MAKING the RIGHT Choices for R-410A Systems

New component selection choices and more rigorous servicing techniques are required to ensure success while working with R-410A equipment BY AL MAIER

Choosing the appropriate components during both design and service is necessary to ensure safety and increased R-410A system efficiency and reliability.

As the industry moves closer to the 2010 phaseout of R-22, more manufacturers are beginning to produce air-conditioning and refrigeration systems that use environmentally friendly HFC refrigerants such as R-410A. It is estimated that 15 percent to 20 percent of new air-conditioning units introduced into service in 2006 will use the chlorine-free, energy-efficient, nonflammable R-410A.

To accommodate its use, manufacturers have developed a new generation of components. As a result, both engineers and service technicians face choices today that did not previously exist.

Choosing the appropriate components during both design and service is necessary to ensure safety and increased R-410A system efficiency and reliability. This article will cover new component selection choices and the more rigorous servicing techniques that are required to ensure success while working with R-410A.

In the new world of HFC refrigerants, all the old rules regarding proper design and servicing of air-conditioning and refrigeration systems still apply. But the penalty for not using proper techniques when producing, assembling and servicing R-410A systems is much greater.

Choosing the wrong components

for an R-410A system can make the system susceptible to burst, which can lead to system failure and, worse yet, serious injury. Furthermore, not using proper service techniques will lead to repeated in-warranty system failures which are not only costly, but can cause irreparable damage to a contractor's reputation.

R-410A has unique performance specifications and characteristics for oil, moisture indication, thermal expansion valves, compressors, filter driers and refrigerant handling. By having a solid understanding of these characteristics, engineers and contractors can save time up front, design and build more reliable systems, and minimize system failures and their associated costs.

Refrigerant differences

The first and most noticeable difference between working with R-22 and R-410A exists in the system operating pressures. At a typical air conditioner evaporating temperature of 45° F, the saturated pressure of R-410A is 54 psi greater than that of R-22. At a typical condensing temperature of 100° F, the saturated pressure of R-410A is 121 psi greater than that of R-22.

Engineers and service technicians need to understand that the higher pressures of R-410A require contractors and technicians to use only new gauge sets that have been specially designed to handle the higher pressures. These high-pressure gauge sets are typically rated for 500 psi to 800 psi on the high side. All hoses also must be rated for 800 psi.

In addition to high-pressure gauge sets and hoses, use high-pressure recovery machines and tanks specifically designed for R-410A. Technicians should inspect equipment labels for the color rose, which is used to identify equipment designed for use with R-410A. By using high-pressure charging and recovery equipment, technicians and contractors can safely work with R-410A.

The higher pressures of R-410A also require air-conditioning and refrigeration system designs to utilize only those system components that have been approved for higher pressures. Components and tubing designed and approved for a maximum working pressure of at least 680 psig are recommended for R-410A systems.

One downside of the system requirements for higher-pressure R-410A is that R-22 systems cannot be retrofitted for use with R-410A. If an R-22 system must be directly retrofitted to an HFC refrigerant, then R-407C is a good option because it has operating pressures similar to R-22.

Differences in oils

The next significant difference between R-22 and R-410A systems is refrigerant oil. For HFC systems, you must use polyolester (POE) oils, which are typically included in HFC-rated compressors. Service contractors must be aware of the differences between POE oil and mineral oil, as improper handling of POE oil will lead to system failure much more quickly than the same improper handling of mineral oil.

POE oils attract moisture much more quickly than the mineral oils historically used for CFC and some HCFC systems. POE oil is highly reactive to moisture and forms acids in a chemical reaction with water. It is also significantly more difficult to remove moisture from POE oil once it has been absorbed.

The general term for oil's ability to attract and retain moisture is hygroscopicity, and POE oils are very hygroscopic. Some POE oils absorb up to 20 times more moisture than ordinary mineral oils.

When assembling or repairing HFC systems with hygroscopic POE oils, you must minimize the amount of time the system is left open. Ideally, leave the system open for less than 15 minutes. Always try to use a dry nitrogen environment when any POE system is open for assembly or service. While this also is true for servicing mineral oil systems, the practice of using dry nitrogen has not been rigorously followed as much as it should be.

