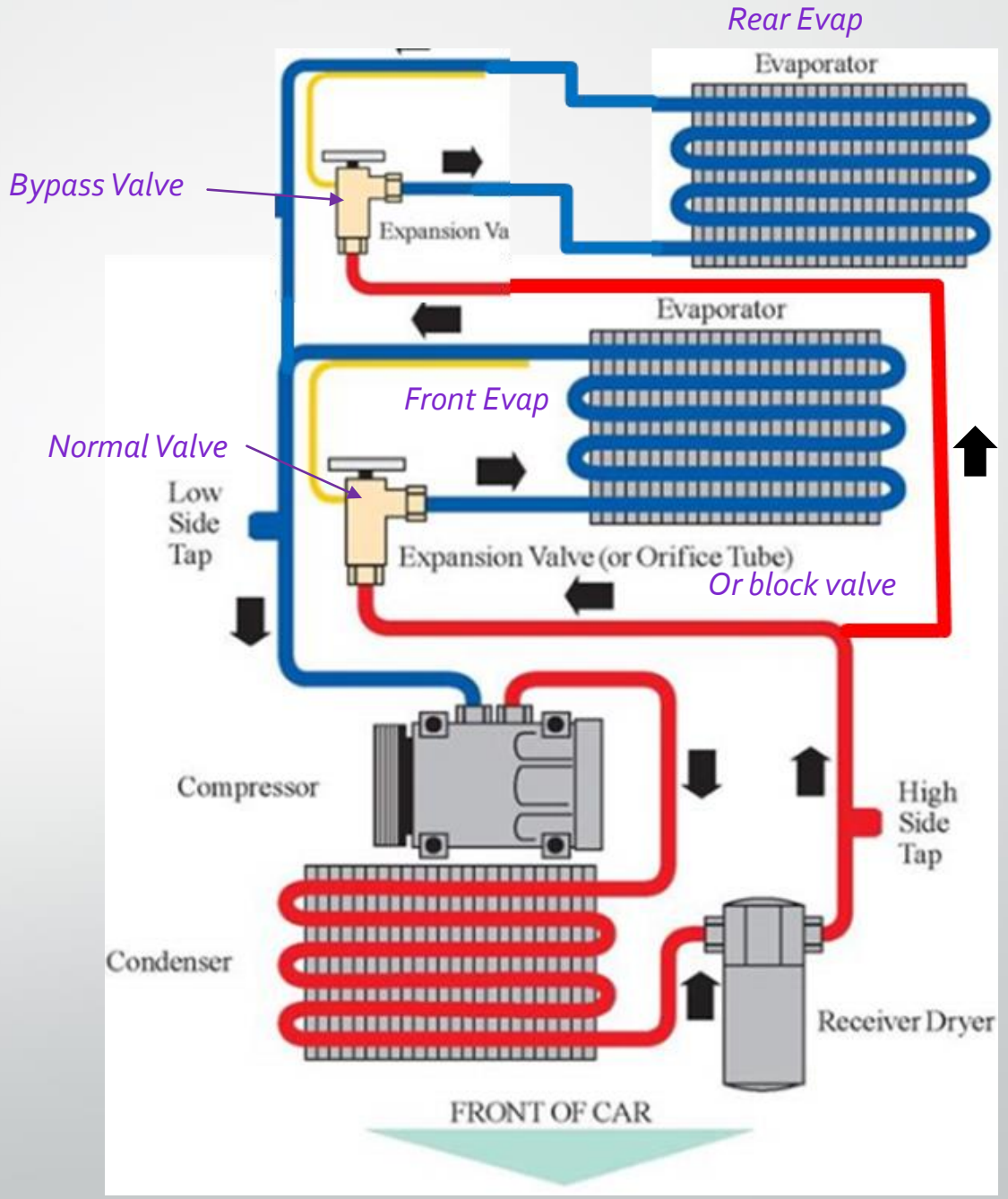
- Forward / Reverse Flow
- Biased / Unbiased orifice designs
- Single / multiple component control charges
- Optional nicked / drilled bypass bleed
- English / metric fittings
- Various length cap tubes available
  - Straight, Coiled (pigtail) or Bulb
  - Pre-bent cap tube orientation available
  - Various equalizer lengths & fittings

