TECH TIP # 28

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

13 SEER and the TEV

Removing the Mystery of the Thermostatic Expansion Valve

As the new requirements for the 13 SEER (seasonal energy efficiency ratio) air conditioners come forth, the understanding of these refrigerant system components become more and more critical. The HVAC industry strategy is that this expansion device will probably exist on all new 13 SEER air conditioning systems. A thorough understanding of this device is a must.

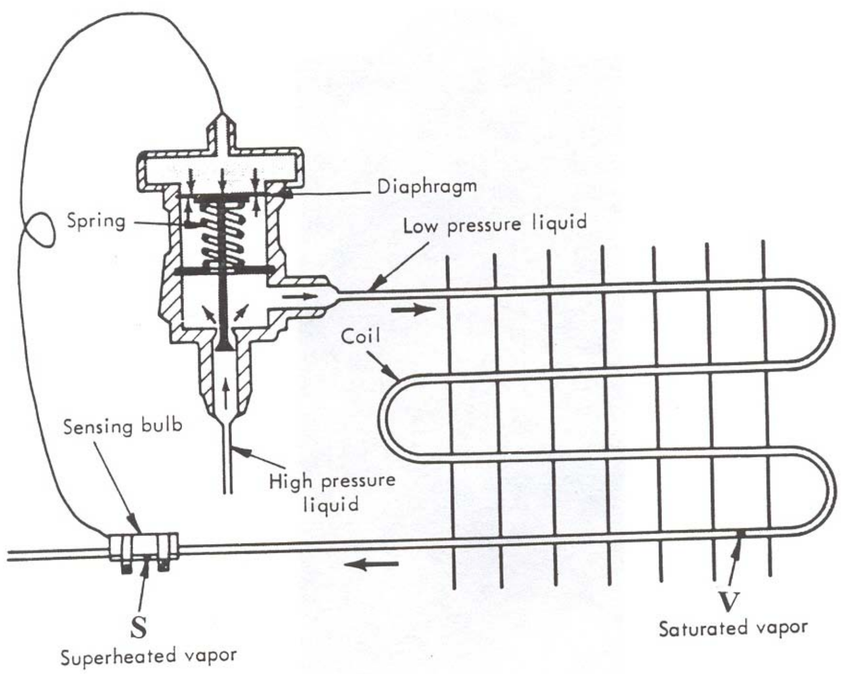
A TXV Primer –

The Evaporator and Thermostatic Expansion Valve

The cooling coil (evaporator) is where heat extraction occurs in residential air-conditioning. The cold coil surfaces continuously remove heat from the circulating air by boiling a liquid refrigerant inside. To be effective, the amount of refrigerant flowing through the coil must be controlled – too much or too little affects performance. Ideally, the coil should be full of boiling liquid refrigerant.

The simplified illustration below shows how a thermostatic expansion value (TXV) is used as one means to regulate refrigerant inside a cooling coil. Here's how it works.

The valve has two chambers separated by a diaphragm. The lower chamber is open to the pressure inside the cooling coil while the upper chamber is open through small tubing to a sensing bulb attached to the coil suction line at the point where refrigerant vapor is exiting the coil. If the diaphragm flexes up or down it moves a valve stem that opens or closes a valve port. This valve action lets more liquid refrigerant in or reduces the amount of refrigerant entering the coil.



Published by the Independent Study Institute, a division of the Heating, Airconditioning & Refrigeration Distributors International. The Institute offers accredited, industry training courses in HVAC/R technology. Direct inquiries to HARDI 3455 Mill Run Drive, Ste. 820, Columbus, OH 43026. Phone 888/253-2128 (toll free) · 614/345-4328 · Fax 614/345-9161

www.hardinet.org

Assume at point *V* inside the coil, all liquid refrigerant has boiled and only *Vapor* is left. Between V and S at the sensing bulb, the temperature of the refrigerant vapor rises as the vapor absorbs sensible heat. This is called superheat. (Between the TXV and point V, a single refrigerant, like R-22, holds at a constant temperature while boiling and absorbing heat.)
If the sensing bulb detects "too hot" refrigerant vapor, the sensor increases the pressure on top of the diaphragm tending to close the valve port and reduce the amount of refrigerant entering the coil. If the sensing bulb detects "too cool" refrigerant vapor, the pressure on the diaphragm is reduced and the valve opens to let more liquid refrigerant flow. A spring inside the valve body also tends to close the valve so the pressure above the diaphragm must overcome both the spring and evaporator pressure to open. The sensor and tubing contain a refrigerant whose pressure increases or decreases with temperature change causing the pressure to change above the diaphragm.

Generalities

The expansion device (there are eight different types) is one of the four basic components that comprise the basic refrigeration cycle. These basic components are the compressor, evaporator, condenser and the metering device. The metering device usually come attached to the evaporator coil, concealed inside the evaporator casing or plenum. Therefore many people don't know where it is located. It can either be a valve that modulates or a fixed bore device.