If a POE system is open for the same amount of time service technicians are used to having mineral oil systems open, there is a much greater chance of moisture contamination of the oil and, consequently, downstream system failures. These failures will cause expensive callbacks and repairs. Most important, if the failures occur within the service warranty period, the contractor will be responsible for the repair costs.

Need for proper service

Ultimately, it will be less expensive to properly repair the system initially than it would be to make repeat calls after a hasty first repair. Keeping systems free from air, moisture and non-condensable materials always improves system reliability and does not require any additional time by the service technician.

All it takes is knowledge, training and discipline. Service technicians need to be aware of these issues and properly trained on servicing R-410A systems so they can avoid these costs and the potential damage to their reputations.

To minimize the risk of moisture-related system failures,

R-22 and R-410A Pressures

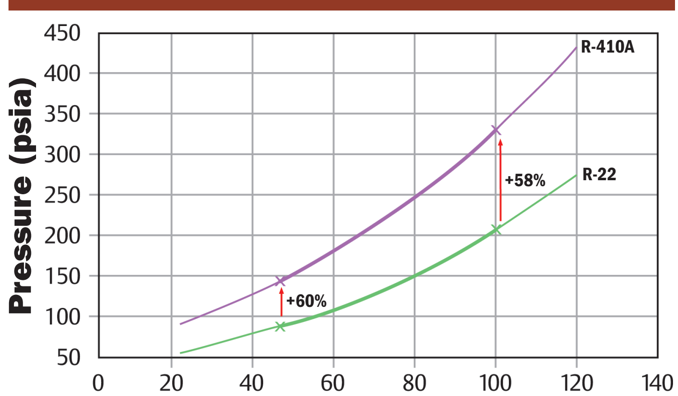

Figure 1

R-410A pressures are more than 50 percent higher than R-22.

Service technicians need to be properly trained on servicing R-410A systems to avoid unnecessary costs to customers and damage to their reputation.

all new R-410A designs should include a moisture indicator. Of course, the device must be rated for the higher pressures of R-410A, as previously mentioned. To minimize moisture infiltration caused by the very device used to detect moisture, use a hermetic device that does not have O-rings or knife-edge seals.

For maximum protection against moisture, a device that detects and notifies when the moisture level inside the system achieves 50 ppm is recommended. This level closely equates with most new oil specifications of less than 50 ppm moisture.

With R-22 systems, the typical detection level is at 75 ppm to 125 ppm moisture, the level at which acids begin to form. This level of warning is too high for hygroscopic POE oil.

Moisture indicators with multiple levels of warning that coincide with increasing moisture levels also are recommended for POE oil. The earlier the detection and warning of moisture concerns, the better the chance to catch and correct the moisture problem, minimizing downtime and service cost, while maximizing system reliability.

Thermal expansion valves are regularly used as the expansion device in air-conditioning systems designed for R-410A because they can help improve the total system efficiency and performance and can control the superheat. When choosing a thermal expansion device for an R-410A system, the engineer or service technician should make sure to choose one that has been both designed and tested for the higher pressures of this refrigerant.

Valves suitable for R-410A are marked with the higher maximum working pressure (MWP) rating (700 psig) and have a rose-colored marking on the label. Note that due to the different temperature-pressure characteristics, valves designed for other refrigerants will not operate properly in R-410A systems.

The compressor used in an R-410A system also must be designed specifically for the refrigerant. Compressor manufacturers optimize motors, displacements, bearings, valves and others for the particular refrigerant and its expected operating conditions. Consequently, R-410A compressors are vastly different from the R-22 models they replace, so use only specifically rated R-410A compressors with the higher-pressure refrigerant.

Importance of filter driers

No matter how carefully an air-conditioning or refrigeration system is assembled or serviced, a small amount of moisture contamination is inevitable. Refrigerant liquid-line filter driers remove moisture circulating through the refrigeration system and then hold that moisture to prevent it from contaminating the expansion device, evaporator, compressor or oil. However, filter driers only hold a fixed amount of water.

