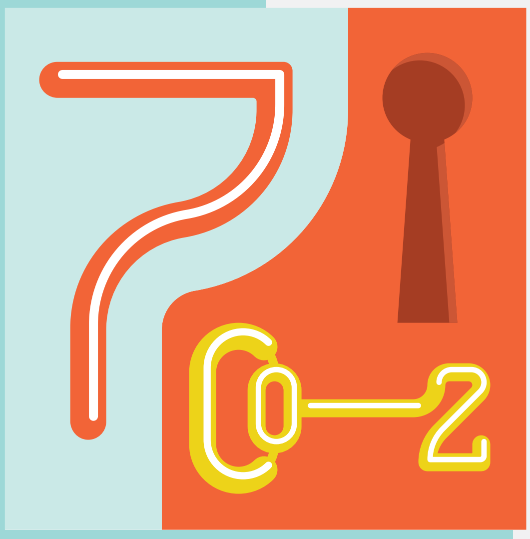

SEVEN KEYS TO SERVICING CO_2 SYSTEMS

Even with high pressures and other peculiarities, transcritical CO_2 systems are easy to manage if you're properly trained

By Andre Patenaude

Carbon dioxide (R744) continues to gain momentum as a leading option for refrigeration systems. In recent years it has demonstrated favorable results in a variety of system configurations, particularly in Europe, Australia and Canada. Investment costs are dropping, as innovations in component technology and application methods continue to reveal potential performance gains.

All of these results are ensuring that CO_2 will be a long-term option, making it valuable for service technicians to understand how they differ from HFC systems. Citing seven key strategies, this article will examine R744 transcritical systems from a service technician's perspective to help them effectively prepare for the refrigerant's unique properties.

1 KEEP COOL UNDER PRESSURE

Many technicians new to R744 are concerned about its higher operating pressures compared to HFCs. The good news is R744 is easy to manage if you're properly trained.

It's first important to know where the high-pressure areas are located. In a typical transcritical booster system, the really high pressures will only occur on a hot summer day between the medium-temperature compressors and the pressure-reducing valve, mostly on or near the roof.

Pressures in this area can reach extremes of up to 1,400 psig at 240°F (115.6°C) and typically require stainless steel piping, though high-pressure copper pipes are likely in the near future. The remainder of the system, however, will be in 400–500 psig range — almost the same pressures technicians are accustomed to in 410A high-side systems.

2 UNDERSTAND R744'S CRITICAL AND TRIPLE POINTS

The critical point of R744 is only 87.8 °F (31 °C)/1,055 psig, a relatively low temperature for a refrigerant. At this point, liquid and vapor densities become the same. Above the critical point the pressures and temperatures are independent of each other. R744 systems operating above this point are said to be in "supercritical" mode.

Another important concept to understand is the "triple point." The three phases of CO_2 (i.e., solid, liquid and vapor) coexist at -69.8 °F (-56.6 °C). That may seem low, but the corresponding pressure is 60.4 psig. R744 at that point will turn to dry ice in an instant.

For this reason technicians can't begin charging an R744 system with liquid because the internal pressures will be well below 60.4 psig. To be on the safe side, the system must be vapor-charged until all sections have equalized to around 145 psig before techs can switch to faster-charging liquid bottles.

3 OPTIMIZE EFFICIENCY IN WARM AMBIENT ENVIRONMENTS

Transcritical R744 systems work more efficiently in colder environments. In Toronto, Canada, for example, a system might only operate 200 hours per year in supercritical mode. In Atlanta, Ga., the same system could require 1,020 annual supercritical hours.

Manufacturers and suppliers are working to reduce annual supercritical time in warmer regions to fewer than 100 hours. Five strategies already underway include:

» Spray nozzles cool airflow across the condenser coil by misting water, keeping condensing temperatures lower.

» Adiabatic gas coolers create the same effect by trickling water down adiabatic pads mounted outside condensers. In the Atlanta example, an adiabatic system could reduce supercritical operation to below 100 hours per year.

» Parallel or "flash tank" compression uses an independent compressor to reduce energy consumption at high ambient temperatures.

» Subcooling continues to cool gas exiting the gas cooler, thereby increasing efficiency, even in warm ambient conditions.

