

R410A

Refrigerant of the Future for Air Conditioning

Concluding Part 2

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by **Pete Dexter**

Technical Support Manager, Asia-Pacific
Emerson Climate Technologies

This article compares characteristics of various refrigerants and explains why air conditioning manufacturers around the world are increasingly choosing R410A to meet the challenges of higher efficiency and environmental responsibility while keeping their systems affordable. As explained in para 1 several refrigerants have emerged as candidates to replace R22, the most widely used fluorocarbon refrigerant in the world. These include the environmentally-friendly hydrofluorocarbon (HFC) refrigerants R134a, R410A and R407C.

R134a is a pure refrigerant, whereas R407C and R410A are blends of refrigerants. R410A is a mixture of R32 and R125, while R407C is a blend of R32, R125, and R134a. The advantage of blending refrigerants is that properties such as flammability, capacity, discharge temperature, and efficiency can be tailored for specific applications.

There are many considerations in

choosing a refrigerant, and each has an impact on the overall performance, reliability, cost, and market acceptance of a manufacturer's air conditioning system. It's interesting to note that transport properties affecting heat transfer and pressure drop vary widely for the new refrigerants and have a significant effect on system design and performance. Some of the properties are shown for the new refrigerants in comparison to R22 in *Table 1*, and a brief discussion of the more important considerations follows.

R134a is a lower capacity and lower pressure refrigerant than R22. Because of these characteristics, an R134a air conditioner of the same capacity requires a larger-displacement compressor and larger evaporator, condenser, and tubing. The end result is a system which costs more to build and to operate than an equivalent R22 system.

R407C was designed to have similar capacity and pressures as

R22. Because of this, it can be used in R22 systems with a minimum of re-design. However, system efficiency is approximately 5% lower than with R22 in the same system. This is partly due to an effect called temperature glide which can reduce heat transfer in a standard condenser and evaporator. R407C exhibits a relatively high temperature glide (6°K) compared to the other refrigerants, which have almost no glide.

R410A is a higher capacity and higher pressure refrigerant than R22. Operating pressures are 50-60% higher. As a result of the higher pressures and higher gas density, smaller displacement compressors can be used along with smaller diameter tubing and valves. Concerns about protection against high condensing pressures have been met with the use of high pressure cutouts on these systems.

About the Author

Pete Dexter is a registered professional engineer and holds a masters degree in mechanical engineering from Purdue University. He has an experience of nearly 30 years in handling compressors for HVAC applications.

	R410A	R407C	R134a
Operating pressures	159%	101%	68%
Temperature glide	0.2°K	6.0°K	0.0°K
Evaporator Heat Transfer	135%	90%	90%
Condenser Heat Transfer	105%	95%	95%
Pressure Drop	72%	100%	128%
Tubing size	Smaller	Same	Larger
Refrigerant charge	70%	95%	100%
Re-design required	Significant	Minor	Significant
System COP	98-106%	95-100%	95-100%
System Cost	Lower	Same	Slightly more

Table 1 : Refrigerant comparison to R22.

Compressors are built with thicker shells to withstand the higher operating pressures. A side benefit of their heavier construction has been that R410A compressors have sound levels which are typically 2-4 dB lower than equivalent R22 compressors.

Refrigerant R410A has a significant heat transfer advantage over R22 in both the evaporator (+35%) and the condenser (+5%). R134a and R407C both have lower heat transfer coefficients than R22. R410A also benefits from lower pressure drop for the same mass flow which allows the use of smaller diameter tubing and valves than with either R22 or the other refrigerants. This has the potential to save significant material cost in the construction of an R410A system and becomes even more beneficial in long-line split and multi-evaporator systems. It requires system redesign, of course, to take full advantage of the heat transfer and pressure drop advantages of R410A – such techniques as the use of smaller diameter tubing in the coils, different fin geometry, and re-circuiting to increase the length and decrease the number of refrigerant circuits. The end result is that systems which have been redesigned for R410A will have smaller and lower-cost evaporators and condensers and up to 30% less refrigerant charge. The lower refrigerant charge, besides costing less, can improve overall reliability of the system.

