THE R-22 PHASEOUT: Do You Have a Plan?

On Jan. 1, 2010, new HVACR equipment will no longer be shipped with R-22 refrigerant. Is the industry and business ready?

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The 2010 phaseout of R-22 refrigerant in new HVACR equipment, which once seemed so far away, will arrive in one year's time. And while 12 months remain to prepare, the reality is that year will pass very quickly.

Most manufacturers of HVACR parts and components, as well as the chemical manufacturers, were hoping for a smooth transition from R-22 to the new alternatives; that, however, is not occurring. In reality, what has happened is the "hockey-stick effect"—instead of having a relatively smooth and slow conversion over a long period, a very short and rapid conversion is going to happen at the very last moment. It is not even clear what will replace R-22, if only one replacement actually exists. R-22's versatility means one refrigerant alone is unlikely to take its place.

OEMs and the future

The phaseout picture is somewhat clearer for original equipment manufacturers (OEMs); most made a decision early on as to what refrigerant to use in order to design new equipment, prepare their manufacturing base, parts supply, manufacturing lines, etc. Yet some have not fully committed to a design, or even to a refrigerant. Even when a new design is available and ready, the cost differential between R-22 and replacements has made deploying new equipment designs a marketing/sales challenge. Still, several R-22 replacement choices exist.

For residential and light-commercial to commercial A/C, the overwhelming choice is R-410A. But this refrigerant, a blend of R-32 and R-125 with very low glide (less than 1°F), has very different characteristics from R-22; in particular, its operating pressure and volumetric capacity are significantly higher. This implies a major equipment redesign instead of simple component changes. For larger equipment, R-410A will play a role, but significant use of R-134a also is expected. In refrigeration, R-404A and R-507A seem to be preferred for low- to medium-temperature applications, with R-134a figuring in at higher-temperature applications. Once OEMs decide what refrigerant to use, all similar applications will probably use the same refrigerant. OEMs also will issue guidelines on equipment maintenance, running efficiencies and capacities, and energy ratings.

However, other issues exist that should concern OEMs. For example, it may be necessary to increase bulk-tank manufacturing of refrigerants beyond the industry's storage capability; even if the manufacturing lines, equipment design and replacement refrigerants are available, there may be no place to store them. Steel price and availability, as well as other issues—such as plumbing inside the plant, new charging stations, testing equipment—further complicate the situation.

The retrofit conundrum

When it comes to retrofit choices to replace R-22, things are far from clear. As was the case during the R-12 and R-502 phaseouts that were enforced several years ago, numerous possible replacements continue to enter the market. The diverse, and sometimes wild, claims range

from true "drop-ins" to improved capacity and efficiency. Keep in mind that the only refrigerant that truly behaves like R-22 in R-22 equipment *is* R-22. Using any other refrigerant will require compromises; the type of compromises users are willing to make or not make will define, to a great extent, the refrigerant they choose.

Any contractor, facility owner/manager, supermarket chain, etc., also must have a plan to deal with possible R-22 price increases and/or availability issues that may occur given the strict phaseout rules being enforced by the U.S. Environmental Protection Agency (EPA). Equipment owners will have three basic choices: replace the current equipment with new equipment; retrofit existing equipment; or do nothing and continue purchasing R-22 while it is commercially available.

Replace current R-22 equipment with one of the new OEM-selected equipment alternatives—This is probably the most costly option, at least in the short term. The advantages are obvious: the best possible systems with the most up-to-date technology designed specifically to fulfill the owner's need, as well as improved efficiency, more capacity and better features than current equipment. But this comes at a fairly high price, so while in some cases this may be the best option, carefully consider cost payback, system availability from OEMs, labor, cost to remodel and other "hidden" costs.

Retrofitting equipment using one of the refrigerant choices already on the market—Retrofitting an older system designed for R-22—using a new hydrofluorocarbon (HFC) refrigerant—simply extends the life of that system beyond the phaseout date. A system retrofit is, in essence, a compromise of needs, value, labor and productivity. Before an owner or maintenance contractor decides to head down this road to solve their "phaseout dilemma," a number of questions should be asked:

As the R-22 phaseout date pushes closer, numerous issues industry-wide continue to crop up. One concern—especially for OEMs—is the amount of storage capacity available as bulk-tank manufacturing of refrigerants increases to meet new demands.