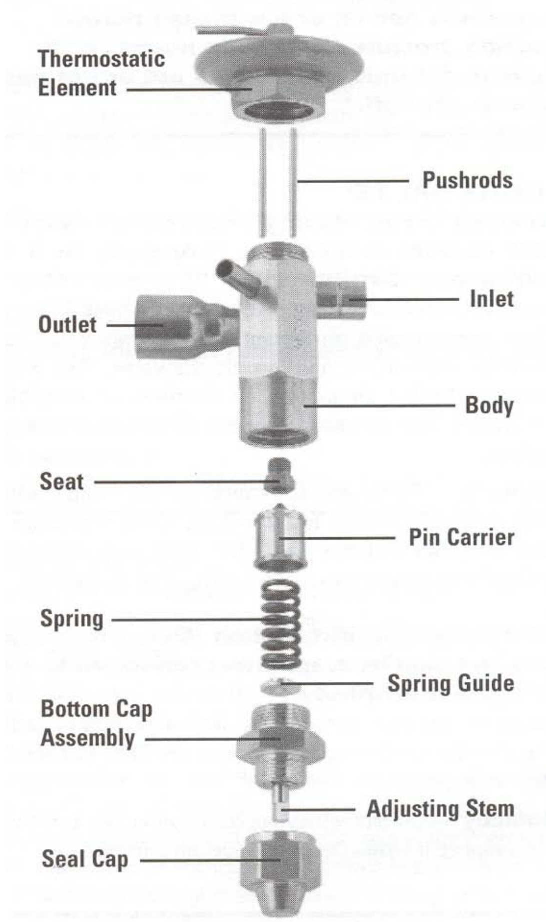
The expansion device is one of the division lines or points between the high and low sides of the system. The other division line or point is the compressor valves located internal to the compressor. The expansion device is responsible for creating a known restriction in the liquid line. The expansion device is usually located in the liquid line just prior to the evaporator coil. This restriction will accomplish two items. First, it restricts the refrigerant flow from the condenser to raise the temperature/pressure relationship of the refrigerant above the condensing medium (usually outside air). Since heat only flows from a warmer to a cooler temperature, the refrigerant temperature must be higher than the air (to which the heat is being transferred). Second, the reduction in temperature/pressure lowers the boiling point of the refrigerant so that the evaporator becomes cool and heat from the conditioned space is transferred into the coil.

The expansion device is responsible for metering the correct amount of refrigerant to the evaporator. The evaporator works best when it is full of liquid refrigerant without any refrigerant going over into the suction line. Any liquid refrigerant that enters the suction line may get into the compressor piston/cylinder clearance space causing compressor failure and/or reduced capacity.

The thermostatic expansion valve meters refrigerant to the evaporator using a thermal sensing element (power element) to monitor the level of superheat exiting the evaporator coil. This valve maintains a relatively constant superheat by opening or closing in response to a thermal sensing element.
Remember that superheat is the amount of heat added to a gas above its boiling point. And if you have superheat in the suction gas then there is no liquid refrigerant. But too much superheat is not desirable because you are losing space where liquid refrigerant could be.

Parts and Pieces

The thermostatic expansion valve is composed of many individual pieces. These parts and made to very close tolerances and precision. The valve body has is accurately machined piece of brass or stainless steel that holds the cage assembly and has an inlet and outlet fitting for the refrigerant piping. The connections for the refrigeration system piping could be flanged, flared or soldered type. Located on this valve body may be a ¼" external equalizer fitting.



The diaphragm, made of thin metal, is located inside the power element and moves the needle in and out of the valve seat in response to system load requirements. The size of the needle and seat area determines how much liquid refrigerant will pass through the valve with a specific pressure drop.

The internal spring (also known as the superheat spring) is one of the three operating pressures that act on the diaphragm. This spring tends to be a closing force for the TEV by pushing the needle into the seat. If the valve has an adjustment stem, the stem applies more or less pressure on the diaphragm for different superheat values. Turning the stem clockwise increases superheat while turning the stem counterclockwise decreases superheat. The spring is usually set for a factory setting of 8 to 12 degrees of superheat.

The power element consists of the thermal bulb, transmission line and diaphragm. This portion is either welded or screwed onto the valve body. The charge inside the thermal bulb and transmission line is a refrigerant which correlates to a known temperature pressure relationship. The pressure from the thermal bulb is on the top of the diaphragm and is an opening force on the valve. The pressure on the bottom side of the diaphragm is the spring pressure as well as the suction pressure. The spring and suction pressures tend to be closing forces. As the temperature of the thermal bulb increases, due to an increased load on the evaporator, the temperature/pressure relationship of the bulb also increases. As the pressure increases the valve tends to move to the more open position allowing more refrigerant to flow to satisfy the load requirements.

The power element charges may contain a liquid charge, cross liquid charge, vapor charge or a cross vapor charge.