R410A can yield up to 6% higher system COP than R22 for an equivalent size system depending on condensing temperature. This is particularly true at the lower condensing temperatures typical of high efficiency systems and when operating at partial load. The higher R410A system efficiency is the product of lower compression losses in the compressor, better heat transfer in the evaporator and condenser, and lower pressure drops throughout the system. The higher

heat transfer and lower pressure drops result in a lower condensing temperature and a higher evaporating temperature for the same operating conditions. This puts the compressor in a more favorable operating range requiring less power and offering better efficiency. In addition, large compressors used in light commercial air conditioning systems benefit even more than smaller residential compressors from the lower compression losses experienced with R410A.

Advantages such as high heat transfer, low pressure drop, low temperature glide, less refrigerant charge, and quieter and more efficient compressor operation give R410A clear advantages over other environmentally-acceptable replacements for R22. The refrigerant comparisons described above help to illustrate why air conditioning manufacturers are using R410A in combination with other new technologies to meet the challenges of designing higher efficiency and affordable systems.

Global Outlook On R410A – Trends In Major World Markets

Let us now focus on the usage of R410A in various major global markets as of today and also our outlook for the future.

Japanese Market

Let us first start with Japan, as this is the market that converted to R410A most rapidly. Traditionally, Japan has been wary of using R410A for larger systems due to the pressure vessel regulation and safety concerns. There was a divide in opinion on R407C versus R410A. The first application of R410A was with smaller systems less than 2HP. The small horsepower market quickly converted to R410A and has over 95% penetration. As OEMs started getting more experience with R410A, the shift started to happen for larger horsepower systems too. The EER regulation in Japan was another factor that accelerated this conversion. The OEMs were doing system redesign for R410A and at the same

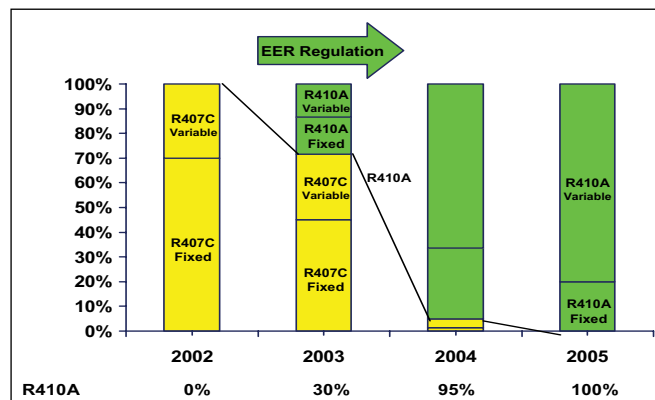


Chart 1 : Japan market transition.

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time they used a larger chassis to reduce condensing temperatures and get the true benefit of R410A. Since a lower condensing temperature helps to improve COP, and R410A has better efficiency at lower condensing temperatures, OEMs increased the size of the chassis during this process.

Chart 1 explains the market transition in Japan. As can be seen from the graph, the market moved very rapidly from R407C to R410A.

Australian/New Zealand Market

The next market that is converting rapidly is Australia and New Zealand. A number of Japanese OEMs are exporting to Australia and they are introducing the R410A system, as it is already in production in Japan. The local OEMs have also started to react to this market situation and are introducing R410A models. Chart 2 shows the shift in the market towards R410A.

