Size the Refrigerant Distributor Nozzle Right Now, Or Pay Later

During a refrigerant conversion, properly sizing the refrigerant distributor nozzle is a key to retaining efficiency and performance throughout the system.

By Chris Pate

It is simply amazing to think a component that costs just a few dollars can cause so much frustration when troubleshooting a refrigeration system at low load or a system with a hunting thermostatic expansion valve (TEV). A somewhat scarier thought is that this same component can cost hundreds, if not thousands, of dollars in troubleshooting labor or because of lost efficiency over the life of the refrigeration equipment. The component: the often overlooked or forgotten nozzle found in the refrigerant distributor.

This topic is increasingly relevant as more supermarket chains, concerned about the future availability and cost of R-22, convert their R-22 systems to more environmentally friendly and efficient refrigerants. As the pace of refrigerant conversions increases, more contractors—many unfamiliar with how to properly perform a refrigerant conversion—will find themselves involved.

Understanding the basics
Having said that, let us take a closer look at the purpose of the distributor nozzle, and how critical it is for the technician to properly size the nozzle during a refrigerant conversion for the system to maintain overall performance and efficiency.

The primary purpose of the distributor and nozzle is to ensure each circuit on a multi-circuited evaporator coil receives an equal amount of saturated (liquid and vapor) refrigerant. This equal distribution is accomplished by directing the saturated refrigerant exiting the TEV through the nozzle’s orifice. The orifice’s reduced area both accelerates the refrigerant directs it toward the tip of the dispersion cone. Traveling at a high velocity, the refrigerant hits the dispersion cone and creates a homogeneous liquid/vapor mixture. This mixture then travels down the circuit tubes, with an equal amount of refrigerant delivered to each evaporator circuit, as shown in Figure 1 below; this ensures the maximum amount of heat transfer is achieved and peak coil efficiency.

Figure 1 – The distributor and nozzle direct a liquid/vapor refrigerant mixture down circuit tubes, delivering refrigerant to each evaporator circuit.
Problem 1: the orifice is too large
If the nozzle’s orifice is too large, the refrigerant will lack the velocity needed to create a homogeneous mixture, and the liquid and vapor will separate. The denser liquid refrigerant will settle to the bottom: the circuits connected to the lower portion of the distributor will then receive more liquid; the upper circuits will get more vapor. This unequal circuit loading decreases the capacity of the evaporator and/or causes the TEV to hunt.

The answer as to why the TEV will hunt is pretty straightforward. The TEV senses the bottom circuit is flooded with liquid refrigerant, at 0˚ of superheat, and forces the TEV to close. This causes the top circuits—already starved of refrigerant—to operate at an even higher superheat. Once the bottom circuit is no longer flooding through with liquid, the TEV will sense the high superheat from the upper circuits and want to quickly open. This will once again flood the bottom circuit and start the cycle all over again.

Mounting the distributor in a vertical position may help in some cases, but it will not solve the problem for all systems with an oversized orifice. An easy way to determine unequal refrigerant-mixture distribution is via temperature measurement of each circuit tube where it exits the coil but before the suction manifold. As shown in Figure 2 below, if all the temperatures are within a few degrees of each other, refrigerant distribution is good; a wider temperature range may indicate poor refrigerant distribution. (Author’s Note: Uneven air flow or an unevenly distributed heat load across the coil can produce the same results.) This only applies to refrigeration coils, not air conditioning “A” or “N” coils.

Figure 2 – The difference between even and uneven circuit loading of refrigerant mixture is apparent in this diagram.

Problem 2: orifice is too small
A nozzle with an undersized orifice can also cause problems. If the orifice is too small, excessive pressure drop across the distributor nozzle occurs. Remember that pressure
drop is one of the major factors in determining TEV capacity; any excessive pressure drop created by the undersized orifice will rob the TEV of its available pressure drop, and reducing the TEV’s capacity. Lower TEV capacity may cause excessive pull down times at start-up, after a defrost cycle, or may not allow the system to pull down to its operating temperature. To counteract this capacity reduction, some contractors will simply lower the suction pressure settings so the system can reach temperature. However, lowering the suction pressure will cause the system to operate less efficiently and potentially negate any gains obtained by using more efficient refrigerants. Figure 3 illustrates the recommended pressure drops across the distributor nozzle and circuit tubes.