Right Angle Valve Families

- Internally Equalized
- Externally Equalized
- Flare Fittings
- Filter Screens

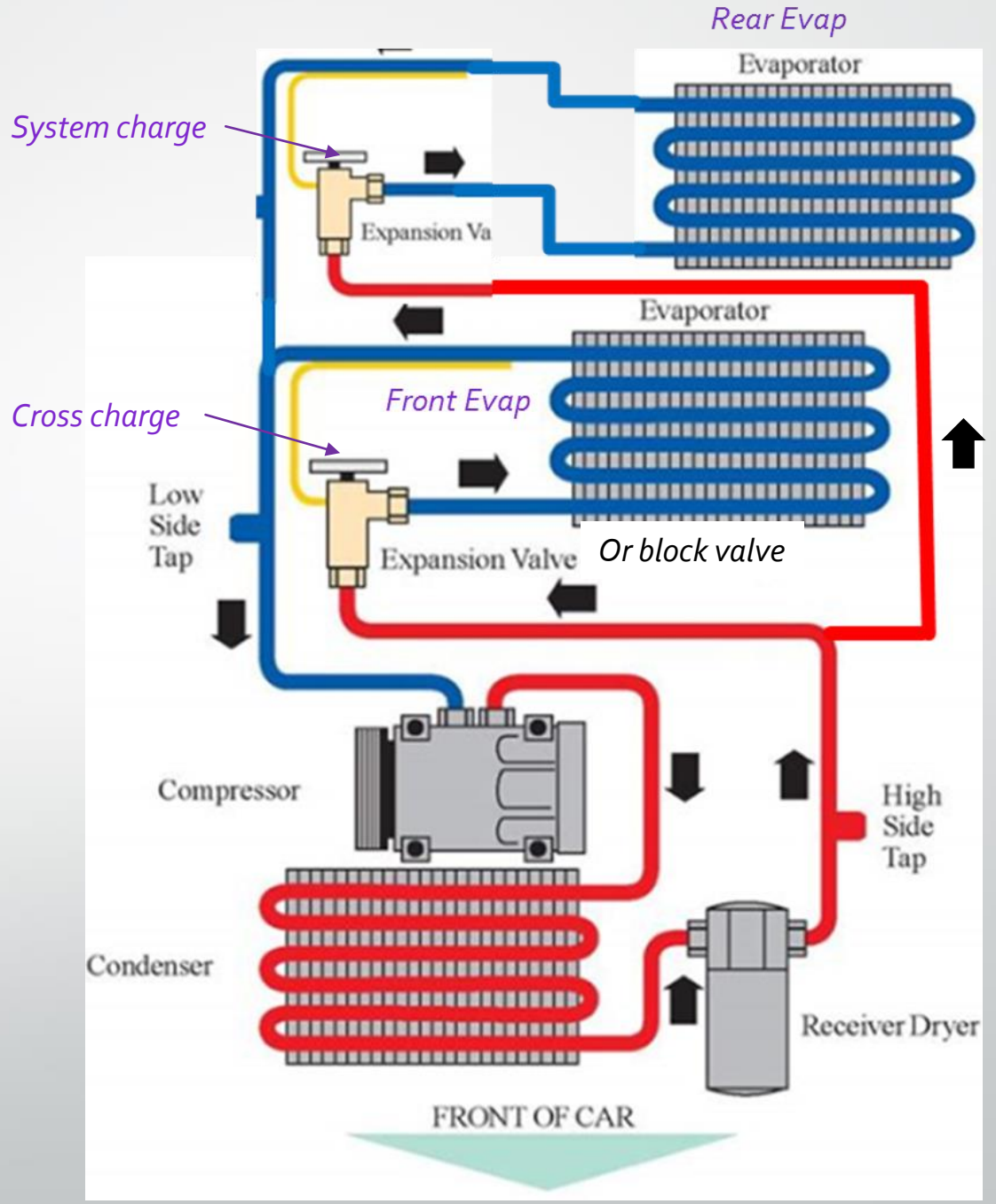
Specialty Valves

- Nicked seat TXV's
- Also called "bypass" or "bleed" valves
- In block valves, these have a controlled amount of damage to the seat
- In right angle valves, these have a small drilled hole from the inlet to the outlet
- Both of these allow small amount of flow (oil and refrigerant) even when the valve is closed
- These were designed to reduce oil drop out and pooling of refrigerant in rear or dual evaporator systems



