R-717 was among the first refrigerants to be used in refrigeration applications. Its superior thermodynamic properties made it a logical first choice, but its toxicity (classified as B2L: low flammability and high toxicity) has been a deterrent to operators unwilling to risk potential leaks. The advent of CFC refrigerants in the mid-twentieth century drove the refrigeration industry away from R-717 toward lower-risk synthetic alternatives. To this day, ammonia’s suitability in low-temperature applications has made it a mainstay in industrial, process cooling, cold storage and ice rink applications. Through leak detection protocols, careful adherence to safe application procedures and lower refrigerant charges, R-717 systems can be used safely and effectively in a broad range of refrigeration applications.

**PROPANE**

Propane is a hydrocarbon that was also identified in the early days of refrigeration as an effective refrigerant. Its high-capacity, energy-efficient performance and very low GWP are offset by its classification as an A3 (highly flammable) substance. But, as synthetic refrigerants became available for many refrigeration applications, R-290 was largely abandoned in lieu of CFC-based counterparts. Since the 2000s, R-290 has been regaining popularity as a lower-GWP, effective alternative to HFCs like R-404A and HFC-134a — especially for a wide range of low-charge, reach-in displays.

**CARBON DIOXIDE**

Non-toxic and non-flammable, CO₂ has proved to be a very effective alternative to HFCs in both low- and medium-temperature applications. CO₂-based refrigeration systems have been successfully deployed in commercial and industrial applications for nearly two decades. Because of its low critical point (87.8 °F) and high operating pressure (around 1,500 psig or 103 bar), CO₂ refrigeration strategies — such as cascade, secondary and transcritical booster — must be designed to account for its unique characteristics. In light of current environmental regulations, the popularity of these systems has increased significantly in North America in recent years.
Innovative installations

Today, the use of natural refrigerants is on the rise. As technologies improve, equipment manufacturers are working closely with end-users to adapt to develop innovative solutions. This has resulted in a number of innovative refrigeration applications that take advantage of the capabilities of natural refrigerants.

There are currently several global efforts to implement natural refrigerant systems. To ensure safety standards, natural refrigerants will continue to play a key role in the development of innovative applications.

Refrigerant phase-down calculator

Emerson has developed a useful tool to help retailers make the transition from higher-GWP HFC refrigerants to lower-GWP natural and synthetic refrigerant alternatives. This web app helps decision makers forecast the life cycle climate performance (LCCP) of a specific architecture or system based on their preferred refrigeration architecture and refrigerant choice. As CO₂ systems become more extensive in larger food retail applications, this tool will help retailers demonstrate the impacts of phasing down the current carbon footprint impacts while phasing in lower-GWP options.

End users start by inputting key information about their current and proposed system architectures, such as design temperatures for stores, store counts of current and future architecture, load graphical charts that will help them demonstrate the impacts. The refrigerant phase-down calculator provides users with the following insights:

- Forecast the impacts of phase-down and phase-in of new refrigerant and system architectures.
- Key metrics that can be downloaded as charts, including total LCCP per store, total LCPE per store, and total weighted CO₂.

There are several benefits of using natural refrigerants in refrigeration systems.

- **Safety and Health**: Natural refrigerants are considered safer than synthetic alternatives, reducing the risks associated with leaks and spills.
- **Environment**: Natural refrigerants have a lower environmental impact, contributing to reduced greenhouse gas emissions and improved energy efficiency.
- **Performance**: They offer superior performance characteristics, potentially leading to increased efficiency and reduced operational costs.
- **Regulatory Compliance**: Natural refrigerants offer compliance with various regulatory standards and certifications, ensuring the legal and safety requirements are met.
- **Innovation**: They provide opportunities for innovation in refrigeration technology and system design.

There are several challenges and considerations when transitioning to natural refrigerants, including:

- **Compatibility with existing systems**: Ensuring compatibility with existing refrigeration systems and machinery.
- **Training and expertise**: Training staff on the operation and maintenance of systems using natural refrigerants.
- **Cost**: Initial costs may be higher, but long-term savings can be achieved.
- **Regulatory changes**: Adapting to changing regulatory requirements and standards.

In summary, the use of natural refrigerants in refrigeration systems presents numerous advantages, including improved safety, lower environmental impact, and enhanced performance. However, careful planning and implementation are crucial to ensure successful transition and continued success in these applications.