"How much longer will I keep the system?" The answer should depend on the system's age. Newer equipment may already have all the technology a brand new system would offer, negating the need—or even the advantage—of replacement. Excellent retrofit candidates are systems found in stores slated for redesign; especially if the equipment only needs to last for a few years. For equipment that is neither too old nor too new, review how reliable it is, if significant labor is needed to restore it, how well the system's capacity matches the cooling loads, etc. It could even be possible that the system was fitted with components that would allow the use of a more permanent OEM-type refrigerant.

"How much work am I willing to put into the retrofit?" While no true "drop-in" retrofit exists—regardless of the marketing hype and advertisements to that effect—some retrofit refrigerants may be much easier to use. In most cases, a simple retrofit will provide the desired setpoints and maintain capacity—but by sacrificing the unit's efficiency and operating costs. Putting some work into the retrofit may greatly improve system performance—even if using the same

CURRENT REFRIGERANT RETROFIT OPTIONS AND THEIR BASIC PROPERTIES

ASHRAE Number	Retrofit or OEM[1]	GWP	Operating Pressures (vs. R-22)	Mass Flow Rates (vs. R-22)	Mineral Oil Miscibility[2]
R-22	OEM	1500	--	--	Poor
R-404A	OEM	3260	Higher	Higher	Very Poor
R-407A	Retrofit	1770	Higher	Slightly Higher	Very Poor
R-407C	OEM	1525	Slightly Higher	Similar	Very Poor
R-410A	OEM	--	Higher	Lower	Very Poor
R-417A	Retrofit	1950	Lower	Higher	Very Poor
R-421A	Retrofit	2170	Slightly Lower	Slightly Lower	Very Poor
R-422A	Retrofit	2530	Higher	Higher	Poor
R-422B	Retrofit	2080	Slightly Lower	Slightly Lower	Poor
R-422C	Retrofit	2490	Higher	Higher	Poor
R-422D	Retrofit	2230	Similar	Similar	Poor
R-424A	Retrofit	2020	Lower	Lower	Very Poor
R-427A	Retrofit	1830	Similar	Similar	Poor
R-428A	Retrofit	3060	Higher	Higher	Poor
R-434A	Retrofit	2660	Higher	Higher	Poor
R-507A	OEM	3300	Higher	Higher	Very Poor

(1) Refers to the original marketing intention for the product. There is really no technical reason why an OEM refrigerant couldn't be used for retrofits or vice versa
(2) Poor means that its use with MO is possible, but in systems with good oil circulation. Very Poor means that POE oil is highly recommended.

COMPARING PERFORMANCE OF LEADING REFRIGERANTS

	R-22	R-404A	R-407C	R-407A	R-422D	R-427A
Capacity (BTU/hr)	13746 (100%)	12450 (90.6%)	12891 (93.8%)	13375 (97.3%)	10431 (75.9%)	12020 (87.4%)
C.O.P.	1.42 (100%)	1.18 (83%)	1.34 (94.4%)	1.34 (94.4%)	1.14 (80.3%)	1.31 (92.3%)
Mass Flow (lb/min)	3.53 (100%)	4.67 (132.3%)	3.46 (98%)	3.90 (110.5%)	4.11 (116.4%)	3.42 (96.9%)
Discharge Temp (°F)	217 (0°F)	179 (-38°F)	193 (-24°F)	192 (-25°F)	170 (-47°F)	189 (-28°F)
Discharge Pres (psig)	211 (0 psig)	256 (+45 psig)	223 (+11 psig)	242 (+31 psig)	214 (+3 psig)	214 (+3 psig)

Data obtained from equipment testing under controlled conditions at 80°F ambient and 30°F box, with R-22 TXV and optimized charge amounts.

retrofit refrigerant. This improvement may occur by replacing the current oil with a more miscible oil; internally cleaning the system of excess oil from years of service; or even replacing a thermal expansion valve (TXV) due to a higher mass flow rate requirement of the refrigerant. The labor costs to achieve this, however, may be higher.

