

The demand for refrigerant blends is on the up. Environmental concerns are factor, as is the increased cost of a number of refrigerants, which was compounded by the introduction of the carbon-equivalent levy last year. As Sean McGowan reports, one of the new breeds of refrigerant set to make an impact in 2013 is R407F.

# THE LOW-DOWN ON R407F

As the HVAC&R industry continues to move away from the use of high-GWP (global-warming potential) HFCs, refrigerant blends such as the new R407F will play a key role in the transition to reduced-GWP alternatives and natural refrigerants.

Also known as Performax LT, R407F is a zeotropic synthetic refrigerant made up of a combination of three HFC refrigerants: HFC-32, HFC-125 and HFC-134a, at ratios of 30:30:40, respectively.

It was designed predominantly as a non-ozone-depleting replacement for existing HCFC R22 systems, with operating characteristics extremely close to R22. The latter is an ozone-depleting refrigerant that is currently being managed by import quota and phase-out under the Montreal Protocol.

R407F can also be used as an alternative for R404A and R507 in both low and medium-temperature applications.

Non-flammable and non-toxic, the blend was classified A1/A1 by ASHRAE. And according to Caroline

Rham, BOC Limited's market manager for refrigerants, BOC will begin supplying R407F this year.

"R407F is one of the most efficient HCFC R22 replacements, and has the lowest GWP value," says Rham.

According to literature published by manufacturer Honeywell, its GWP value of 1555 is significantly lower than R404A's value of 3260 (based on IPCC 1996 figures).

Although it has yet to appear in commercial quantities in Australia, Julian Hudson, director of JCH Refrigeration Consulting, says that in the UK, a number of supermarket chains have used R407F to retrofit R22 and R404A systems, with some success.

"Results from the UK suggest a 5 to 12 per cent increase in energy efficiency in stores that have been retrofitted from R404A and R507 to R407F," he says.

Hudson also has firsthand experience with the new refrigerant blend through his involvement in a recent

supermarket project in China for a leading UK chain. He says it will be the first to use R407F for both low and medium temperatures, but warns there are a number of issues users should be aware of when considering R407F.

"When used in low-temperature applications there is a very high compression ratio that will lead to excessive discharge temperatures," he says.

"If the system being retrofitted is an existing R22 plant running with liquid injection or two-stage compression, then there should be no issues relating to discharge temperatures. But care should be taken retrofitting or installing new systems without due consideration given to the control of discharge temperatures."

In the case of the project in China, Hudson says particular attention was given to the low-temperature rack design to ensure low-discharge temperatures. At the time of publication, the plant had been operational for a number of weeks. He says it appears to be running well, without excessive discharge temperatures.

According to Dave Redden, M.AIRAH, principal with Refrigeration Innovations, issues of compressor overheating are being addressed by manufacturers.

"Bitzer recommends using supplementary cooling of the compressor, whereas Bock has an air-cooled model that can be used off the shelf," he says.

Redden is also working on a project for which the client has elected to use R407F.

"It is useful as a general-purpose refrigerant, as it covers the low and medium-temperature ranges," Redden says of R407F. "While I cannot determine the exact reason [for his client using it] I suspect the high price of R404a would have been in their thinking."

## UNIQUE CHARACTERISTICS

R407F has a number of characteristics that should be understood before giving it consideration as a drop-in alternative.

For instance, it is not miscible with mineral and alkybenzene oils commonly used with R22. And as a zeotropic blend, it has a glide of between 3°C and 6°C.



Importantly, it will also fractionate when leaking in the vapour side of a system. In the event of a leak, each refrigerant that makes up the blend will leak independently, changing its original composition. Once a certain percentage of the original charge is leaked, the refrigerant left in the system is no longer in its 30:30:40 ratio mix.

In most cases, this will require the refrigerant to be reclaimed, and once the leak is repaired, the whole system charge must be replaced with virgin refrigerant in order to keep the R407F ratio intact.

"This could be a very expensive exercise, in particular for older refrigeration plant that has been retrofitted with R407F and has a high leakage rate due to the age of the plant," says Hudson.

It is for this reason that he believes it is unlikely that large-scale use of R407F will eventuate.

"Although I have not seen pricing as yet, one would imagine it would have a list price of over \$200 per kilogram," Hudson says. "This would be a similar price to R410A, which has a similar GWP, and at this price it would not be economically viable to use in large quantities."

According to Rham, there are a number of considerations when choosing a replacement.

These include the refrigerant's ASHRAE Safety classification for toxicity and flammability; its efficiency; heat-transfer and material compatibility; as well as lubricant, glide and operating pressure differences.

"The greater the difference between the existing refrigerant and the alternative refrigerant, the more complex the system adjustments will be," she says.

Rham also warns about using the term "drop-in" to describe replacement refrigerants.

"The term 'drop-in' implies that for retrofits all you have to do is drop in the new product and the system will work as if nothing has changed," she says. "This is not so! No two refrigerants will behave the same, and you still need routine practices such as recovering the original refrigerant, setting superheat and changing the filter-dryer. In the industry, 'drop-in' implies no oil change."

Rham says that because R407F is a blend refrigerant, it is essential that systems be charged with liquid, as vapour charging may result in a change of composition and could damage the system. It should also be used with synthetic lubricants such as polyolesters to ensure adequate oil return.

## THE RISE OF BLENDS

Although refrigerant blends came to prominence as a consequence of CFCs being phased out, most continue to have relatively high GWPs, leaving some uncertainty about their role in the future.

"The new blends being produced by the refrigerant manufacturers, in particular the 400 series, have lower GWPs, and I see it as a last-ditch attempt to hold onto their market share," says Hudson.

"In the Australian market, the impact of the HFC levy means it makes little sense from a business perspective to use large quantities of HFC refrigerants that have a high GWP, as there are better performing natural refrigerant technologies available."

As always, it becomes an argument between the short term and long term for many.

"From a business perspective, end users and contractors need to focus on the long-term impact of the cost of both direct and indirect emissions when installing a refrigeration plant using a blend," Hudson says.

Redden sees blends continuing to be used as the industry transitions to more energy-efficient plant.

"We saw this occur in the 1990s when CFC was phased out," he says. "The use of blends will grow because end users see it as a stop gap, before upgrading to more energy-efficient plant using natural refrigerants."

Whether or not the use of blends in Australia is limited to light commercial applications – where the refrigerant charges are relatively small – may largely be determined by the success of the fourth generation of refrigerants: HFO hydrofluoroolefins.

Derivatives of alkenes (olefins) rather than alkanes, these emerging refrigerants are reported to have very low GWPs. They include HFO-1234y and HFO-1234ze – the latter a direct replacement for the single-molecule HFC R134a.

In the meantime, blends such as R407F at least provide another choice for those end users operating aging R22 plant. ▲