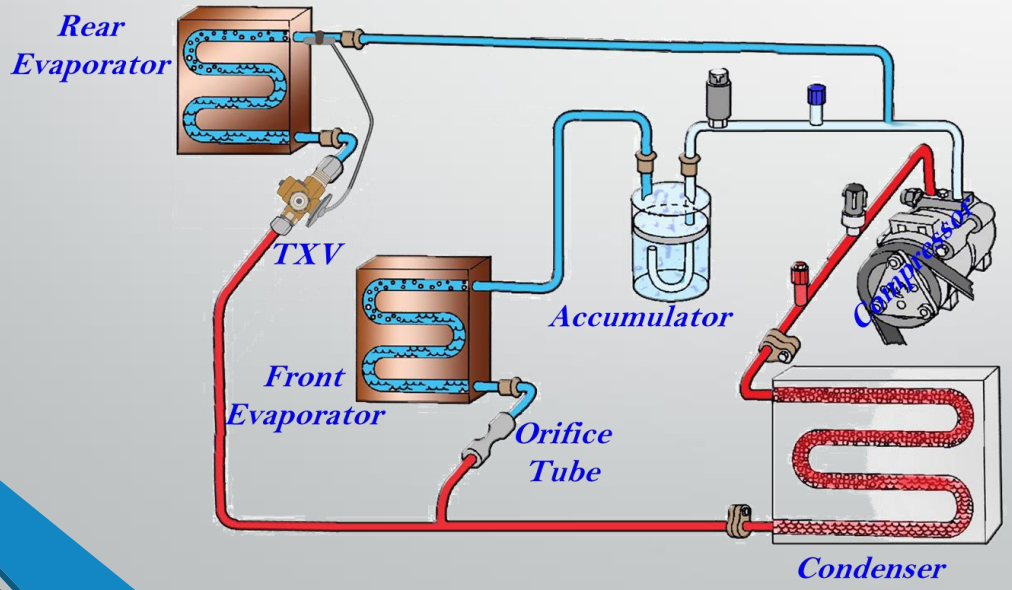
Specialty Valves

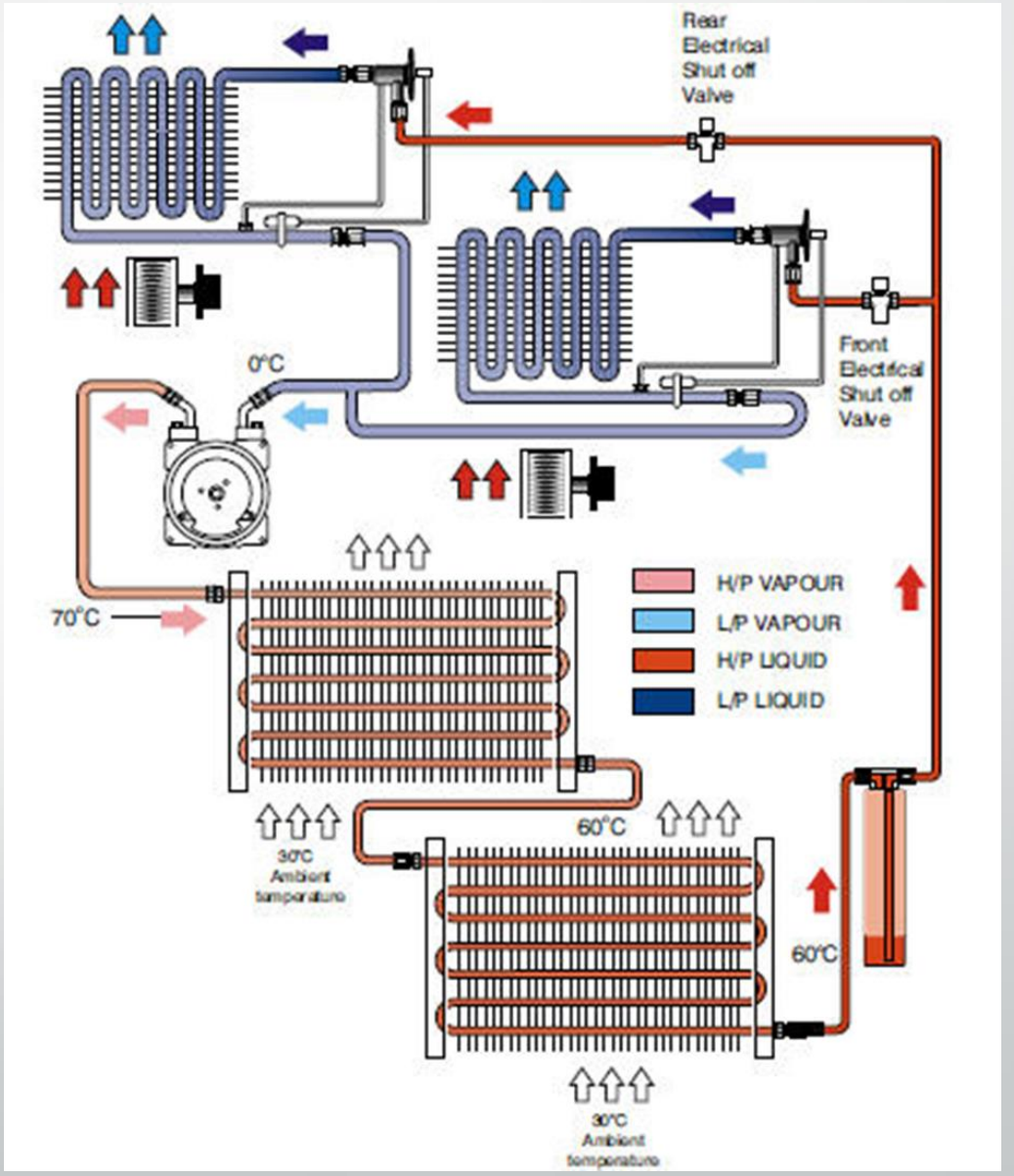
- Cross charges TXV's
- Meaning the refrigerant inside the power element is different than what is in the system
- This can be an effective way to prevent TXV's on dual evaporator systems from fighting for control
- These were also designed for use in rear, auxiliary or dual evaporator systems to reduce harmonic synchronization sometimes called "hunting"