Operation

There are three fundamental pressures acting on the valve's diaphragm which affect its operation. The first is the thermal sensing bulb pressure (**P1**). This pressure is a function of the temperature of the thermostatic charge inside the power element. The pressure acts on the top of the valve diaphragm causing the valve to move to a more open position. The second is the evaporator pressure (**P2**) and the third is the pressure of the spring (**P3**) inside the valve body. The suction and spring pressures act together underneath the diaphragm causing the valve to move to a more closed position. During normal valve operation, the sensing bulb pressure must equal the suction pressure plus the spring pressure.

P1 = P2 + P3

The function of the sensing bulb is to sense the temperature of the refrigerant vapor as it leaves the evaporator. Ideally, the bulb temperature will exactly match the refrigerant vapor temperature. As the bulb temperature increases, bulb pressure also increases causing the valve pin to move away from the valve seat, allowing more refrigerant to flow into the evaporator. The valve continues in this opening direction until the evaporator pressure increases sufficiently such that the sum of the evaporator and spring pressures balance with the sensing bulb pressure. On the other hand, as the bulb temperature decreases, the sensing bulb pressure decreases causing the valve pin too move toward the valve seat, allowing less refrigerant to flow into the evaporator. The valve continues to close until the evaporator pressure decreases sufficiently such that the sum of the evaporator and spring pressures balance with the bulb pressure.

A change in refrigerant vapor temperature at the outlet of the evaporator is caused by one of two events. The first is if the spring pressure is altered by means of the valve adjustment and the second is the heat load on the evaporator changes. When the spring pressure is increased by turning the valve adjustment clockwise, refrigerant flow into the evaporator is decreased. Vapor temperature at the evaporator outlet increases since the point where the refrigerant completely vaporizes moves further back within the evaporator, leaving more evaporator surface area to heat the refrigerant in its vapor form. The actual refrigerant vapor and bulb temperature will be controlled at the point where bulb pressure balances with the sum of the evaporator and spring pressures. Conversely, decreasing spring pressure by turning the valve adjustment counterclockwise increases refrigerant flow into the evaporator and decreases refrigerant vapor and bulb temperature. Spring pressure determines the superheat at which the valve controls. Increasing spring pressure increases superheat, decreasing spring pressure decreases superheat.

An increase in the heat load on the evaporator causes refrigerant to evaporate at a faster rate. As a result, the point of complete vaporization of the refrigerant flow is moved further back within the evaporator. Refrigerant vapor and bulb temperature increase, causing bulb pressure to rise and the valve to move in an opening direction until the three pressures are in balance. Conversely, a reduction in the heat load on the evaporator will cause the vapor and bulb temperature to fall and the valve to move in a closed direction until the three pressures are in balance. Unlike a change in the spring pressure due to valve adjustment, a change in the heat load on the evaporator does not appreciably affect the superheat at which the thermostatic expansion valve controls. This is due to the fact that the thermostatic expansion valve is designed to maintain an essentially constant difference between bulb and evaporator pressures, thus controlling superheat regardless of the heat load.

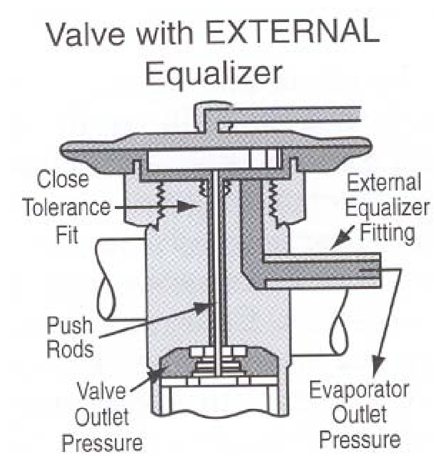
Effect of Pressure Drop Across the Valve Port

An additional pressure affecting valve operation, which is not considered fundamental, arises from the actual pressure drop across the valve port. This pressure (**P4)** can be related to the three fundamental pressures as the product of pressure drop across the valve port and the ratio of the port area to the effective area of the diaphragm. With conventional TEV design, this pressure is an opening influence since refrigerant flow tends to move the valve in an opening direction. The original equation is changed to **P1 + P4 = P2 + P3**. Also, as you can see from the chart below, as the pressure drop across the valve increases the flow rate capacity of the valve increases.