"What are my criteria for a retrofit—low global-warming potential (GWP) or zero ozone-depleting potential (ODP)—or are there other factors as well?" Many possible R-22 replacements, while being zero ODP as mandated, have either a slightly higher to a much higher GWP than R-22. In many cases, well-intentioned companies with a "green" mandate will look to replace R-22 with a retrofit refrigerant without factoring in that the replacement may have a higher GWP and provide poorer efficiency—a combination worse from an environmental perspective than keeping R-22 in the system. A sensible approach is to review both efficiency match and GWP ratings when looking to replace refrigerants, which may help weed out many poor candidates.

"Is refrigerant cost alone my main concern?" While in general it should not be, in some instances this may be the case. Keep in mind that while a great number of retrofit alternatives may help keep the prices down today, more permanent refrigerants—which may be higher-priced today—may trend downward in cost and make more sense in the future.

Performance and properties

OEM or retrofit refrigerant selection should be based on whether the refrigerant is intended as a permanent solution for new equipment, or as a temporary replacement for older equipment that is using R-22. That is because most refrigerants labeled as OEM—R-404A, for example—also could be used in a retrofit situation if all necessary considerations for conversion (oil compatibility, TXV sizing, etc.) are taken into account. Retrofit

refrigerants are designed to make the retrofit process simpler, but are by no means the only choices.

The table "Comparing Performance of Leading Refrigerants" compares performance data for some of the leading refrigerants in the market today. The industry lab data was obtained using R-22 equipment simulating a retrofit, with only the amount of the charge being optimized on each case. The values indicate the percentage difference between R-22 and the alternative for the specific property, or the actual difference in the cases of temperature and pressure.

The aforementioned table gives a glimpse into some of the data and properties that need consideration when selecting a retrofit refrigerant. For example, while R-404A provides one of the highest capacity ratios compared to R-22, its discharge pressure will increase by 45 psig, which may make it unusable in some equipment. Also, the data is specific to the conditions listed; however, in some

R-22's versatility likely means no one refrigerant will serve as a replacement, and new refrigerants will pose new sets of issues for technicians. For example R-410A, shown here on a charging line at a refrigerant manufacturing plant, has much higher operating pressure and volumetric capacity that R-22—requireing different system components and measurement tools.

cases, the refrigerant will perform better or worse at other conditions. Again, using R-404A as an example, its capacity at lower temperatures will actually surpass that of R-22 with a much cooler discharge temperature. R-404A would then be an excellent choice for a low-temperature refrigeration retrofit, but a relatively poor one for A/C systems.

Remember, this data is for refrigerants used in retrofits, not in new OEM-type applications. OEM refrigerant use will likely result in much better performance, due to system optimization and design that cannot be accomplished during a retrofit.

Maintain the equipment on R-22

For some, simply continuing to purchase R-22 may be the best choice. Although R-22 is being phased out of new equipment in 2010, the EPA will allow R-22 production for service purposes 10 years beyond that point *(Editor's Note: As part of the Montreal Protocol, virgin R-22 production levels will decrease over that time, possibly leading to significant price increases.)*. For owners of systems in good condition, it might be sensible to keep sufficient amounts of R-22 on hand for the years of service before equipment replacement becomes necessary. Conversely, this approach may be a gamble for owners of leaky or unpredictable systems, since they may run out of R-22 and be forced into one of the other two options on short notice.

While a singular phaseout "approach plan" may be the best strategy for small- to medium-size equipment owners, people or companies with large numbers of systems may find it best to combine these different approaches. Leaky, inefficient equipment can be easily targeted for replacement, especially with relatively small systems. It may make sense to retrofit other equipment using an alternative retrofit refrigerant; R-22 collected from the systems being retrofitted or replaced could then be banked and used later to service other units less suitable for replacement and/or retrofit.

While many choices exist when it comes to planning for the R-22 phaseout, no one-size-fits-all solution exists. A careful plan needs to be drafted quickly and put in place as soon as possible, regardless of the size and number of systems being operated. Having no plan—or implementing a plan poorly or too late—may have dire economic consequences when managing the change from R-22 to ODP-free refrigerants.

The industry currently has a large number of choices, both from a refrigerants point of view and exit strategies. How the pieces of the puzzle are put together has the potential to significantly impact how the phaseout—and its economics—will affect businesses everywhere.◆

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