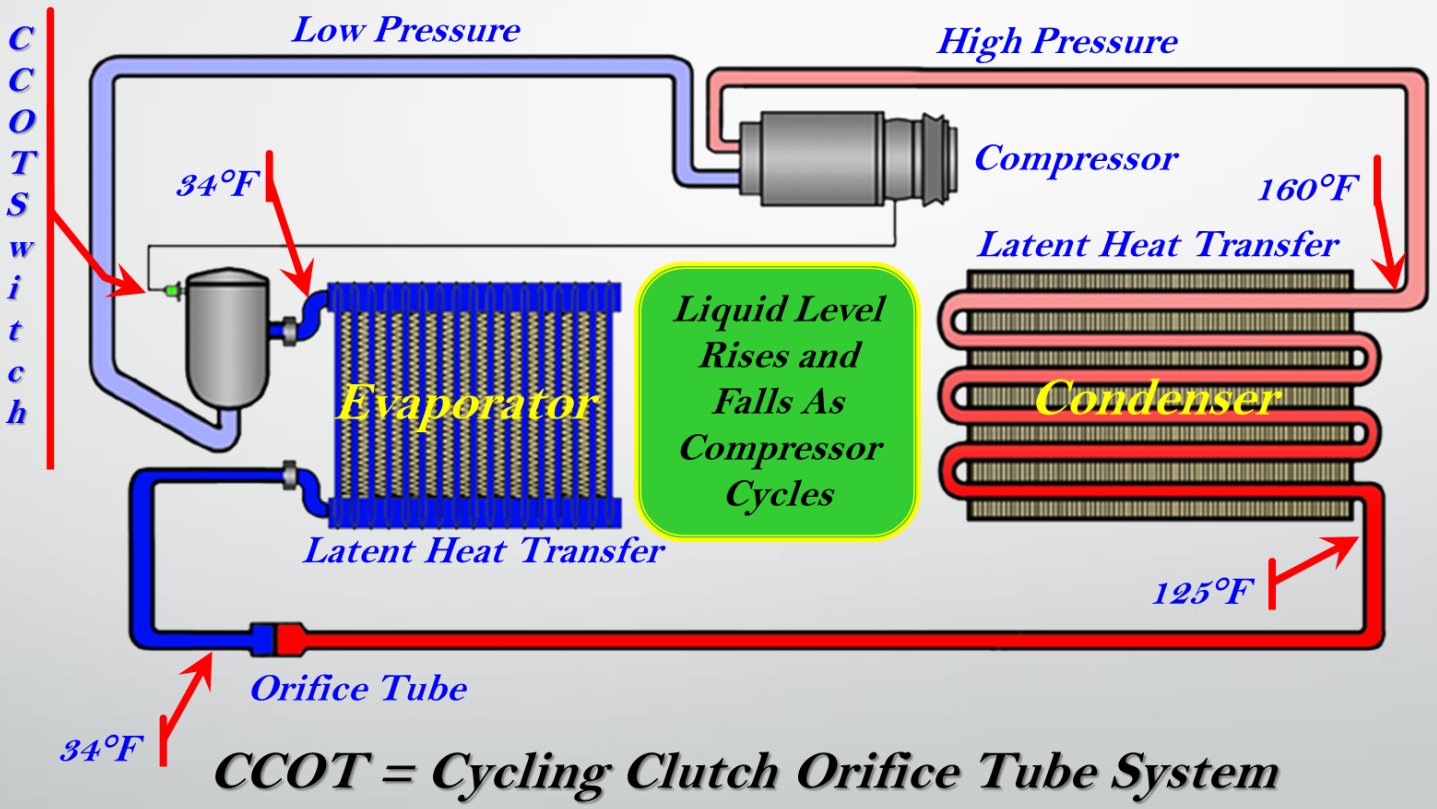
Specialty Valves

- These valves have many uses to achieve a multitude of system requirements
- Be aware of what the valve is trying to do within the system