EVAPORATOR TEMPERATURE (°F)	PRESSURE DROP ACROSS TEV (PSI)											
	30	50	75	100	125	150	175	200	225	250	275	300
	CORRECTION FACTOR, CF PRESSURE DROP											
40°	0.55	0.71	0.87	1.00	1.12	1.22	1.32	1.41	1.50	1.58	1.66	1.73
20° & 0°	0.49	0.63	0.77	0.89	1.00	1.10	1.18	1.26	1.34	1.41	1.48	1.55
– 10° & – 20°	0.45	0.58	0.71	0.82	0.91	1.00	1.08	1.15	1.22	1.29	1.35	1.41
– 40°	0.41	0.53	0.65	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.25	1.31

Equalization Method

External equalized



Evaporator coils tend to have a pressure drop from the inlet to the outlet of the coil. This pressure drop could come from the coil itself because of long circuitry or a distributor is placed behind the expansion valve. If there is a 2.5 psig pressure drop from the inlet to the outlet of the evaporator coil an external equalizer valve should be used. If excessive pressure is present the TEV will cause the valve to starve the coil of liquid refrigerant and the valve capacity will be inefficient. Since a lower closing pressure is felt under the diaphragm, the opening force of the TXV is greater and the valve tends to remain opens more and fill the evaporator coil with refrigerant.

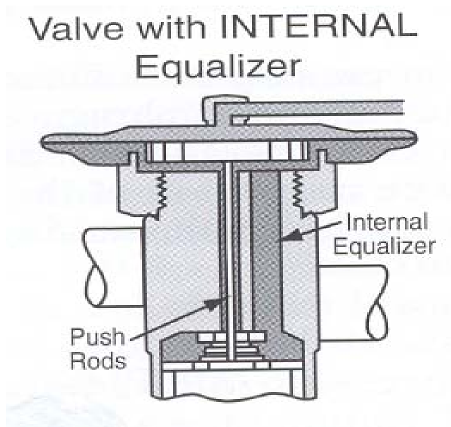
If the valve is externally equalized, the underside of the valve diaphragm is isolated from the valve outlet pressure by the use of packing material around the push rods or with push rods which are closely fitted. Evaporator pressure is transmitted to the diaphragm by a tube connecting the suction line near the evaporator outlet to an external fitting on the valve. The external fitting is connected to a passageway which leads to the underside of the valve diaphragm.

An externally equalized TEV may be used for all refrigeration applications. It provides no operational disadvantages with respect to an internally equalized valve other than requiring an external equalizer line be connected.

When an externally equalized valve is used, the equalizer connection on the thermostatic expansion valve must be connected to the outlet of the evaporator coil and ***not*** capped or plugged.

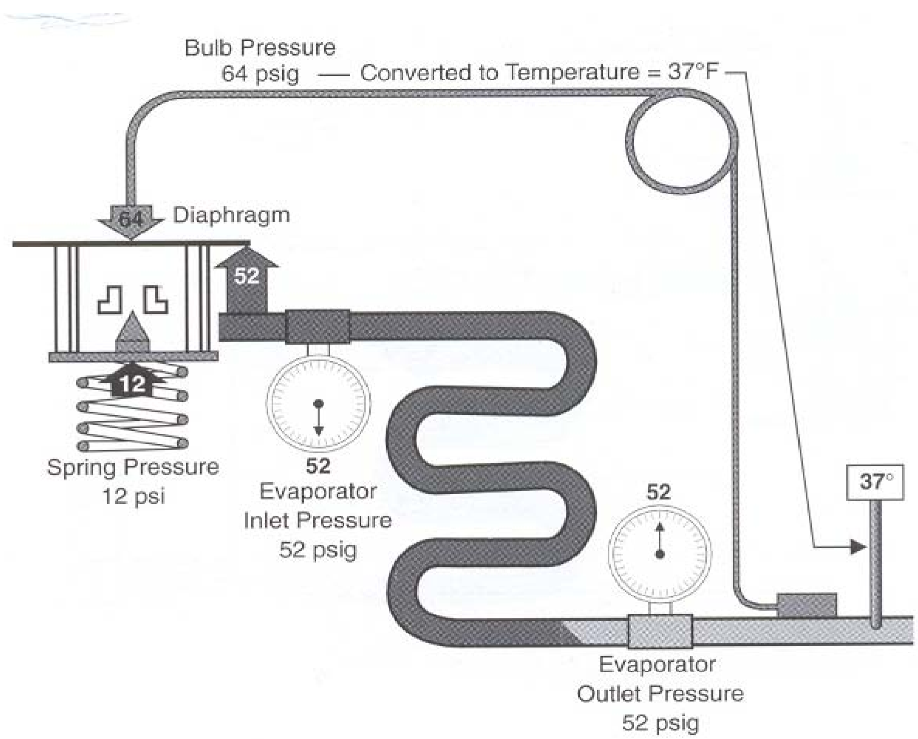
Internal Equalized

Evaporator pressure is transmitted to the underside of the valve diaphragm via a passageway within the valve body or through a clearance around the push rods. Internal equalized TEV's should be limited to single circuit evaporator coils having a pressure drop no greater than the equivalent of a 2º F saturated temperature change. Refer to the table below for recommended maximum allowable pressure drop values for internally equalized valves.



