

The case for R-290

*Reviewing the pros and cons for wider adoption
of this low-GWP, natural refrigerant alternative*



The viability of propane (R-290) as a refrigerant is a recurring topic of debate in the commercial refrigeration and air conditioning industries. In light of the EPA's recent refrigerant delisting ruling, it's a discussion that's likely to return to the forefront.

While the United States has been especially hesitant to adopt R-290, it has gained wider acceptance in Europe, where environmental concerns and stricter regulations are driving the adoption of more eco-friendly alternatives. R-290's true properties and characteristics are largely unknown to those outside the industry, leading to common misconceptions among the public. The purpose of this article is to present an unbiased evaluation of R-290 and establish a factual baseline of understanding.

A long history in refrigeration

R-290 is a hydrocarbon that was introduced into the refrigeration industry in the early 1900s. Like other natural refrigerants, it was used through the 1930s until it was replaced by chlorofluorocarbons (CFCs). Since the 2000s, R-290 has been regaining popularity in a wide range of applications. With its increase in capacity and low global warming potential (GWP), R-290 has emerged as an alternative to hydrofluorocarbons (HFCs) like R-404A and HFC-134a.

Global regulatory actions to ban high-GWP refrigerants have placed renewed emphasis on R-290 and other natural refrigerants. It was officially approved in a recent EPA SNAP ruling, and has been identified as a viable HFC alternative in the E.U.'s F Gas regulations. And, with R-404A and HFC-134a officially delisted by the EPA in many commercial refrigeration applications, natural refrigerants—including R-290—are primed for a broader resurgence.

Advantages and applications

Because of its long history in refrigeration, R-290's performance efficiencies and thermodynamic properties have been well vetted. In terms of pressure, low back pressure, discharge temperature, volumetric capacity, capacity loss and coefficient of performance (COP), R-290 is very similar to R-22 (even outperforming it in certain characteristics).

At Copeland test labs, we've found R-290 capable of high-performing, efficient operation. Compared to the refrigerants it will likely be called upon to replace—like the recently delisted R-404A and HFC-134a—R-290 yields more capacity with lower wattage consumption (see Table 1). We've developed a full line of Copeland hermetic compressors to be compatible with R-290.

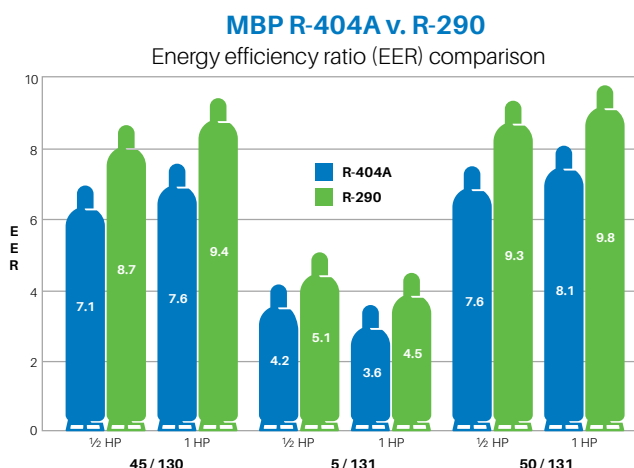


Table 1: results from Copeland test labs, comparing the EER of R-404A to R-290 in medium back pressure (MBP), show a significant improvement when using R-290.

In terms of achieving regulatory compliance, R-290 is very appealing. First, its global warming potential (GWP = 3) is well below the global threshold of 150 GWP, which places it in an elite class of refrigerants from the standpoint of minimal environmental impact. And, its high-efficiency characteristics also qualify it as a candidate for meeting the Department of Energy's (DOE) energy reduction rules that take effect in 2017.

Because of its small charge limit of 150g, R-290 is typically used in smaller commercial applications, such as: beverage coolers, frozen drink machines, ice machines, small ice-cream freezers and small reach-in units. As such, select national foodservice chains recently began installing ice machines designed with R-290.

The applications of R-290 in large food retail applications are more limited. Even in cases where it has been used with special permission to allow for 300g of charge, more compressors are needed to generate the capacity required to meet the refrigeration load. Most supermarkets currently consider this a deterrent for installing an R-290-based refrigeration system.

