

TROUBLESHOOTING Thermal Expansion Valves

With the advent of the 13 SEER regulations in January 2007, nearly every manufacturer of split residential air-conditioning equipment changed their designs from using flow raters to using thermal expansion valves (TXVs) for controlling the rate at which refrigerant is fed to the evaporator. The TXV enables a more energy-efficient system because it maintains the evaporator closer to the optimum superheat at all operating conditions, and it enables the system to pull-down to optimum conditions faster after an off cycle.

TXV function and operation

Although TXVs offer many operating advantages, they are viewed as a somewhat mysterious device by those not familiar with them and as a result are often replaced needlessly. The TXV has only one function. It meters the flow of liquid refrigerant into the evaporator in exact proportion to the evaporation rate of the refrigerant in the evaporator. By responding to the temperature of the refrigerant gas leaving the evaporator and the pressure of the evaporator, the TXV can control the gas leaving the evaporator at a predetermined superheat.

Superheat is the temperature of a vapor above its saturation temperature. It is found by measuring the actual temperature at the outlet of the evaporator and subtracting the temperature corresponding to the evaporating pressure from it.

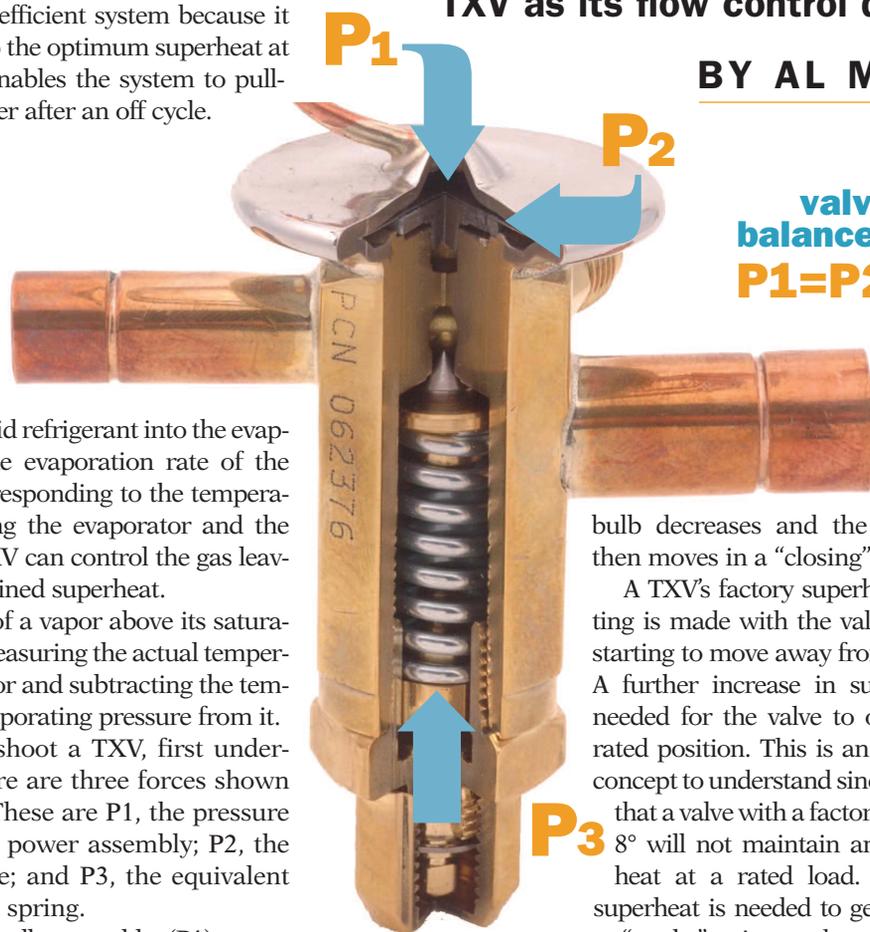
In order to correctly troubleshoot a TXV, first understand how the valve works. There are three forces shown that govern a TXV's operation. These are P1, the pressure created by the remote bulb and power assembly; P2, the evaporator or equalizer pressure; and P3, the equivalent spring pressure of the superheat spring.

The pressure in the remote bulb assembly (P1) corresponds to the refrigerant temperature leaving the evaporator. As this pressure increases, it tends to move the valve in an "opening" direction. Opposed to this force on the diaphragm's underside and acting in a closing direction is the force exerted by the evaporator pressure and the pressure exerted by the superheat spring. The valve will assume a stable position when these forces are in equilibrium ($P1=P2+P3$).