Refrigerant	Evaporating Temperature º F				
	40	20	0	- 20	- 40
	Pressure Drop -- psi				
R-12, R-134a	2.00	1.50	1.00	0.75	----
R-22	3.00	2.00	1.50	1.00	0.75
R-404A, R-502, R-507	3.00	2.50	1.75	1.25	1.00
R-717 (Ammonia)	3.00	2.00	1.50	1.00	---

Figure 1



Closing pressure (Evaporator inlet pressure + spring pressure)……………………52 + 12 = 64 psig

Bulb pressure necessary to open valve…………………………………………………... = 64 psig

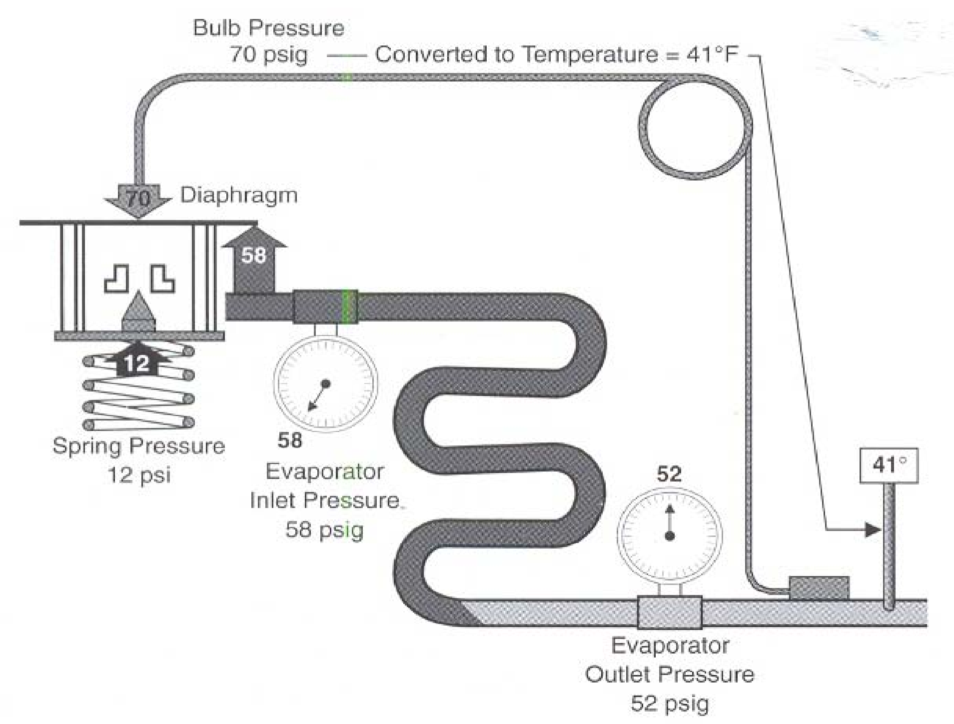
Bulb Pressure equivalent to 64 psig………………………………………………………..37º F

Saturated temperature equivalent to evaporator outlet pressure………………………………...28º F

Superheat (Bulb temperature minus saturated evaporator temperature)..………………………..9º F

The above diagram shows an internally equalized valve feeding a single circuit evaporator which has no pressure drop. The system refrigerant is R-22 and the power element thermostatic charge is also charged with R-22. The evaporator pressure at the valve outlet and at the sensing bulb location is 52 psig. The sum of this pressure and the 12 psi spring pressure produces a 64 psig pressure in the closing direction. For the valve to properly operate, a 64 psig opening bulb pressure is required to balance pressure. Since the sensing bulb consists of liquid R-22, its pressure temperature characteristic is identical to the saturation curve of R-22, and a 37º F bulb temperature is required. The superheat at which the valve is controlling is calculated by subtracting the saturation temperature of the evaporator pressure at the thermal sensing bulb location from the bulb temperature. In this case, the superheat is 9º F.

Figure 2



Closing pressure (Evaporator inlet pressure + spring pressure)……………………58 + 12 = 70 psig

