bulgin

Transitioning to Cleaner, More Efficient Commercial Refrigeration

bulgin

Keeping up with refrigerants has never been an easy task for the designers, engineers, manufacturers, and distributors who work in the commercial refrigeration industry.

Regulations have followed a long, winding path full of sharp turns and unexpected switchbacks as environmental science has evolved. Multinational governing bodies have spent years debating clean energy goals and finding a realistic means of achieving them.

Today, hydrocarbons — well-known substances with a history of reliability — have emerged as a solution that offers high performance and efficiency without degrading the environment. Some say their use will put an end to the decades of indecision and revisions that have caused manufacturers so many headaches. But for that to happen, the industry must first find a way to keep their flammable and explosive capabilities in check.

How We Got Here: Responding to Changing Conditions

Hydrocarbons (HCs) have been around since the dawn of commercial refrigeration in the early 1900s, when companies replaced blocks of ice cut from frozen lakes and streams with propane or butane fluids, which absorbed, then disposed of heat as it circulated inside refrigerator walls.

In the 1930s manufacturers began using chlorofluorocarbons (CFCs), which worked the same way, but were more powerful and non-flammable. CFCs — including the DuPont-trademarked Freon compound, which was so successful it became synonymous with the substance — became the standard in commercial refrigeration.

But in the 1970s, scientists discovered that CFCs turn ozone molecules (O_3) into oxygen (O_2), collectively eroding the Earth's ozone layer, which protects the planet from the sun's harmful ultraviolet-B radiation. In 1987, an international treaty, the Montreal Protocol, was created to protect the ozone layer. It went into effect in 1989, and gradually phased out production of CFCs.

Many in the refrigeration industry then switched to hydrochlorofluorocarbons (HCFCs), such as R-22, as a transitional substitute. While HCFCs also contain chlorine atoms, they are less damaging to the ozone layer because their hydrogen atoms cause them to break down in the atmosphere faster.

But as science evolved, environmental organizations extended their focus beyond the ozone layer to study greenhouse gas emissions, which trap the sun's heat and cause global warming.

Both CFCs and HCFCs act as powerful greenhouse gases. In 2007, the Montreal Protocol adopted an accelerated schedule to phase out HCFCs, eliminating them by 2020 in developed nations and by 2030 in developing countries.

As a result of the HCFC phase-out, hydrofluorocarbons (HFCs), such as R-410A, became increasingly popular refrigerants. However, they, too, were found to have serious problems. While they don't threaten the ozone layer, they carry a high global warming potential (GWP). According to the Dutch National Institute for Public Health and the Environment (RIVM), the five most commonly used HFCs are 150 to 5,000 times more potent greenhouse gases than carbon dioxide, and a less-common type is up to 12,500 times more potent.

In addition, HFC emissions were growing at a rate of 8% a year, mostly because of increased demand for refrigeration and air conditioning in developing countries. Without intervention, they could account for up to 19% of global carbon dioxide emissions by 2050, according to the Montreal Protocol.

Additional studies and pressure from environmental groups led to the passage of an amendment to the Montreal Protocol in 2016. The Kigali Amendment, which has now been signed by 138 nations (including the U.S. in 2022), aims to cut the production and consumption of HFCs by more than 80 percent over the next 30 years.

Countries across the globe are now regulating the use of HFCs. The amendment allows each country to create its own laws for achieving phase-down goals. Europe has accelerated its timetable ahead of protocol requirements. In the U.S., the situation is more complicated. In 2015 and 2016, the Environmental Protection Agency (EPA) published Significant New Alternative Policy (SNAP) regulations to restrict the use of high-GWC HFCs. Though a court later ruled these federal regulations invalid nationwide, a growing number of individual states have either implemented the rules or are scaling in similar HFC prohibitions.

Back to the Future: The Hydrocarbon Resurgence

With CFCs and HCFCs largely gone and HFCs on the way out, the commercial refrigeration industry is now shifting back to a familiar and reliable cooling source: hydrocarbons. It turns out they have a sterling environmental profile, as well as impressive performance capabilities. For these reasons, many in the industry see HCs as the ultimate solution — a medium that will satisfy both users and regulators for the foreseeable future, and finally free manufacturers and distributors from the endless, costly revision cycles they have experienced over the past few decades.

HC contenders that have gained the most traction are propane-based R-290 for commercial systems and R-660A for home systems. A naturally-occurring and non-toxic substance, R-290 is very eco-friendly, and has been approved by the EPA for commercial refrigeration applications. Its GWP rating of 3 is far below the SNAP rules' suggested limit of 150 for industrial and supermarket refrigeration systems, putting it in line with today's state rules. Its ozone-depletion rating is nearly zero.

