Balancing Environmental Impact & Efficiency in the Changing Refrigerant Landscape

BY BRIAN S. SMITH

Any discussion of the history of the HVAC industry includes the evolution of the refrigerants that make cooling possible. Just as equipment has evolved over the years, so have refrigerants, transitioning first in the 1930s from the earliest refrigerants—flammable and toxic fluids like ethers, sulfur dioxide and methyl chloride—to chlorofluorocarbon (CFC) refrigerants. Although introduced first in the 1930s, hydrochlorofluorocarbons (HCFCs) did not see commercial use until two decades later.

In the 1970s, as scientists identified CFCs and HCFCs as contributors to the depletion of the ozone layer, another transition began. These scientific findings eventually led to the Montreal Protocol, an international treaty which, in 1987, established a schedule for banning substances responsible for ozone depletion, among them CFCs and HCFCs. Following the terms of the treaty, CFC phaseout was completed in 1996, and equipment using HCFCs (i.e. R-22 and R-123) will be banned after Dec. 31, 2019 for developed nations. Some nations have accelerated the HCFC phaseout dates, with bans in effect today.

In the 1990s, hydrofluorocarbons (HFCs) emerged as an alternative to CFCs and HCFCs, boasting an attractive zero ozone-depletion factor as well as low toxicity and zero flammability. Since then, HFCs have become the refrigerant of choice for commercial applications. With increased emphasis on climate change and greenhouse-gas emissions, lower global-warming potential (GWP) refrigerants, including hydrofluoroolefins (HFOs), previously available HFCs with flammability and HFC/HFO blends are being proposed as potential alternatives to today’s refrigerants.

For some, but not all, of the industry sectors, these new refrigerants are viable alternatives to the current HCFCs or HFCs in use. This past July, regulators in the European Union and United States took actions to reduce emissions from several industries, including solvents, foams, mobile air-conditioning, vending machines and commercial refrigeration.

No phaseout of HFCs for chillers
Through a concerted effort across the design, supply chain, manufacturing process, transportation, installation and servicing of chiller equipment, the chiller industry has achieved the highest efficiency, lowest leak rates and highest recovery rates of most industry sectors that use refrigerants. As a result, recent regulatory rules do not target the most widely used HFCs in the chiller business, R-410A and R-134a. The U.S. Environmental Protection Agency (EPA) rules focus on industries with the highest greenhouse-gas emissions, including foam, automotive and commercial refrigeration. Chillers are on the other end of the spectrum and projected to represent less than 2% of global HFC emissions in 2020, with an even lower percentage of greenhouse-gas emissions.

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Alternative refrigerants trade-offs/unintended consequences
Many of the proposed refrigerant alternatives face significant hurdles to universal adoption, including flammability, toxicity, stability, reliability and availability. Just as important to chiller manufacturers and operators, many alternative refrigerants have been shown to compromise chiller efficiency, requiring additional energy to provide cooling. This can negatively impact the environment, as power plants must produce more energy, burning additional fossil fuel and emitting more CO₂ in the process.
Which raises the question: How should facility managers and business owners make well-informed decisions regarding refrigerants when buying or maintaining HVAC equipment?

**Safety and reliability influence choice of refrigerants**

Safety and reliability of the fluid represent an important set of factors to consider in the choice of refrigerants. It is worth noting that many of the commercial refrigerants coming onto the market today are flammable. In response, building codes and standards, such as ASHRAE 15 and ISO 5149, are being revised to establish rules for how equipment and building design must accommodate these fluids and how the flammable refrigerants should be transported, handled and used safely.

At the same time, HVAC equipment manufacturers must modify equipment design to address flammability issues. All of this takes time—time to write new codes and standards, redesign equipment, train technicians in what amounts to a new technology, incorporate emerging codes and revised standards in building codes and push for their adoption by local jurisdictions. Until all of this takes place and consensus-based safety standards are developed and consistently applied, mildly flammable (Class 2L) refrigerants should only be considered as alternatives to HFCs at sites familiar with and properly prepared to handle Class 2 flammable refrigerants.

New refrigerants must also be tested for reliability to ensure compatibility with HVAC system gaskets, elastomers and construction materials. They must prove long-term stability, as well, because if a refrigerant begins to break down over time, it can impact system performance and operating costs or cause damage to the equipment.

**Low GWP does not mean low environmental impact**

When it comes to choosing a refrigerant, efficiency and sustainability should also guide the selection process. This means any new refrigerant should enable a chiller to operate as efficiently or better than it did using more conventional refrigerants. In fact, the benefits offered by a low-GWP refrigerant can be canceled or even reversed by refrigerants that negatively impact the energy-efficient performance of a chiller. That’s because, as mentioned earlier, reduced chiller efficiency translates to more energy required to produce the specified level of cooling. The indirect emission that results from power plants burning additional fossil fuel to produce that energy can exceed the impact of venting the full charge of a chiller’s refrigerant directly into the atmosphere. In fact, more than 95% of the total equivalent CO₂ emissions over the life of air-conditioning equipment can be due to energy use alone.

In addition, decreased efficiency creates a need for larger or additional equipment to meet cooling requirements. This means higher first costs for building owners, who must purchase the extra equipment, and additional emissions, the byproduct of powering them.

So, it is important to remember that GWP is just one measure of a refrigerant’s environmental impact. Depending on the choice of refrigerant, chiller efficiency can be a more reliable measure.

**Consider refrigerant availability**

Finally, alternative refrigerants must be available and affordable. Some of the recently introduced refrigerants have been released in limited quantities or are available in some markets and not others. The challenge is understandable; it takes time for new product production to ramp up and for supply chains to be established. But in the meantime, the lack of availability creates incalculable risk. Technicians cannot be properly trained in the refrigerant’s use. And for building owners who commit to a refrigerant that is not widely available at the outset, the long-term cost of ownership may turn out to be prohibitive if supply remains limited.

Additionally, many of the emerging refrigerants cost many times more than existing fluids. And where flammability is an issue, extra costs associated with facility safety equipment, increased ventilation requirements and potentially higher insurance premiums can further drive up the cost of the refrigerant choice.

**HFCs remain a solid choice**

In the end, the choice of a refrigerant should not be made on the basis of a single factor, such as GWP, but evaluated on the basis of multiple factors unique to an application. Nor should the decision be influenced by pressure to try one of the new alternatives under the incorrect assumption that HFCs are on an accelerated phaseout schedule. For many in the industry, the transition to HFOs and other new refrigerants is still too soon and too risky. Until questions regarding these new refrigerants are answered and the industry decides on the best replacement—one that balances environmental impact with efficiency—HFCs remain a good option—familiar refrigerants that remain safe for users, economical and, when used in chillers that have been optimized for the refrigerant, environmentally sound.

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