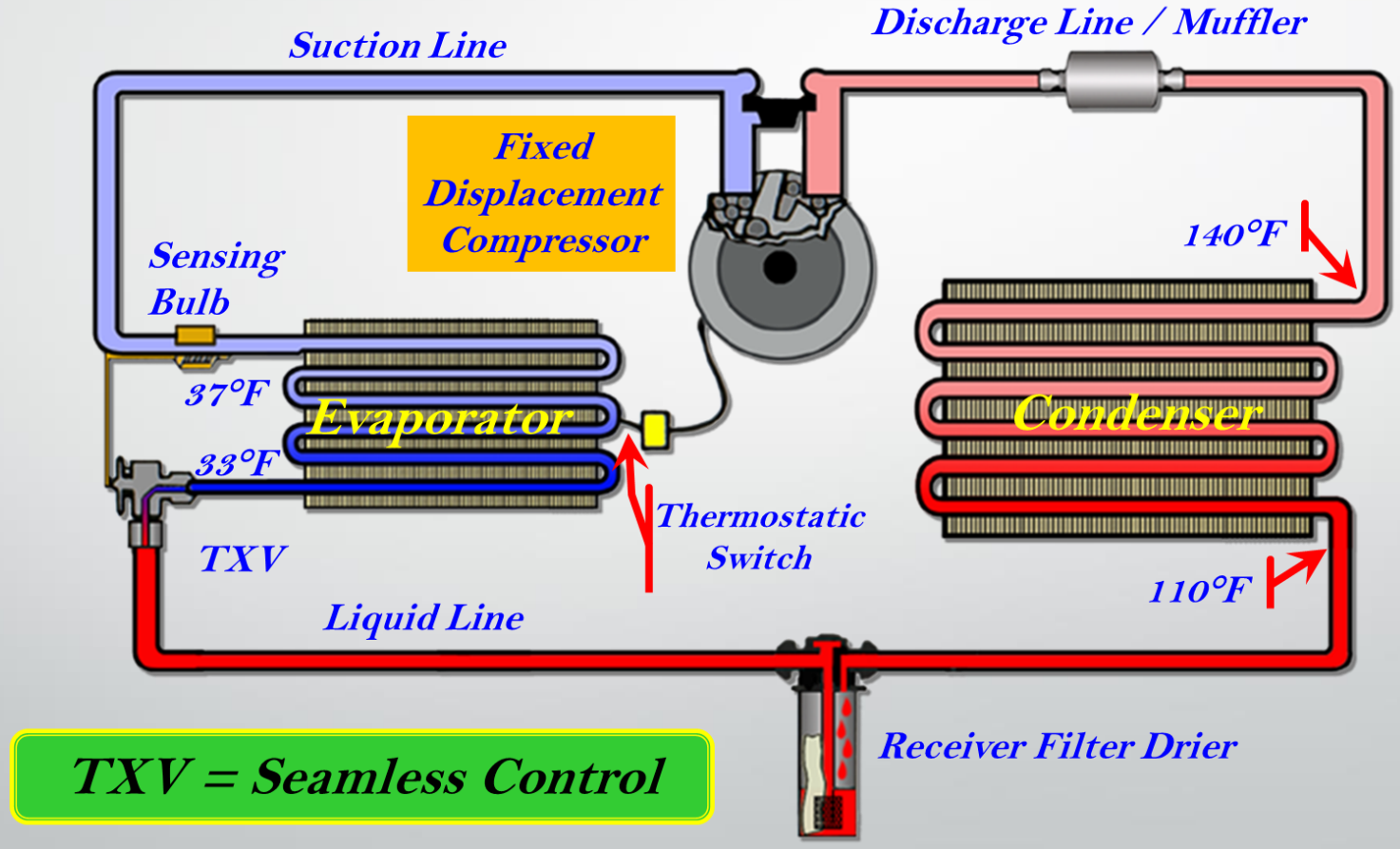




System Types: CCOT

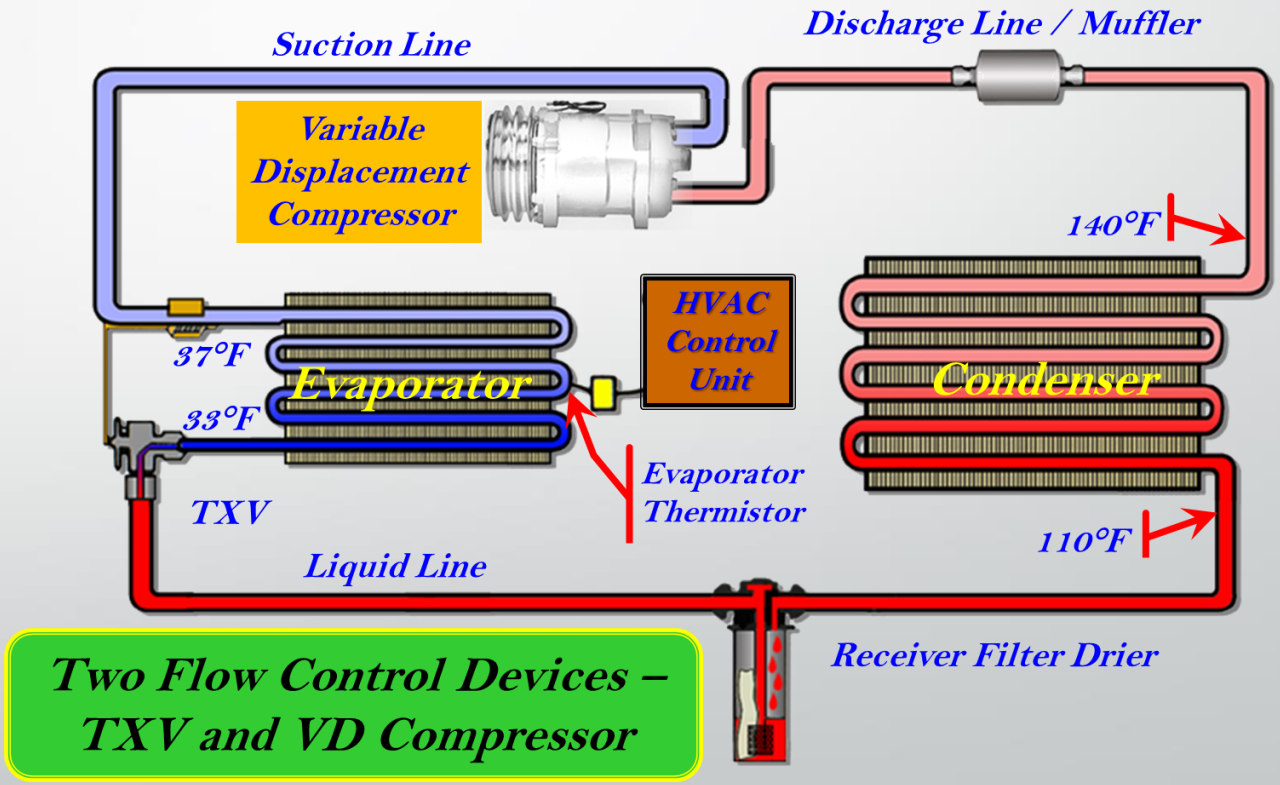


System Types: TXV - Fixed Displacement



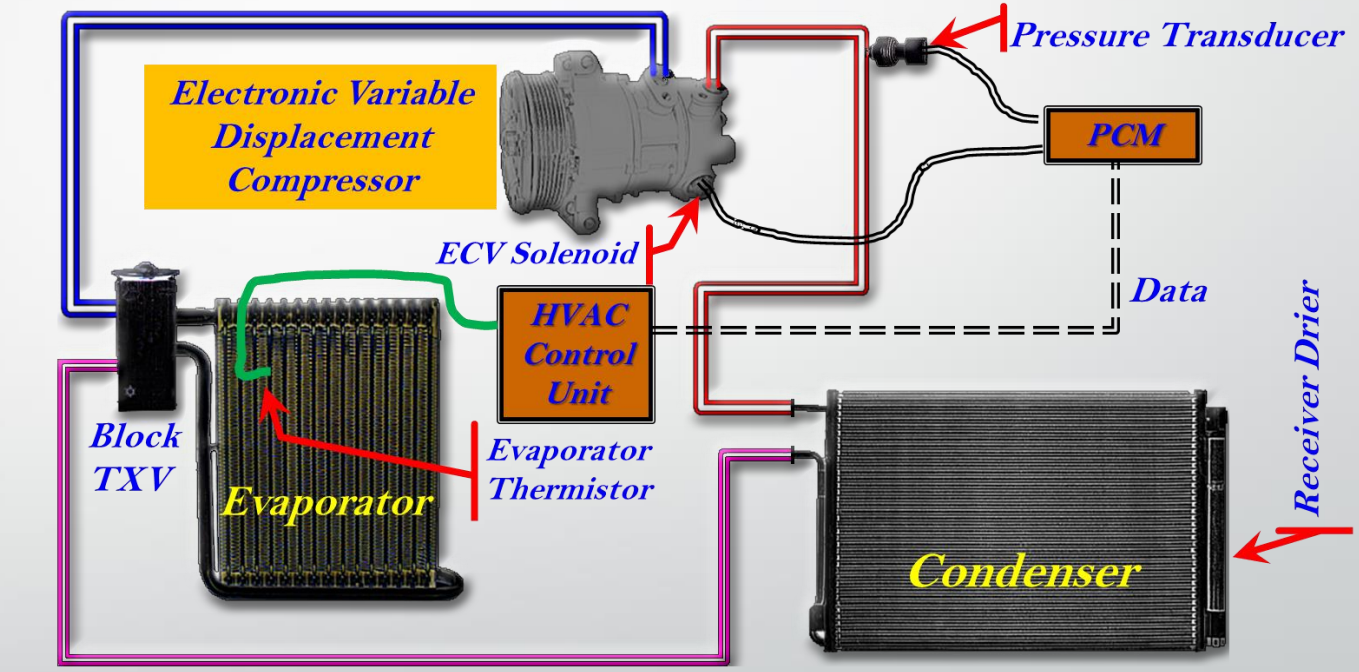
System Types: TXV – Variable Displacement

