Exploring the Differences Between R-410A and R-22

Come Jan. 1, 2010, OEMs will no longer be able to produce new equipment with R-22 refrigerant——and with R-410A poised to serve as the dominant replacement, it is important to understand why.

BY GUS ROLOTTI

R-410A is the HFC refrigerant most original equipment manufacturers have selected to use in new air-conditioning units when the HCFC R-22 is phased out of all new equipment at the beginning of 2010. This is another step in the overall Montreal Protocol phaseout plan that will ultimately result in the elimination of HCFC-refrigerant use altogether.

A large number of R-410A units already have been installed and are being serviced today. However, since R-22 will continue to be available for years to come, HVACR technicians will find themselves working with both R-22 and R-410A units in the field when servicing installed units. Understanding the key differences of each refrigerant and the units in which they are used allows technicians to manage the transition period without problems. Following are a few of the major differences between the refrigerants and some guidance on how to handle them.

Getting physical

Exploring the physical properties of these refrigerants is a good place to start. R-22 is an HCFC and contains a small amount of chlorine, which gives it an ODP of greater than 0–0.055. Although this number is very small, especially compared to the ODP of R-11 or R-12, it is still greater than zero. R-410A, conversely, is an HFC, and has an ODP of 0.

The elimination of ODP, however, is not the only reason that R-410A has become the leading replacement choice over other available HFC candidates. One of the most beneficial properties is its large volumetric capacity, which enables it to remove more heat than R-22 for the same unit of volume. That greater volumetric capacity allowed designers to develop smaller systems that deliver the same cooling capacity as R-22 units. In many cases, OEMs have capitalized on this. The benefits of R-410A have allowed OEMs to comply with stricter DOE-mandated energy regulations imposed on new systems without increasing the spatial "footprint" of the system.

Despite some of the advantages of using R-410A as a replacement for R-22 in A/C applications, it has not seen much incorporation or development on the refrigeration side, where refrigerants such as R-404A and R-507A have taken the lead.

›› Because R-410A has a much higher pressure than R-22—about 50% or more higher under the same temperature conditions—technicians must have pressure gauges, hoses and recovery equipment rated to deal with those higher pressures.

Beware of the mix

R-22 and R-410A, while intended for the same type of applications, are indeed very different refrigerants. Therefore, they cannot be mixed, and the equipment they are used in will be different. Neither refrigerant can be used to top off a system that contains the other, and units designed for one refrigerant cannot be charged with the other. Cross charging can result in poor or no operation; equipment failure; or, in some extreme cases, create a safety hazard. This also means that R-410A can never be used as a retrofit refrigerant for R-22 units. Retrofitting and servicing R-22 units require the use of one of the many R-22 retrofit refrigerants available.

On a very basic, practical level, R-22 and R-410A have three obvious differences: operating conditions—particularly, system pressures; lubricating oil requirements; and charging procedures.

A comparison of the pressure-temperature relationship of the two refrigerants at saturation conditions shows that R-410A's pressures are much higher than R-22's for the same temperature. In fact, R-410A's pressures can be about 50% or more higher for the same temperature conditions, which is why R-410A cannot be used as a retrofit in R-22 equipment. This also explains why many of the tools, accessories and components used for R-22 cannot be used with R-410A. Pressure gauges and hoses need to be rated for the higher pressures, or they can be damaged. Recovery equipment—especially cylinders—needs to be rated to a minimum of 400 psi. Incidentally, properly pressure-rated cylinders filled with R-410A should be handled in the same manner as R-22 cylinders; this will ensure the same level of safety, regardless of the higher pressures of R-410A.

Oil recommendations for R-410A

R-410A requires the use of POE oils because the refrigerant will not work with the common R-22 oils. The issue here is oil circulation and compressor lubrication. Common oils used with R-22 are not miscible with R-410A and, therefore, will not circulate in the system. This will cause, at the very minimum, the accumulation of oil in the evaporator and lead to reduced performance and cooling capacity. This also may cause the compressor to run with less than the required amount of oil, which could lead to premature wear and eventual failure due to a lack of proper lubrication.

On the subject of oils, it is important to remember that POE oils are hygroscopic and should be treated with care to avoid increasing their moisture level. Unused oil containers should always be capped. [*Editor's Note: For more information on this topic, see the May 2009* RSES Journal *MSAC Hotline on pg. 39.]* Systems should only be open to the atmosphere for the shortest time necessary, and using proper evacuation techniques is a must. Keeping POE oil dry is important, not only to prevent moisture from entering the system, but also because moisture can break up some of the chemical bonds within the oil in a process called hydrolysis, which decomposes it. This decomposition would result in the separation of the basic building blocks of the oil—alcohols and acids. If a large quantity of acid forms, it could corrode the system's internal components and reduce its life.

[*Editor's Note:* RSES Journal's *Technical Review Committee also offered the following information on this subject: The POE lubricant is made from an acid. It is then combined with a neutralizer and a resultant water is produced. The water is extracted, an additive is inserted—with the result being the POE, which*

Jeff Staub, Application Engineering Manager for Danfoss North America's Refrigeration & Air Conditioning Division, offers insight about the HVACR industry's transition from R-22 to R-410A.

RSES Journal: What does the R-22 phaseout and switch to R-410A refrigerant mean to service technicians? What major issues should concern them?
Jeff Staub: I believe the phaseout will drastically affect service technicians, based on the EPA's regulation on the manufacture and distribution of R-22. As far as the R-410A transition, this is a move largely affecting OEMs in new-equipment design; some technicians have been using R-410A for 10 years. However, there is a significant pressure increase when comparing R-22 and R-410A. R-22 has a typical high-side pressure of 260 psig, while R-410A's is 420 psig. Technicians must take care in the handling of R-410A and the POE oil in the system, as both have a much greater affinity to water than R-22 and mineral oil. Water in a refrigeration system is detrimental, as it can form ice, or react with the refrigerant or oil and form acids, which could reduce the reliability of the system.