As the temperature of the refrigerant leaving the evaporator increases above its saturation temperature—corresponding to the evaporator pressure—the pressure in the remote bulb increases, causing the valve pin to move in an "opening" direction. Conversely, as the refrigerant gas temperature leaving the evaporator decreases, the pressure in the remote

Here is the correct way to diagnose and troubleshoot a system with a TXV as its flow control device.

BY AL MAIER



valve is in balance when $P1=P2+P3$

bulb decreases and the valve pin then moves in a "closing" direction.

A TXV's factory superheating setting is made with the valve pin just starting to move away from the seat. A further increase in superheat is needed for the valve to open to its rated position. This is an important concept to understand since it means that a valve with a factory setting of 8° will not maintain an 8° superheat at a rated load. Additional superheat is needed to get the valve to "stroke" to its rated capacity.

Troubleshooting TXVs

There are three principle modes of failure of a TXV. The valve may feed too much refrigerant (flooding); it may not feed enough refrigerant (starving); or can alternately feed too much and then too little (hunting). Each of these will be discussed in greater detail:

Flooding

Flooding occurs when the refrigerant amount being fed to the evaporator is more than can be evaporated, resulting in liquid refrigerant going back to the compressor. Symptoms of flooding include frosting of the compressor

shell, noisy compressors, low superheat at the evaporator, and normal- or higher-than-normal suction pressures. Causes of flooding include:

- **Undersized or inefficient compressor.** If the compressor capacity is low, the suction pressure will be higher than normal and the superheat will be low. If this condition is suspected, consult with the compressor manufacturer;

- **Low superheat setting.** On externally adjustable valves, turn the adjusting stem clockwise to increase the superheat;

- **Moisture.** Any moisture in the system can freeze in the TXV, preventing the valve from functioning as intended. If this is suspected, install a high-quality liquid-line filter drier. It also is advisable to install a liquid-line moisture indicator to enable the technician to monitor the moisture level within the operating system;

- **Dirt or debris.** Any foreign material that gets past the inlet strainer can become lodged between the pin and the port of the TXV, preventing it from properly closing. Here again, a high-quality filter drier should be installed in the system to prevent the circulation of dirt and debris and cause system malfunctions;

- **TXV seat leak.** If the pin and port do not seat properly, liquid refrigerant will flow through the valve when there should be none. Inspecting the valve may reveal dirt and debris, in which case the TXV can be cleaned and put back into service. Inspection may also reveal damage to the pin or port due to wire drawing or erosion of the pin. In such a case, the valve should be replaced;

- **Oversized valve.** Make certain the correct valve specified by the equipment manufacturer is installed in the system. A valve too large for the capacity of the system will tend to overfeed; and

- **Incorrect bulb position.** Ideally, the power element bulb should be attached to a horizontal run of suction line—immediately after the evaporator outlet. It should be in close proximity to the equalizer connection, but upstream of it. The bulb needs to be firmly attached to the suction line to maintain good thermal contact. Additionally, the bulb must not be influenced by external sources of heat.

Measuring/adjusting superheat steps

To measure superheat:

1. Determine suction pressure at the evaporator outlet;
2. Use a pressure/temperature chart for the appropriate refrigerant, and determine the saturation temperature corresponding to the pressure measured in step 1;
3. Measure the temperature of the suction line at the remote bulb location; and
4. Subtract the saturation temperature determined in step 2 from the temperature measured in step 3. The difference is the superheat.

Adjusting superheat for externally adjustable TXVs only:

1. Remove the seal cap from the bottom of the valve, exposing the adjusting stem;
2. Rotate the stem clockwise to increase the superheat—decreases flow of refrigerant; and
3. Rotate the stem counterclockwise to decrease the superheat—increases flow of refrigerant.

Starving

Starving occurs when the refrigerant amount feeding the evaporator is fully evaporated long before the outlet. Symptoms of starving include insufficient refrigeration effect—warmer than desired load temperature—high superheat at the evaporator outlet and low-suction pressure. Causes of starving include:

- **Moisture.** Any moisture in the system can freeze in the TXV, preventing the valve from functioning as intended. If this is suspected, install a high-quality liquid-line filter drier. It is also advisable to install a liquid-line moisture indicator so the technician can monitor the moisture level within the operating system;

- **Dirt or debris.** Any foreign material that gets past the inlet strainer can become lodged between the pin and the TXV's port, preventing it from correctly closing. Here again, a high-quality filter drier should be installed in the system to prevent the circulation of dirt and debris that cause system malfunctions;

- **Insufficient Delta P across valve.** If the pressure drop across the valve is too low the valve's capacity is reduced. This sometimes happens during low ambient operation when the head pressure is allowed to "float" with the ambient. To correct for this, raise the head pressure or replace the valve with one that has a larger capacity;