Technicians should not be alarmed if there isn’t 10 psi drop through the circuit tubes. Circuit tubes are provided with the coils that have been tested and approved for use by the coil manufacturers, so the tech should size the nozzle’s orifice accordingly to achieve the total recommended pressure drop. A number of tools are available to help calculate the pressure drop across the nozzle and circuit tubes.

Add R-422D after R-408A and before R-502

![Figure 3 – Recommended pressure drops across the distributor nozzles and circuit tubes.](image)

**Nozzles and refrigerant conversions**

After discussing the potential problems with incorrectly sized nozzle orifices, there are some things techs should keep in mind when performing a refrigerant conversion. First, an orifice’s capacity will change as when the technician changes a system from one refrigerant to another. For example, the same-size orifice that feeds 0.96 tons of capacity for R-22 will only feed 0.63 tons for R-404A, or 0.56 tons for R-422D on a 20°F evaporator. The capacity of the nozzle’s orifice is greatly affected when switching to or from R-22. Techs should take care when working with so-called “drop-in” refrigerants for R-22; the TEV and nozzle capacities will be reduced.

While a contractor may believe that no customer will pay to have all the nozzles in their display cases checked and/or replaced, most case manufacturers have standardized their coils to reduce cost. The manufacturer will use the same coil for a wide range of refrigerants, selecting a nozzle that will provide proper performance regardless of the refrigerant used. However, checking the sizing of the nozzles’ orifices on all walk-in coolers and freezers is crucial.

When doing an initial walkthrough to determine what parts are needed to complete the conversion, the contractor should write down all the evaporator model numbers for walk-in coolers and freezers, along with the distributor model types. This information is critical to properly size the nozzles and their orifices. Figure 4 illustrates the distributor nomenclature that should be written down. In Figure 5 the distributor
model type is needed to determine the nozzle size or letter, while the evaporator model number will be used to determine the orifice size or number.

Occasionally the technician will get lucky, and the orifice size will be stamped on the distributor body as shown in Figure 6. If this is not the case, however, the orifice size can only be determined by looking for the number stamped into the nozzle; this requires unbrazing the distributor from the TEV. For this situation, the tech can keep a stash of distributor nozzles at the jobsite and hope they have the correct ones; contact the coil manufacturer for the proper nozzle and orifice sizing prior to starting the job; or contact to the distributor manufacturer directly. Most distributor manufacturers have experienced personnel that can assist in properly sizing refrigerant nozzles and orifices, as well as double-check the TEV sizing.

Finally, some customers will add a mechanical subcooler to their system to improve system efficiency and/or to help counteract the reduced TEV capacity that occurs when switching from R-22. This greater capacity also applies to the nozzle. As shown in Figure 7 below, a decrease in liquid temperature from 100°F to 50°F will double the capacity of the nozzle. Again, the tech should make sure to check TEV and nozzle sizing if they are adding or removing a mechanical subcooler.

<table>
<thead>
<tr>
<th>Type</th>
<th>Number Circuits</th>
<th>Size Circuits</th>
<th>Nozzle Orifice Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1126</td>
<td>16</td>
<td>1/4”</td>
<td>17</td>
</tr>
</tbody>
</table>

Figure 4

Figure 5

Figure 6

Figure 7 – Nozzle capacity multipliers based on liquid temperature readings.

To reiterate, the distributor nozzle is often the most forgotten component in a system. The device’s simplicity can lead people to overlook or downplay its importance in the overall refrigeration system. But to the contractor who has replaced several TEVs
while trying to fix a hunting TEV or a store owner that is paying higher utility bills due to lost efficiency, it certainly is a top priority.

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