- Both the TXV and variable displacement compressor can modulate refrigerant flow
- It can be difficult to diagnose the source of the problem
  - If the suction pressure is high and does not come down when the engine is raced, suspect the compressor
  - If the suction pressure is low and the temperature is high, suspect the TXV – it may have a restricted flow



System Types: TXV and ECV

- Both the TXV and electronic control valve in the compressor can modulate refrigerant flow
- It can be difficult to diagnose the source of the problem
  - If the suction pressure is high and does not come down when the engine is raced, suspect the compressor
  - If the suction pressure is low and the temperature is high, suspect the TXV – it may have a restricted flow



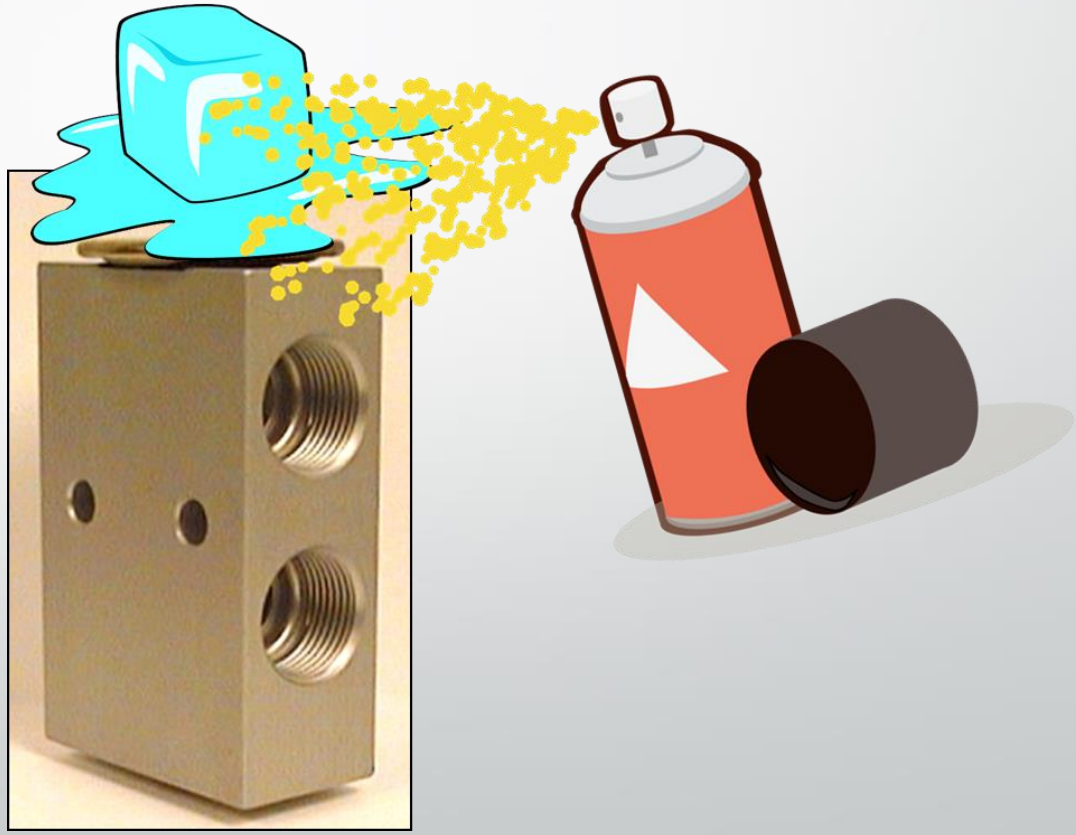
Two Flow Control Devices – TXV and ECV Compressor

Troubleshooting Expansion Valves

- Symptoms of a bad TXV
  - Frost on evaporator or coming through vents
  - Low suction and head pressure
  - High evaporator and compressor superheat
  - Short cycling low pressure control
- What causes a TXV to freeze?
  - Excessive moisture in the system, saturated dryer
- Can a "dirty or plugged" TVX be cleaned?
  - Block type, no. Best to replace
  - Brass right angle type, maybe. Check to see if valve has an inlet screen. If so, clean, replace. If not, best to replace

Trouble Shooting

- Checking basic function
- Cool the power element, power dome or power head
- Use ice, ice pack or cooling aerosol
  - When on the system, pressure should drop when this is applied
  - When in your hand, the operating pin should move – opening and closing the valve