Bulb pressure necessary to open valve…………………………………………….….. = 70 psig

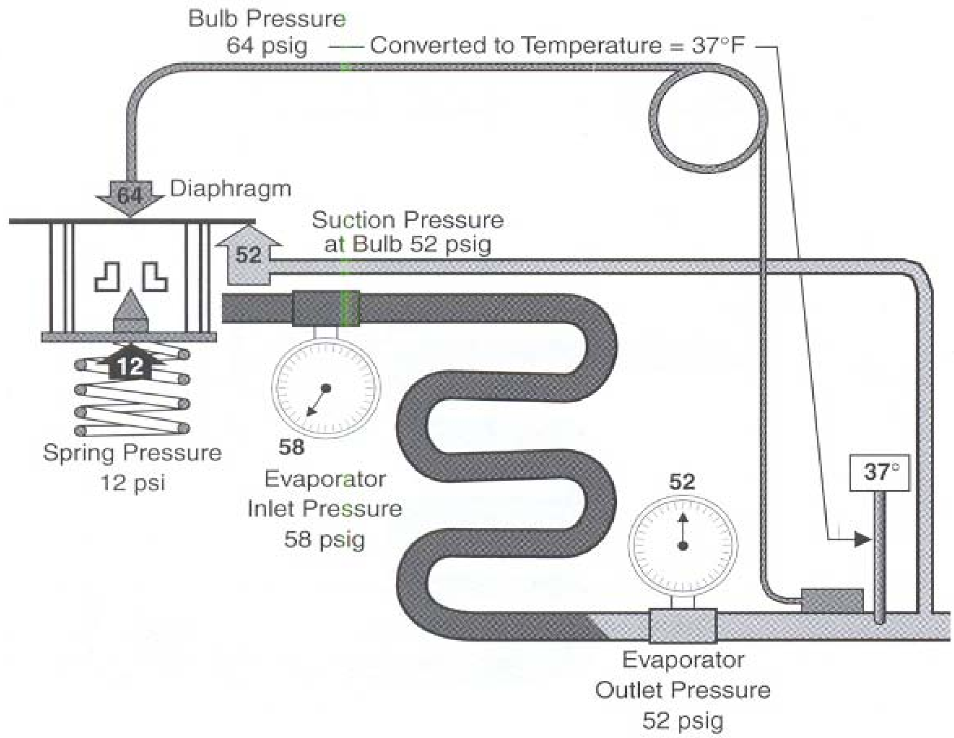
Bulb Pressure equivalent to 64 psig………………………………………………………..41º F

Saturated temperature equivalent to evaporator outlet pressure………………………………...28º F

Superheat (Bulb temperature minus saturated evaporator temperature)..………………...……..13º F

Figure 2 shows the same internally equalized valve on a system having the same evaporator pressure at the sensing bulb location. The evaporator coil now has a pressure drop of 6 psi. Since an internally equalized valve senses evaporator pressure at the valve outlet, the total pressure in the closing direction becomes 58 psig plus the 12 psi spring pressure or 70 psig. A bulb pressure of 70 psig is now required for proper valve regulation, which translates to a 41º F bulb temperature. The superheat becomes 13º F, or
4º F higher than the superheat calculated in Figure 1. This rise in superheat is due to the pressure drop in the evaporator. Consequently, pressure drop between the valve outlet and the sensing bulb location causes an internally equalized TEV to operate at a higher than desired superheat.

Figure 3



Closing pressure (Evaporator inlet pressure + spring pressure)……………………52 + 12 = 64 psig

Bulb pressure necessary to open valve…………………………………………….. = 64 psig

Bulb Pressure equivalent to 64 psig……………………………………………………..37º F

Saturated temperature equivalent to evaporator outlet pressure………………………………...28º F

Superheat (Bulb temperature minus saturated evaporator temperature)..………………………..9º F

Figure 3 shows the same system as in Figure 2, but with an externally equalized TEV installed. Since an externally TEV senses evaporator pressure at the outlet of the evaporator, it is not influenced by pressure drop through the evaporator. As a result, the TEV senses the correct pressure, and controls at the desired superheat.

An externally equalized TEV should be used whenever a refrigerant distributor is used with the evaporator.

Thermostatic Charges

As stated previously, the TEV's sensing bulb transmits pressure to the top of the diaphragm by a length of capillary tubing. The *thermostatic charge* is the substance in the TEV's sensing bulb which responds to suction line temperature to create the bulb pressure, and it is designed to allow the TEV to operate at a satisfactory level of superheat over a specific range of evaporating temperatures. The subject of thermostatic charges is best approached by describing the categories into which charges are classified. These categories include the following:

1. Liquid charge
2. Gas charge
3. Liquid cross charge
4. Gas cross charge
5. Adsorption Charge

The conventional liquid charge consists of the same refrigerant in the thermostatic power element that is used in the refrigeration system, while the liquid cross charge consists of a refrigerant mixture. The term cross charge arises from the fact that the pressure temperature characteristic of the refrigerant mixture used within the sensing bulb will cross the saturation curve of the system refrigerant at some point.

Both the liquid and liquid cross charges possess sufficient liquid such that the bulb, capillary tubing, and diaphragm chamber will contain some liquid under all temperature conditions. This characteristic prevents charge migration of the thermostatic charge away from the sensing bulb if the sensing bulb temperature becomes warmer than other parts of the thermostatic element. Charge migration will result in loss of valve control. An additional characteristic of these charges is their lack of a maximum operating pressure (MOP) feature. A thermostatic charge with an MOP feature causes the TEV to close above a predetermined evaporator pressure, thereby restricting flow to the evaporator and limiting the maximum evaporator pressure at which the system can operate.

