Supermarket Refrigeration

System Changes, Present and Future

How refrigerant regulations, cost and becoming green are driving technology and training.

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All tables courtesy of Emerson Climate Technologies.

From an outsider's perspective the commercial refrigeration industry will not seem fast paced compared to what is being read and heard about in other industries, like at Silicon Valley for example. However, the landscape is changing and will continue to change based on many key factors. Knowing what the potential changes are and understanding why they are taking place will help HVACR professionals embrace the developments and be better equipped to handle them in the field.

Forces driving changes

Many factors are at play as to why commercial refrigeration systems and refrigerants are changing. Foremost on retailers' minds is always cost. Cost can come in many forms: first cost, energy cost and maintenance cost. Retailers must take a balanced approach to these cost drivers to get the overall best value, and the answers can be very different depending on facility location.

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Regulations are also driving the market. Refrigerants that deplete the upper atmosphere ozone (such as R-22) and refrigerants that have relatively high GWP values (such as R-

REFRIGERANT OPTIONS

Refrigerant	Type	GWP
R-12	CFC	10,900
R-502	CFC	4,700
R-22	HCFC	1,810
R-134a	HFC	1,430
R-404A	HFC	3,922
R-407A	HFC	2,107
R-407C	HFC	1,774
R-410A	HFC	2,088
R-422A	HFC	3,143
R-422D	HFC	2,729
R-32	HFC	675
R-1234yf	HFO	4
HC-290	Propane	20
R-717	Ammonia	0
R-744	Carbon Dioxide	1

404A with a GWP of 3,922) have and will be looked at by agencies like the EPA. In order to curtail usage, other regions in the world have already implemented tighter leak requirements and taxes on the use of certain classes of refrigerant gases that are detrimental to the environment. Regulations will also impact system efficiency levels. A/C systems have

Refrigerant Options to Replace HFCs—High-level Summary (A/C & Refrigeration)

	Current HFCs	R-32 (HFC)	HFO Blends	Carbon Dioxide	Hydrocarbons
Global Warming Potential (GWP)	-2,000 to 4,000	675	4-650	1	<10
Compressor Design & Cost					
Energy Efficiency					
Safety		Mildly Flammable			Highly Flammable
Refrigerant Cost					
System Cost					

Consider the green, yellow and red color scheme shown above like a stoplight. Some boxes are filled in for greater detail; green is positive, yellow is cautionary and orange/red are areas for concern.

been regulated for years with little energy requirements given for commercial refrigeration. Smaller systems (such as ice machines) have Energy Star ratings, but bigger rack systems found in grocery stores have not been subject to energy standards. Regulations such as California's Title 24 will change that over time.

Also, there is a significant movement for retailers to become green and to develop sustainability measures. The role of refrigeration is very prominent in terms of energy consumption and emissions that could potentially escape to the atmosphere, two very important sustainability measures. Today, retailing organizations may have a vice president of sustainability, a role that would not have existed 10–15 years ago. Companies release sustainability reports and join voluntary groups, such as the EPA's Greenchill Partnership. This type of visibility leads to an increased interest in measuring results. The measuring of results leads to new programs to achieve desired outcomes.

Changes that are happening

To address the concerns outlined above, the refrigeration industry has many options at hand. Parallel rack systems have been the standard for years, but recently the industry has seen a trend with more distributed and secondary-loop system installs. Secondary systems use a secondary fluid (such as CO_2 or glycol) that is pumped to the cases and back to the machine room or rooftop. This allows for significantly less refrigerant charge, reducing the leak-rate potential of the system. Distributed systems locate the refrigeration system closer to the cases. Instead of having two to three racks in a machine room, five to six smaller refrigeration systems may be located around the store. Like secondary systems, the distributed architecture also enables less refrigerant charge with the

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added benefit of efficiency gains in comparison to standard parallel-rack systems.

The vast majority of new parallel-rack, secondary and distributed systems deploy HFC refrigerants. The supermarket industry has predominantly used R-404A. More recently, lower-GWP refrigerants such as R-407A, R-407C, and R-134a have been used to help retailers achieve their sustainability goals. Because of the need to continue to minimize negative environmental impacts from refrigeration systems, refrigerant manufacturers are continuing to work on making lower-GWP refrigerants that behave similarly to today's offerings. Professionals can expect to see these new refrigerants out on the market in the upcoming years.

A very recent trend in North America is to use natural refrigerants to further the improvements of GWP reductions. Natural refrigerants, such as CO_2, have almost zero global-warming impact. CO_2 has been used for a few years in Europe with hundreds of successful store deployments. The most pervasive usage of CO_2 as a refrigerant is in a cascade system, where an HFC refrigerant such as R-404A or R-134a is used for the medium-temperature cases and then CO_2 is used for the low-temperature cases. A heat exchanger is placed in the circuit between the liquid line from the HFC condenser and the discharge of the CO_2 compressors. This keeps the condensing temperature low enough to keep the CO_2 in a subcritical state. These systems are currently more expensive to deploy than standard systems previously discussed. The maintenance is also different, presenting a learning curve for technicians and contractors. As with all new technology rollouts, more system installs and training will bring these systems closer in line to today's more prevalent architectures.

An even newer natural solution for North America is to utilize transcritical CO_2. This is an "all-natural" solution where CO_2 is the refrigerant for both the low- and medium-temperature cases. The GWP impact of the refrigerant on the environment itself is virtually eliminated, but cost and maintenance challenges are present. These systems operate most efficiently in colder climates, and as such, the great majority of North American installations are in Canada. Functionally, these systems operate under very high pressures, so safe maintenance practices are clearly a priority.

Another recent development in refrigeration is the implementation of "smart" components. Low-cost electronics are now enabling more and more information to be mined from systems in order to make intelligible troubleshooting and optimization decisions. No matter what the system architecture or refrigerant of choice, these electronic-enabled products, such as compressors, will allow contractors to provide services more accurately and faster—improving the efficiency of the maintenance process.

What all this means

With all of these different options for system architectures, refrigerants as well as advances with electronics, what should industry professionals be doing to prepare? First, acknowledge that the systems of tomorrow will be different than those of today. The industry can expect changes in refrigerants to continue and new and creative ways to make those systems more efficient and maintenance friendly. Second, be proactive and look for training opportunities in order to adapt to these changes. Manufacturers often take responsibility to educate their customer base on how these new products work. Take advantage of these tools that are offered and keep up or stay ahead of the game.

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