R-290 has gained widespread acceptance in Europe and is spreading rapidly in the U.S. California, Colorado, Delaware, Maryland, Massachusetts, New Jersey, New York, Vermont, and Washington required R-290 adoption for new systems by 2021. Maine, Rhode Island, and Virginia required it by 2022. Canada also made the transition in 2022, and many other U.S. states are proposing legislation.

The new laws do not apply to refrigeration systems already in use, but any new systems will have to follow them by the deadline dates. Many manufacturers have shifted their product offerings to feature R-290, and retailers are expressing a growing interest in it.

R-290 Performance Capabilities

Even in areas where it isn't required (yet), there are some compelling performance benefits in switching to R-290. Its high thermal conductivity makes it an effective and efficient cooling agent, and its operating costs are lower than those of its fluorinated cousins. Compared to R-404A and HFC-134A, for example, it has greater capacity while using less wattage.

It also has lower high-side compressor pressure, increasing the life expectancy of appliances. Its operational consistency keeps ice in good condition and makes it easier for service technicians to measure the size of capillary tubes and charge amounts.

Overcoming Flammability Challenges

Despite their strong environmental and performance appeal, hydrocarbons do come with a significant drawback: they are classified by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) as A3 flammable substances. Even though the refrigeration unit containing R-290 is hermetically sealed, special safety procedures must be observed for installing and servicing equipment that uses it.

In the U.S., ASHRAE Standard 34 classifies refrigerants according to toxicity and flammability, while ASHRAE Standard 15 and UL Standard 60335-2-40 lay out safety requirements for installation. In Europe, equipment containing hydrocarbons must be certified by ATEX. Many countries in Asia and Africa adhere to one or more of these standards, or have developed their own rules based on them.

Manufacturers must follow strict specifications for placement of electrical equipment near HC units, and leakage simulation testing is required. In both the U.S. and Europe, charge limits are restricted to 150g unless companies apply for certification extending the limit to 300g.

Flammable refrigerants can only be used in new appliances built to regulatory standards. Compressors and other components must be designed specifically for use with HCs, and conversion of existing equipment is not allowed. And even if you have the proper equipment, you may need to wait before using it, since local building codes may need to be changed before it can be installed.

In addition, service technicians and distributors must undergo training and certification requiring them to be familiar with governing standards and aware of ignition sources, best practices for safe handling, and procedures for handling an emergency.

Preventing Explosions with Robust, Certified Door Switches

While the rules surrounding R-290 are complex, fires and explosions can be prevented by a simple means: using certified, extremely robust door switches. That's because ATEX-certified switches — provided they are used within the rated voltage limit — will not ignite if hydrocarbons ever leak out of the compressor.

To obtain ATEX certification, a switch must undergo a series of trials. First, it is conditioned 7,000 times under load to reflect a period of normal operation. Then it is run in a chamber filled with the worst possible mixtures of the relevant explosive gas mix. The contacts are fully unprotected, ensuring complete exposure in a worst case scenario, and the current used for the test is 1.5 times that of the rated current. In each test, the switch is cycled 50 times using fresh gas mixes throughout. Only switches that have zero ignitions under these conditions — which are far worse than those they would encounter in a real-life situation — are granted certification.

By using ATEX-certified switches and following clearly documented procedures for equipment testing and handling, manufacturers and engineers can be confident that refrigerators built to accommodate modern cooling requirements will operate safely.

The refrigeration industry has undergone a long, arduous journey as the world has transitioned to cleaner energy, and now it has circled back to hydrocarbons. With their combination of outstanding performance, reliability, efficiency, and environmental friendliness, today's hydrocarbon refrigerants appear to be the ideal solution for the foreseeable future — as long as their explosive potential can be contained. ATEX-certified switches solve that final challenge, finally making the elusive dream of an efficient green energy solution a reality.

Bulgin—the Market Leader in ATEX-Certified Switches

Bulgin's Series 3100 switches, which have been at the forefront of the market for over two decades, are now certified by both ATEX and UL. These certifications attest to the superior quality, performance, and reliability that have drawn customers to the brand again and again for years.

To learn more about Bulgin's refrigerator switches and how they can improve your product or design, visit Bulgin.com.

bulgin

www.bulgin.com

Americas

Bulgin
10619 Painter Avenue Suite A
Santa Fe Springs
CA 90670 USA
tel: +1-833-428-5446
(1-833-4-bulgin)
fax: +1 760-343-3445
e: info@bulgin.com

UK, Middle East & Africa

Bulgin
200 Cambridge Science Park
Milton Road
Cambridge CB4 0GZ UK
tel: +44 (0) 1803 407757
and +44 (0) 800 056 9059
Germany tel: +49 (0) 800 000 0547
e: info@bulgin.com

Asia Pacific

Bulgin
Singapore tel: +65 800-101-3704
China tel: +86 400-120-8784
e: info@bulgin.com