Similarly, the gas charge consists of the same refrigerant in the thermostatic element that is used in the refrigeration system while the gas cross charge consists of a refrigerant mixture. Unlike the liquid type charges, both gas charges are distinguished by having a vapor charge in the thermostatic element which condenses to a minute quantity of liquid when the TEV is in its normal operating range. This characteristic provides an MOP for the valve at the bulb temperature of which the liquid component of the charge becomes vapor. Above this bulb temperature, a temperature increase does not significantly increase thermostatic charge pressure, limiting the maximum evaporator pressure at which the system can operate. A disadvantage of this type of thermostatic charge is the possibility of charge migration.

The adsorption charge consists of a noncondensable gas and an adsorbent material located in the sensing bulb. As the temperature of the bulb increases, gas is expelled (desorbed) from the adsorbent material increasing bulb pressure. Conversely, as the temperature of the bulb decreases, gas is adsorbed thus decreasing bulb pressure. Like the liquid and liquid cross charges, the adsorption charge does not provide an MOP, and it will not migrate.

Factors Affecting Operation and Performance

Superheat is defined as the difference between the refrigerant vapor temperature and its saturated temperature. To properly measure the superheat the TEV is controlling, the pressure temperature method is used. This method consists of measuring the suction pressure at the thermal sensing bulb location, converting the pressure to its saturation temperature by using a pressure temperature (P/T) chart, and subtracting the saturation temperature from the vapor temperature measured at the thermal sensing bulb location. As an example you have an R-22 system operating with a 68.6 psig suction pressure. The temperature measured at the thermal sensing bulb location is 50º F. Determine the amount of superheat. First convert the 68.6 psig to a saturated temperature. From the P/T chart find 68.6 under the R-22 column and find its corresponding temperature. It is 40º F. The temperature measured at the thermal sensing bulb location is 50º F. Subtracting the two equals 10º F superheat.

Vacuum-Inches of Mercury— *Italic* Figures

SPORLAN **TEMPERATURE PRESSURE CHART**

Pressure-Pounds Per Square Inch Gage **Bold** Figures

TEMPERATURE °F	REFRIGERANT (SPORLAN CODE)				
	R-22(V)	R-410A(Z)	R-407C(N)	R-12(F)	R-134a(J)
-60	*11.9*	*0.9*	*16.0*	*19.0*	*21.6*
-55	*9.2*	1.8	*13.7*	*17.3*	*20.2*
-50	*6.1*	4.3	*11.1*	*15.4*	*18.6*
-45	*2.7*	7.0	*8.1*	*13.3*	*16.7*
-40	0.6	10.1	*4.8*	*11.0*	*14.7*
-35	2.6	13.5	*1.1*	*8.4*	*12.3*
-30	4.9	17.2	1.5	*5.5*	*9.7*
-25	7.5	21.4	3.7	*2.3*	*6.8*
-20	10.2	25.9	6.2	0.6	*3.6*
-18	11.4	27.8	7.2	1.3	*2.2*
-16	12.6	29.7	8.4	2.1	*0.7*
-14	13.9	31.8	9.5	2.8	0.4
-12	15.2	33.9	10.7	3.7	1.2
-10	16.5	36.1	11.9	4.5	2.0
-8	17.9	38.4	13.2	5.4	2.8
-6	19.4	40.7	14.6	6.3	3.7
-4	20.9	43.1	15.9	7.2	4.6
-2	22.4	45.6	17.4	8.2	5.5
0	24.0	48.2	18.9	9.2	6.5
1	24.8	49.5	19.6	9.7	7.0
2	25.7	50.9	20.4	10.2	7.5
3	26.5	52.2	21.2	10.7	8.0
4	27.4	53.6	22.0	11.3	8.6
5	28.3	55.0	22.8	11.8	9.1
6	29.1	56.4	23.7	12.4	9.7
7	30.0	57.9	24.5	12.9	10.2
8	31.0	59.3	25.4	13.5	10.8
9	31.9	60.8	26.2	14.1	11.4
10	32.8	62.3	27.1	14.7	12.0
11	33.8	63.9	28.0	15.3	12.6

TEMPERATURE °F	REFRIGERANT (SPORLAN CODE)				
	R-22(V)	R-410A(Z)	R-407C(N)	R-12(F)	R-134a(J)
12	34.8	65.4	29.0	15.9	13.2
13	35.8	67.0	29.9	16.5	13.8
14	36.8	68.6	30.9	17.1	14.4
15	37.8	70.2	31.8	17.7	15.1
16	38.8	71.9	32.8	18.4	15.7
17	39.9	73.5	33.8	19.0	16.4
18	40.9	75.2	34.8	19.7	17.1
19	42.0	77.0	35.9	20.4	17.7
20	43.1	78.7	36.9	21.1	18.4
21	44.2	80.5	38.0	21.8	19.2
22	45.3	82.3	39.1	22.5	19.9
23	46.5	84.1	40.2	23.2	20.6
24	47.6	85.9	41.3	23.9	21.4
25	48.8	87.8	42.4	24.6	22.1
26	50.0	89.7	43.6	25.4	22.9
27	51.2	91.6	44.7	26.1	23.7
28	52.4	93.5	45.9	26.9	24.5
29	53.7	95.5	47.1	27.7	25.3
30	54.9	97.5	48.4	28.5	26.1
31	56.2	99.5	49.6	29.3	26.9
32	57.5	101.6	50.9	30.1	27.8
33	58.8	103.6	52.1	30.9	28.6
34	60.2	105.7	53.4	31.8	29.5
35	61.5	107.9	54.8	32.6	30.4
36	62.9	110.0	56.1	33.5	31.3
37	64.3	112.2	57.5	34.3	32.2
38	65.7	114.4	58.9	35.2	33.1
39	67.1	116.7	60.3	36.1	34.1
40	68.6	118.9	61.7	37.0	35.0
41	70.0	121.2	63.1	37.9	36.0