Technicians need to become familiar with alternative HFC-blended refrigerants. In particular, they need to focus on capacity matching, oil compatibility and pressure deviations when considering an HFC blend to retrofit a system. There are several HFC-refrigerant blends out there–407A, 407C, 422B and 422D, to name a few–used to replace R-22. Each alternative refrigerant will have a different capacity match–up to 25% deviation of what R-22 currently provides. Some alternative refrigerants are compatible with mineral oil, while others require POE oil, which would mean the technician must replace the oil in the system. Some of the refrigerants have pressures that are similar to R-22 in a refrigeration application and others in an A/C application, so there is not one "best fit" solution.

RJ: How should service technicians deal with those issues?
JS: With R-410A, technicians should select all components specifically rated for R-410A to ensure the system pressures do not exceed the component maximum-working pressure. R-22 only can be used for existing installations.

Service techs should educate themselves about the differences between alternative HFC-blended refrigerants–specifically with regard to capacity difference; oil miscibility or compatibility; pressure and temperature deviation compared to R-22; and if the refrigerant fractionates or has a "glide" associated with it. When you look at a refrigerant cycle–specifically during evaporation and condensation when the refrigerant is in a saturated condition–glide is the temperature difference between the two phases, a liquid phase and a vapor phase. With glide, there is a phase change that occurs over a temperature range instead of a single temperature. If there is a high glide in a system that isn't suited to accommodate the glide, the system could see a decrease in capacity or fractionation of the refrigerant. If there is a leak in a system using a refrigerant that fractionates, typically only one of the refrigerants in the blend will escape. Therefore, the technician would not be able to top off the system, and would have to pull out all the refrigerant and recharge the system.

RJ: What can/should technicians do to prepare for the phaseout?
JS: First, technicians need to evaluate their current inventory of R-22 and make sure it is being used to service existing equipment. R-410A is the replacement refrigerant of choice for new-installation A/C applications. When it comes to R-410A, technicians will need new pressure gauges and new cylinders rated for the higher working pressures. With alternative HFC-blended refrigerants, technicians can use their current gauges and recovery cylinders rated for use with R-22. Technicians need to educate themselves about the alternative HFC-blended refrigerants, and keep in mind that R-22 is not a banned refrigerant; it's just banned from OEMs using it in new equipment. There is the possibility that there will be a shortage of R-22 at the end of 2010, so that's why education about the alternatives is so important. Still, an R-22 shortage is a speculation–while the EPA will begin introducing production caps on R-22, we don't know what the existing inventory level is and we don't know to what extent R-22 will be stockpiled prior to year end.

Staub has more than 15 years of HVACR experience, and is responsible for all levels of customer application support for Danfoss' products, including compressors, controls, heat exchangers and line components. For more information, e-mail JeffStaub@danfoss.com or call 410-513-1189.

is formulated to the compressor manufacturer's specifications for use in its products. In the course of time—and use—the POE compound may be subjected to a reintroduction of water. That in and of itself is not a problem; however, when water is introduced in conjunction with an operating system and the normal heat, the water will reverse the original manufacturing process in the hydrolysis process. Therein lies the problem: the compound now becomes close to the original acid base and can damage the system components. The replacing of driers will not correct or "fix" the damaged lubricant. The damaged compound will need to be removed; new, dry and properly formulated compound (POE) must be reinstalled; and the system will need to be rebalanced as a dry operating system.]

Charging and glide

The charging of R-410A also poses some challenges. R-22 is a single-component refrigerant, whereas R-410A is a 50/50 blend consisting of R-32 and R-125. R-22 will not exhibit a glide, but R-410A—as all blends do—will have a glide and could possibly fractionate. This small glide measures just a fraction of a degree and, in practical terms, cannot be measured using the standard tools of the trade and has little ef-

> **R-22 is a single-component refrigerant, whereas R-410A is a 50/50 blend consisting of R-32 and R-125.**

fect on performance. Having such small glide, its vapor and liquid pressures (dew and bubble pressures) at saturation are almost the same. This is the reason why most pressure-temperature charts listing R-410A include only one pressure—the liquid pressure—for superheat and subcooling calculations in the field. This is unlike what is seen for some other blends—such as R-407C—that require technicians to have the vapor and liquid pressures in order to compute superheat and subcooling. In this regard, the use of a pressure-temperature chart for R-410A is similar to its use with R-22. But in spite of its very low glide, R-410A still should be treated as a blend that can fractionate.

R-410A always should be removed from the cylinders in liquid form and introduced into a system as a liquid, if possible. If the refrigerant is being charged in the vapor side of a running system, it should be allowed to evaporate to avoid damaging the compressor. The effects of fractionation during a leak—or even in operation in systems with a flooded evaporator—will be minimal and, in most cases, almost undetectable. However, they should be avoided as much as possible to minimize the potential compounding effect due to repetition.

Finishing up

While R-22 and R-410A are very different refrigerants that require special handling and care, the same basic principles and practices used today for R-22 also apply to R-410A. Keeping in mind the higher pressures of R-410A; its need for a POE lubricant; utilizing proper charging techniques; and using dedicated gauge sets and hoses to avoid mixing will give R-410A equipment the best chance to achieve the durability and high performance for which it was designed.

Gus Rolotti is the Technical Marketing Director of the Fluorochemicals Group for Arkema Inc. and has dealt with refrigerant-related issues for more than 20 years at Arkema's Technical Center in King of Prussia, PA. He can be reached via e-mail at gus.rolotti@arkema.com.

Circle Reader Service No. 66