» Ejectors allow systems to operate with very low superheat by converting high-pressure gas energy to useful work. This also adds efficiency by increasing saturated suction temperature.

4 PROACTIVELY MANAGE POWER OUTAGES AND STANDSTILL PRESSURES

When an R744 system shuts down, pressures build faster than in HFC systems. It's critical to have a strategy for "power off" conditions ahead of time, whether it's scheduled downtime or unscheduled interruptions like power outages.

One way to avoid losing R744 through pressure relief valves is to install a small standby condensing unit to cool liquid in the flash tank and keep the pressure down. Another option used in some smaller systems is a "fade-out" vessel that can increase system volume when the system is down.

5 PROVIDE PROPER EQUIPMENT FOR SERVICE TECHNICIANS

CO_2 rack manufacturers are making life easier for service technicians by including multiple pressure transducers and temperature sensors in their systems. Techs can call up readings on the controller to get specific information quickly. It's also a good idea to have a good calibrated gauge set with the proper high-pressure hoses in the machine room.

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USE BEST PRACTICES FOR R744 CYLINDER STORAGE, CHARGING AND MAINTENANCE 6

For an R744 system, it's important to have a refrigerant plan that accounts for three key issues:

» Local codes — Where can you store R744 cylinders? Do they have to be inside the building?

» Stock storage — If your system needs 2,000 pounds of CO_2, that's 4,600 pounds of cylinders and refrigerant. A mezzanine might not be the best place to put all that weight in a concentrated area.

» Transferring R744 to the machine room — If the machine room is on the mezzanine, it might be worthwhile to run permanent high-pressure hoses to a charging manifold on a ground-level storage area.

KNOW OTHER UNIQUE PROPERTIES OF R744 7

Understanding R744's peculiarities will significantly reduce maintenance costs and downtime. Here are a few final tips for smartly working with CO_2 systems.

Finding leaks can be challenging, especially if they're in a case. After all, there are already 400 parts per million of CO_2 in the air we breathe. Your detector can also be confused if you're trying to find a leak after hours while a floor buffer is in use.

Preventative maintenance is critical with R744 systems, partly for the business case. End users who install CO_2 systems want a positive return on investment. A proper maintenance plan will help ensure that.

Know the consequences of trapping R744. CO_2 pressure rises faster than HFC, so when techs add valves, they should make sure they're not trapping refrigerant between valves that could potentially close with no escape route. They must provide an escape route through a pressure relief or check valve to another area of the system protected by a pressure-reducing valve.

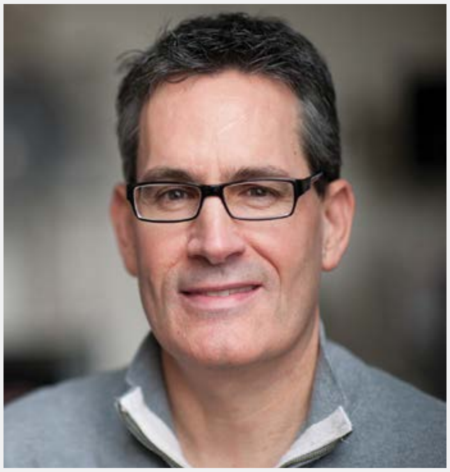
Keep it clean. R744 systems have a lot of joints, and it's important to purge nitrogen to reduce oxidation. Pressure will build up if there's too much metal, particulates or dirt in the system, potentially causing component failures.

Keep it dry. R744 liquid can hold about 20 times more moisture than its vapor form. Wet CO_2 in your liquid line can drop that moisture when it reaches the expansion valve, leaving free water in your evaporators. That's not a good thing because it leads to carbonic acid, which will eat away at the steel components of your system.

Techs can guard against this by making sure they have a moisture indicator in the liquid line that's sensitive enough to measure down to 8 parts per million at 14 °F (-10 °C) liquid.

Grade 4 R744 refrigerant, sometimes called "Coleman" grade, is recommended because it's 99.99 percent pure AP

This article merely scratches the surface, but rack and component manufacturers offer many other resources to make sure service technicians are properly informed when working on CO_2 systems. Watch for these as you pursue your education on R744.



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