Whenever a system is opened for service, you must remove the filter drier and replace it with a new, properly sized and rated drier. This will prevent the unavoidable moisture introduced during service from causing system failure. This is especially true for R-410A systems with hygroscopic POE oil, in which oems typically use driers with up to 50 percent more moisture capacity than in equivalently sized R-22 systems.

In addition to being rated for the higher pressures, liquid-line filter driers used on R-410A systems also should use a desiccant blend specifically designed for POE oils. As compared to R-22-optimized driers, R-410A-optimized filter driers use less activated alumina and more molecular sieve for increased water capacity on these hygroscopic systems.

Inside the liquid-line filter drier, the filter separates particles from the refrigerant flow, preventing clogging of the expansion device. The molecular sieve removes moisture from the refrigerant, preventing it from interacting with the POE oil and forming organic acids. Finally, the activated alumina removes harmful acids that formed by the chemical reaction between the refrigerant and residual moisture in the system.

Compressor manufacturers have studied and tested the various materials used in filter driers to assure compatibility with the materials and oils used in R-410A systems. For example, one leading compressor manufactuer recommends a desiccant blended with a maximum of 25 percent activated alumina for HFC-optimized liquid-line filter driers.

Like the compressor, the filter drier should not be left open to the atmosphere except for the brief time it takes to braze it in place. Leaving the compressor or filter drier open for more than 15 minutes during installation could allow damaging moisture infiltration to occur, contaminating the compressor's POE oil and the drier's desiccant, ultimately leading to system failure. To minimize moisture infiltration during service, installation of the new drier should be the last action the service technician takes during the repair process.

After assembly

After safely and properly reassembling the system with R-410A components, you should perform a thorough and deep evacuation. A typical target for evacuation is 500 microns. Deeper vacuums are recommended to maximize dryness in R-410A systems.

After evacuation, perform a a vacuum-degradation check to ensure there are no system leaks prior to refrigerant charging. Triple evacuations with nitrogen breaks are another proven method for removing moisture and contaminants in refrigeration systems. This procedure is especially useful if the system is known to have had contamination, such as from a compressor burn-out, prior to the service. As with all service procedures, follow the equipment manufacturer's recommendations.

Unlike R-22 charging, which you can do in either a liquid or a gas state, you must charge a system with R-410A in a liquid state. R-410A is a near-azeotrope, which is a blend of two refrigerants that does not form a third unique fluid.

The properties of the two HFC components (R-32 and R-125) that make up R-410A have boiling temperatures that are close to one another. The result is that R-410A has nearly no temperature glide at saturation and can be "topped off" in the field, providing it is done in a liquid state. All other refrigerant charging procedures remain the same for R-410A as they are for R-22.

Air-conditioning systems designed and built to achieve 13 SEER will be more expensive than the 10 SEER units currently available

Many air-conditioner manufacturers discovered that R-410A features superior heat-carrying characteristics compared to R-22 and that systems designed with R-410A can achieve 5 percent to 10 percent higher EER and SEER ratings. R-410A systems can be designed to pump a lower volume of denser refrigerant, increasing the overall heat transfer in both the evaporator and the condenser.

The low-pressure drop and low-temperature glide of R-410A also contribute to reduced system power consumption and improved system efficiency. This is particularly important as the United States shifts production to only 13 SEER or higher air-conditioning units and heat pumps beginning in January 2006.

One of the main disadvantages to R-410A that cannot be overlooked is cost. In some cases, R-410A is three times higher than R-22. The cost of R-410A components can be up to 20 percent more than R-22 components as well.

Air-conditioning systems designed and built to achieve 13 SEER will be more expensive than the 10 SEER units currently available. Failure to use properly designed components in new units or in repairs is unsafe and significantly increases the likelihood of system failures.

Because R-410A is developing into the refrigerant of choice for air-conditioning manufacturers, engineers and service technicians need to understand and be properly trained on the inherent differences between this refrigerant and R-22. They also must be knowledgeable regarding new component choices and must be cognizant that service practices historically used are no longer sufficient.◆

Al Maier is vice president of application engineering at Emerson Climate Technologies Flow Controls.