It's also important to note that R-290 is not to be considered a "drop-in" refrigerant. As with the majority of refrigerants, equipment and components must be specifically designed for use with R-290—it requires a different compressor that will not always directly match the capacity or cost of existing HFC models.

Challenges and misperceptions

While the upside of R-290 may not be readily apparent to the industry outsider, the negative perceptions surrounding it are fairly well-entrenched. It's a common perception shared by the industry and governing bodies. The apprehension stems from the fact that R-290 is classified as an A3 refrigerant—meaning it's considered extremely flammable.

Unfortunately, this negative perception may be somewhat unfounded. Most confuse propane, the domestic "cooking gas" commonly used in backyards for grilling, with propane the refrigerant. They are not the same compound, the former being a class 4 fire hazard. Anyone who's used a match to start a gas grill understands that inherent risk. Misunderstandings like these may very well be feeding into the misperception of R-290.

The 150g charge limit for R-290 in commercial refrigeration amounts to little more than half a cup of liquid. Larger charges up to 300g have been used in the U.S., but these applications require special approval and certification.

In the U.S., specifying an R-290-based refrigeration application can be challenging. End user projects are subject to state and municipal governments for fire and building code approval. Failure to gain the requisite approval, particularly in multiple locations throughout the country, is often a roadblock for R-290 adoption.

Compared to traditional A1-based equipment, specifying R-290-based equipment typically requires an incremental investment in the business infrastructure where the equipment is installed. Building and fire code approvals are also required at OEM production facilities as well, with expenses that typically exceed \$100,000.

But for environmentally forward-leaning companies, R-290 and other natural refrigerants are becoming an increasingly attractive option.

Finally, there are safe-handling considerations for R-290 applications. Both technicians and carriers along every step of the refrigerant supply chain will require proper training and certification.

Careful risk-reward analysis is needed

R-290 has tremendous potential in commercial refrigeration. It is eco-friendly, highly efficient and high-performing. It could effectively eliminate EPA compliance concerns for the foreseeable future. But, despite its potential, R-290 has yet to achieve mass appeal. Public perceptions and an absence of an industry-wide safety infrastructure continue to curb its wider adoption.

While the EPA's recent refrigerant delisting may have cleared the way for wider R-290 adoption, there's no telling if a new class of acceptable alternatives could push R-290 out of the picture again. New mildly flammable A2Ls such as HFO-1234yf offer similar performance and environmental characteristics. HDR-110 shows similar promise but will likely need some equipment system level adjustments. These continue to be tested and are not EPA SNAP approved at this time.

It remains to be seen if the industry and the public will embrace R-290 as a viable natural alternative, or if the analysis taking place throughout the industry is leaning in its favor. No doubt, there are numerous business models and cases with specific benefit being developed; R-290's ability to satisfy these criteria will determine its level of adoption. 🌱

R-290 at-a-glance

R-290 has obvious application benefits and well-known drawbacks. Its many benefits include:

- Hydrocarbon-based, non-synthetic substance
- EPA-approved in commercial refrigeration applications
- Very low environmental impacts; GWP = 3, ODP = 0
- Relatively affordable
- High-efficiency, high-performance, reliable
- Safe when proper protocols and procedures are followed

R-290 suffers from some drawbacks as well:

- Class A3 refrigerant that is flammable
- Globally mandated low charge limits of 150g restrict the application range
- Difficulty getting approved in fire and building codes
- Requires special handling requirements/certifications
- Lack of trained and certified field technicians



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Copeland, a global provider of sustainable climate solutions, combines category-leading brands in compression, controls, software and monitoring for heating, cooling and refrigeration. With best-in-class engineering and design and the broadest portfolio of modulated solutions, we're not just setting the standard for compressor leadership; we're pioneering its evolution. Combining our technology with our smart energy management solutions, we can regulate, track and optimize conditions to help protect temperature-sensitive goods over land and sea, while delivering comfort in any space. Through energy-efficient products, regulation-ready solutions and expertise, we're revolutionizing the next generation of climate technology for the better.

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