- **Undercharged system.** If a system is low on charge then the superheat will be high, the suction pressure low, but the system still will not provide sufficient cooling. A sight glass installed in the liquid line immediately before the TXV is the best way to determine this. "Bubbles" in the sight glass are a clear indication that the system is low on charge. On residential A/C systems, the manufacturers include a chart indicating what the correct pressures are in different operating conditions. These tables can be used to determine if the system charge is correct. Additionally, measure the subcooling at the inlet of the TXV. If there is no subcooling, that too is an indication that the system charge is low;

- **Flash gas at inlet to TXV.** Any restrictions in the liquid line leading to the TXV inlet will cause a pressure drop and result in flash-gas formation. Because the gas density is much less than that of liquid refrigerant, having flash gas feeding the TXV will reduce the valve's capacity and cause high superheat and starving. Flash gas can be found in the following ways:

1. Look for frost or moisture on the liquid line. As the flash gas is formed, it causes a refrigeration effect making the area around it cold. Since the liquid line is normally warm to the touch, a cold spot is usually a sure sign that a restriction exists at that point;

2. If a sight glass is installed,

look for bubbles. A steady stream of bubbles indicates either a low charge or vapor in the liquid line; and

3. Check for subcooling. If subcooled liquid is present at the outlet of the condenser, but not at the inlet of the evaporator, then determine where you have lost the subcooling. In some cases, the liquid line may be undersized, or liquid-to-suction heat exchange may have been lost, resulting in a loss of subcooling.

- **Plugged equalizer line.** If the equalizer line is plugged, the pressure underneath the diaphragm can be higher than the actual evaporator pressure, resulting in a valve that tends to be in a more “closed” position. To correct this, replace or repair the equalizer line;

- **Valve too small.** Check that the valve is correctly sized for the system. Replace with the proper sized valve;

- **Superheat adjusted too high.** On externally adjustable valves, turn the adjusting stem counterclockwise to decrease the superheat;

- **Power assembly failure or partial loss of charge.** If the power assembly has lost all or part of its charge, it will not generate sufficient pressure to cause the valve to “open.” A tech can verify this in the field by holding the bulb in his hand while monitoring the system operating conditions. Hand warmth should cause the pressure to increase, resulting in increased refrigerant flow and an increase in suction pressure. If no change is noted, the valve may have lost its charge. This technique is only valid if the system is correctly charged and the valve has high-quality liquid refrigerant at its inlet. If it is found that the valve has lost its charge, the power assembly must be replaced. In some cases, the power assembly is an integral part of the TXV, in which case the entire valve must be replaced.

- **Cross ambient effect.** Some TXVs have special charges designed to limit the maximum operating pressure of the system. These are designated with a “W” in the charge code followed by a number—for example HW100. With charges of this type, the bulb must always be colder than the power element or the valve’s body. If not, the charge can migrate from the bulb to the power element with a resultant loss of control. If this is suspected, replace the valve with a non-maximum evaporator pressure type charge—in this example, an R-22 refrigerant medium temperature (HC) or R-22 heat pump (HCA); and

- **Strainer clogged.** Dirt or debris in the refrigerant leading to the valve can result in the strainer becoming clogged. Remove and clean the strainers and add a high-capacity liquid-line filter drier to prevent recurrence.

Hunting

Hunting occurs when the TXV alternately opens and closes, causing large fluctuations in superheat. This can be caused by the difference in the time response of the system versus the TXV. Different type charges have been designed with various time constants to minimize this effect, but other factors—such as sudden changes in load or operation at low-load conditions—also can impact this. Causes of hunting include:

- **Valve oversized for application.** A valve that is too large for the application will tend to hunt. If this is suspected, replace the valve with one that is correctly sized for the application;

- **Bulb location.** Verify that the bulb is not located downstream of a P trap on the suction line. Relocate the bulb if this is found. It may also be helpful to insulate the bulb to make certain it is not affected by an air stream;

- **Refrigerant distribution.** On systems with distributors, it is not uncommon to have different circuits with largely differing loads. This can result in some circuits occasionally overfeeding sufficiently to allow liquid to reach the bulb. This, of course, will force the TXV closed until superheat is again achieved; at which time it will open. To correct this requires elimination of the distribution problem;

- **Superheat adjustment.** TXVs have their superheat set at the factory to operate correctly on most systems. At times, however, the factory setting may need to be adjusted. In most cases, increasing the superheat will minimize hunting. Turning the adjustment screw clockwise will increase the superheat; and

- **Moisture.** Any moisture in the system can freeze in the TXV, preventing the valve from functioning as intended. As the moisture freezes and then thaws, the superheat will vary erratically. The use of a high-quality liquid-line filter drier is recommended to prevent this. ♦

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