TEMPERATURE °F	REFRIGERANT (SPORLAN CODE)				
	R-22(V)	R-410A(Z)	R-407C(N)	R-12(F)	R-134a(J)
42	71.5	123.6	64.6	38.9	37.0
43	73.0	125.9	66.1	39.8	38.0
44	74.5	128.3	67.6	40.8	39.0
45	76.1	130.7	69.1	41.7	40.0
46	77.6	133.2	70.6	42.7	41.1
47	79.2	135.6	72.2	43.7	42.2
48	80.8	138.2	73.8	44.7	43.2
49	82.4	140.7	75.4	45.7	44.3
50	84.1	143.3	77.1	46.7	45.4
55	92.6	156.6	106.0	52.1	51.2
60	101.6	170.7	116.2	57.8	57.4
65	111.3	185.7	127.0	63.8	64.0
70	121.5	201.5	138.5	70.2	71.1
75	132.2	218.2	150.6	77.0	78.6
80	143.7	235.9	163.5	84.2	86.7
85	155.7	254.6	177.0	91.7	95.2
90	168.4	274.3	191.3	99.7	104.3
95	181.9	295.0	206.4	108.2	113.9
100	196.0	316.9	222.3	117.0	124.1
105	210.8	339.9	239.0	126.4	134.9
110	226.4	364.1	256.5	136.2	146.3
115	242.8	389.6	274.9	146.5	158.4
120	260.0	416.4	294.2	157.3	171.1
125	278.1	444.5	314.5	168.6	184.5
130	297.0	474.0	335.7	180.5	198.7
135	316.7	505.0	357.8	192.9	213.5
140	337.4	537.6	380.9	205.9	229.2
145	359.1	571.7	405.1	219.5	245.6
150	381.7	607.6	430.3	233.7	262.8
155	405.4	645.2	456.6	248.6	281.0

To determine ***subcooling*** for refrigerant R-407C use BUBBLE POINT values (Temperatures above 50°F — Gray Background); to determine ***superheat*** R-407C, use DEW POINT values (Temperatures 50°F and below).

Subcooling on the other hand is defined as the difference between the refrigerant liquid temperature and its saturation temperature. For example, figure the amount of subcooling of R-22 liquid at 85º F and 196 psig. Convert the 196 psig to it saturated temperature from P/T chart. Its temperature is equal to 100º F. Subtract 100º F from 85º F leaving 15º F subcooling.

The most desirable operating superheat for a particular system largely depends on the temperature difference (TD) between the refrigerant and the medium being cooled. The basic definition of TD is the difference between evaporator temperature and the entering temperature of the medium being cooled whether it is water or air. Systems with a high TD, such as air conditioning and heat pump systems, can tolerate higher superheats without appreciable loss in system capacity. Refrigeration and low temperature systems require low superheats due to their lower TDs.

Application	Air Conditioning & Heat Pump	Commercial Refrigeration	Low Temperature Refrigeration
Evaporator Temperature º F	50º F to 40º F	40º F to 0º F	0º F to -40º F
Suggested Superheat Setting	8º F to 12º F	6º F to 8º F	4º F to 6º F

Sensing bulb location is critical to the correct operation of the TEV. The TEV's sensing bulb should be located on a clean, straight section of horizontal piping of the suction line near the evaporator outlet and, in the case of an externally equalized valve, upstream of the equalizer connection. Generally on suction lines that are 7/8" and larger, it should be installed at 4 or 8 o'clock on the side of the horizontal line. On smaller lines the bulb may be mounted at any point around the circumference except the bottom of the line where oil may influence the sensitivity. As with any component always check the installation instructions that come with the component. Always follow and adhere to manufacturers recommendations.

Final Thoughts

TEV's have been around for some time now and they are going to have a greater impact on metering device usage in the future. With the new energy efficiency guidelines that are coming forth, these controls will be used almost exclusively. Since these are the premiere metering devices for air conditioning, refrigeration and heat pump applications it is important for you to have a basis understanding of the application, installation and operation of these controls.

Special thanks go to Sporlan Valve Company for material used in this Tech Tip.