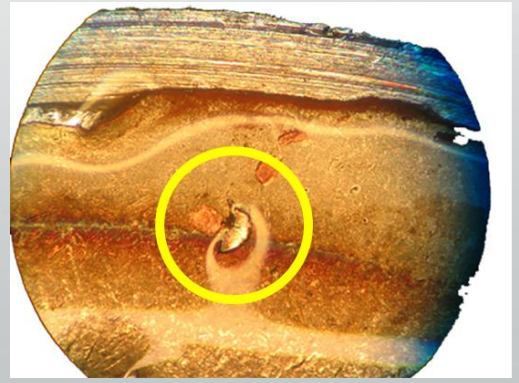


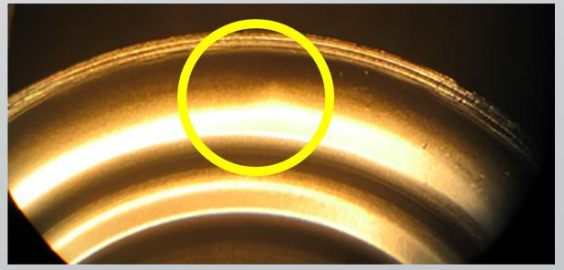
Trouble Shooting

- Compare the evaporator outlet temperature and suction pressure
- The outlet temperature should closely correspond to temperature / pressure relationship chart

Trouble Shooting

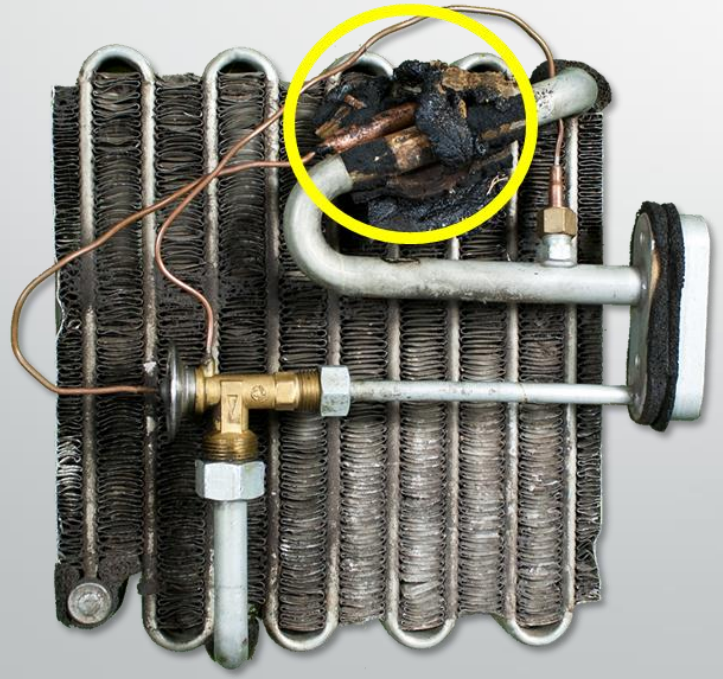
- When removing a TXV to repair a system, be sure to flush it thoroughly
- Tiny grain(s) of debris can enter the underside of the power element – getting trapped between the diaphragm and the lower housing
- This will result in an eventual failure





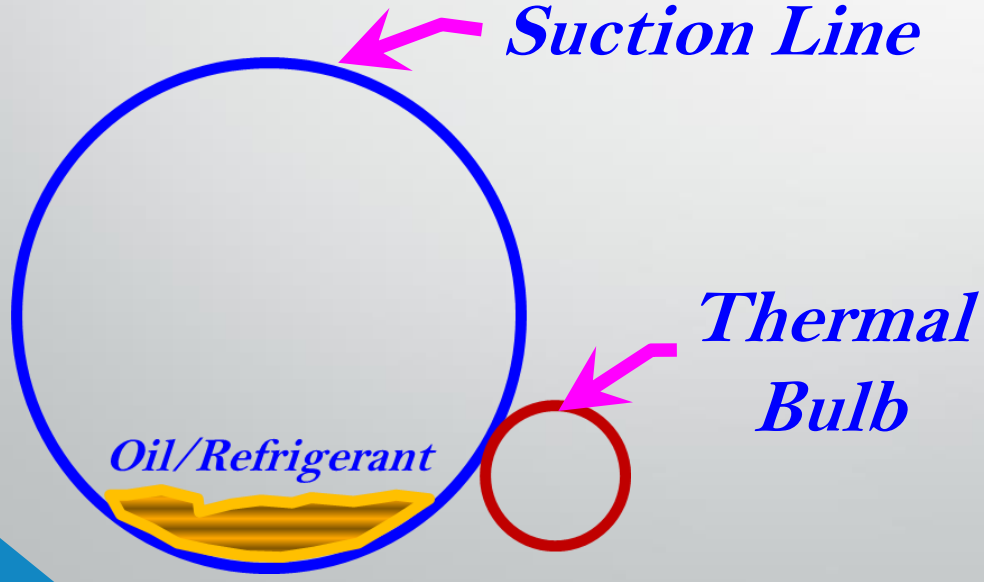
Trouble Shooting

- Thoroughly clean the thermal bulb and mounting surfaces for right angle valves
- This is critical for precise superheat control