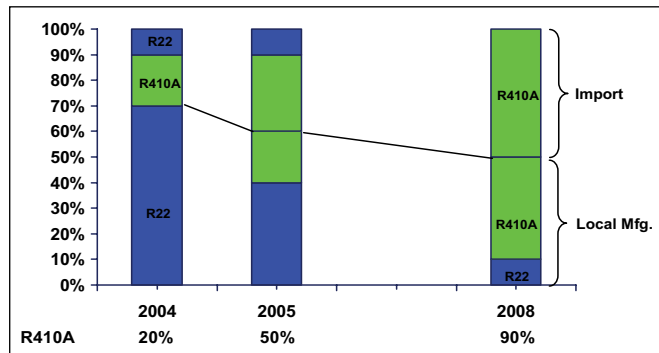


Chart 2 : Australia / New Zealand market transition.

China Market

The development of alternate refrigerant systems has been slow in China, primarily because the domestic market is still largely dominated by R22 and there has been no pressure on the OEMs to make any change. The primary driver in China for R410A has been the export market. Since most of the Chinese OEMs are exporting to Europe they had no choice but to develop systems with R410A. Even though the usage of R410A is very low in the domestic market, the energy standards will result in a wider use of this refrigerant. China is now implementing energy efficiency labeling and unitary and RAC products require the energy labels to be affixed on the systems. As this labeling system becomes more mature, OEMs will have to improve the COP of their systems in order to sell higher energy efficient machines. The R410A compressor by itself does not contribute much to the system efficiency. The efficiency is derived from having a lower condensing temperature (means a larger chassis). Chart 3 shows the market adoption today and how we foresee the future.

For R410A to get a wider acceptance in China, it

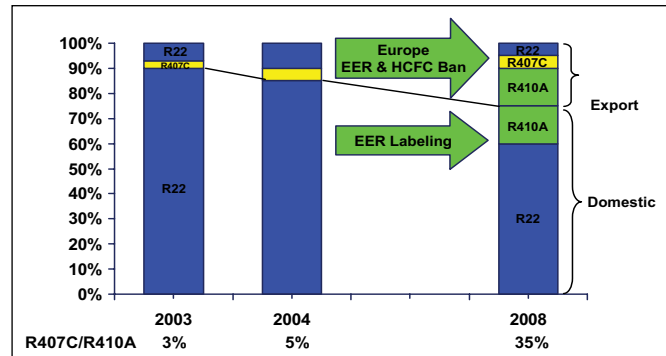


Chart 3 : China market transition.

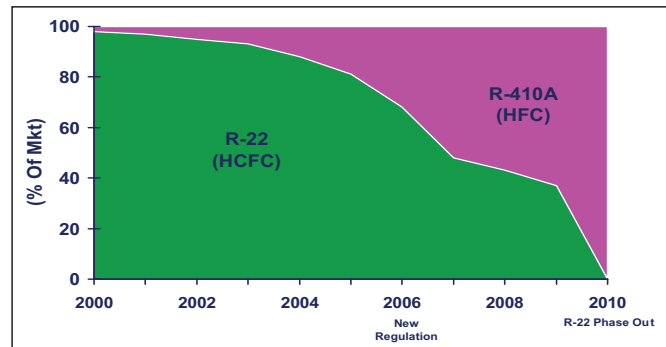


Chart 4 : Residential market conversion to R-410A in USA.

is important that the dealers and installers are trained adequately on how to handle high pressure refrigerant. The pressure gauges and other servicing equipments need to be R410A capable and China is a long way from this.

USA Market

The US market has also adopted R410A, though not as fast as Japan. Chart 4 shows the conversion trend for the residential market.

Our experience with R410A in the US market so far has been very good. The field failure rates of the R410A compressors are 30% lower than that of R22 and that is due to the fact that installers take extra care in keeping the system clean. The noise of the R410A systems is also lower due to the fact that the compressor shell is thicker.

A survey was carried out in the US for dealers to understand their feedback on selling systems with R410A. The factors mentioned were: easier to sell as it is more environmental friendly and quieter, it is the future refrigerant, higher profits in selling such systems, more reliable and also proven technology.

Conclusion

In summary, we can say that most markets are adopting R410A, some fast and some slow. As markets become more aware and concerned about the environment and also energy usage, the adoption of R410A as the technology of choice will be more rapid. ❖