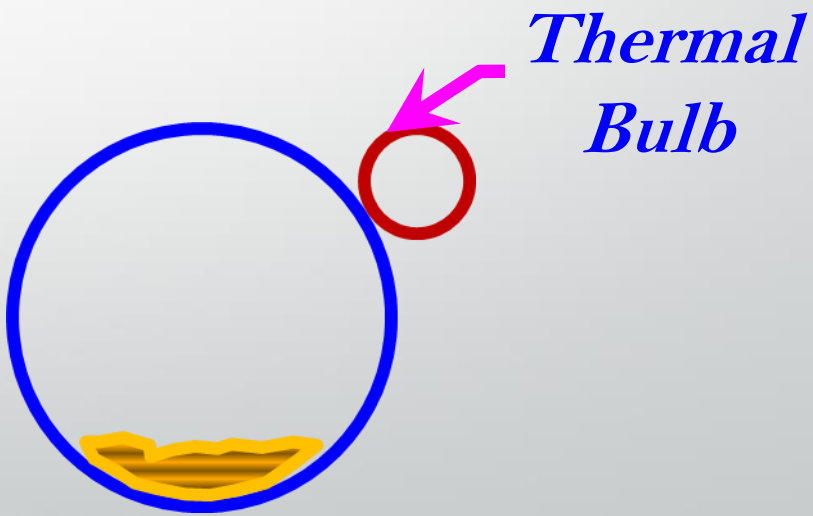


Trouble Shooting

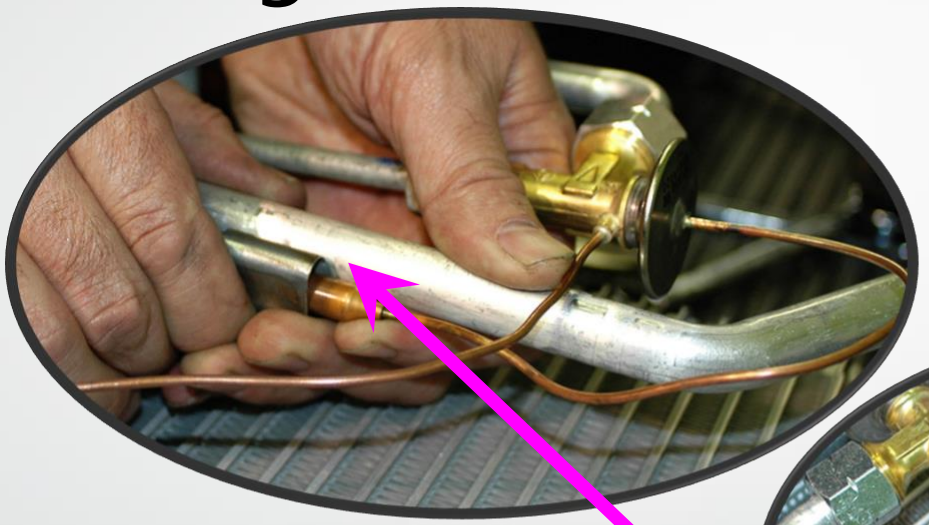
5/8" or larger suction line – mount the thermal bulb at 4 o'clock position

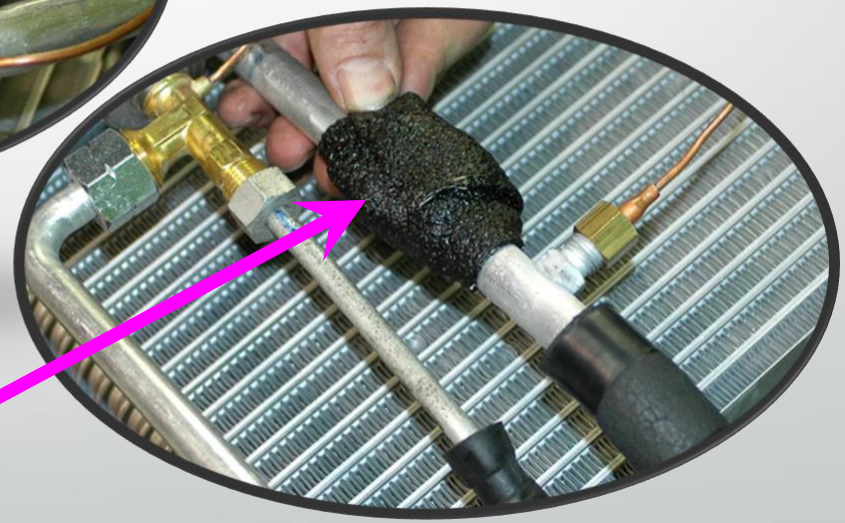


On smaller suction lines – mount thermal bulb near the top of the line



Trouble Shooting





- Thermal bulb insulation on right angle valve
- Securely attach and wrap the bulb in thermal insulating tape

Trouble Shooting

- In orifice tube / TXV dual automotive evaporator systems there are seldom filters for protecting the rear TXV valve
- Debris from a failed compressor will often reach the rear TXV even if the system is flushed
- Often times the rear A/C will stop working after a few days

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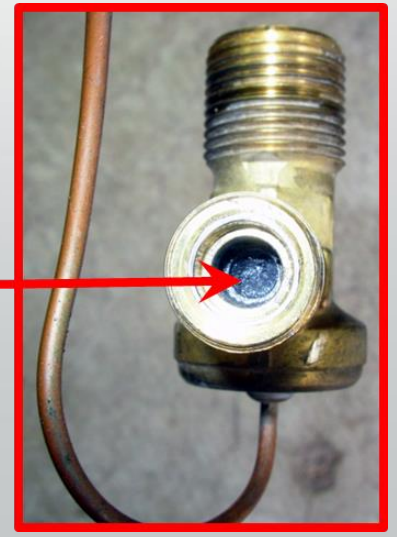

TXV Troubleshooting Chart

Symptom	Possible Cause
Suction Pressure High & Superheat Reading Low	Defective Compressor Incorrect TXV Poor Sensing Bulb Contact with Suction Line Refrigerant Overcharge
Suction Pressure Low & Superheating Reading High	Low Refrigerant Charge Incorrect TXV No Charge in Power Element Vapor in Liquid Line Plugged Receiver/Drier
Suction Pressure Low & Superheating Reading Low	Poor Evaporator Airflow, Iced Evaporator Excessive Oil in Evaporator One TXV Being Affected by Other in System

Questions