

# Refrigerant Gases— an Industry in Transition

A Special Report from Linde Gases



Increasing recognition and acknowledgment of the environmental impact associated with the use of refrigeration and air conditioning equipment has brought about changes in the composition of refrigerant gases and in the way they are being used. This heightened awareness on the part of end users and consumers is playing an important role in accelerating these changes through corporate responsibility agendas, although the evolution of the industry is primarily being driven by legislation introduced to limit ozone depletion and global warming.

Refrigerant gases are used as a heat exchange material in equipment such as refrigerators, freezers, and air conditioning systems. The refrigerant gas is pumped around a closed loop, being repeatedly evaporated and condensed and transferring heat away from where it is not required.

The original chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) were highly efficient refrigerants: their negative environmental impact, however, has led to legislative control. CFCs are now banned from use in refrigeration applications globally, and HCFCs are in the process of being phased out. Many countries have been phasing out HCFCs for years and the transition is nearly complete. For example, the EU banned the sale of new HCFCs in 2010. Emerging economies are starting to phase out HCFCs beginning in 2013. However, while their common replacement, hydrofluorocarbons (HFCs), provide a non-ozone depleting solution, they still have a relatively high global warming potential (GWP).

“Global warming is the leading environmental concern of the 21st century,” says Jon Black, Global Head of Chemicals and Refrigerants, Linde Gases Division. “In refrigeration applications, there are two causes of global warming—indirect release of carbon dioxide (CO<sub>2</sub>) into the atmosphere as a result of energy use, and direct release of harmful refrigerant gases to the atmosphere from leakages, breakdowns, or poor servicing practices. The combination of these two

effects is often referred to as the “total equivalent warming impact” (TEWI).

Against a backdrop of this heightened environmental awareness across all industries, many companies are proactively seeking to reduce their global warming impact, often operating ahead of legislation.

Leak reduction is often a first target. Some systems leak as much as 25 percent of their refrigerant into the atmosphere annually. In the past, when older refrigerants were relatively cheap and benign in terms of human safety—being non-toxic and non-flammable—and environmental issues were less clearly understood, large users of refrigerants like supermarkets focused less on leakage, simply topping off the refrigerant to compensate for leaks.

“Whilst great improvements can certainly be made, in practice, it’s almost impossible to achieve zero leakage, so there really is a need for a refrigerant gas that, in the event of a leak, will have minimum impact on global warming,” says Black.

Therefore the choice of refrigerant gas used is increasingly under scrutiny. In the short term, a viable option is to “retrofit” refrigeration systems to use alternative HFCs that have a lower GWP than the current gas used, but avoid the need for substantial capital expenditure.

To reduce the negative environmental impact, users need new molecules and equipment. Currently the long term solutions appear to be hydrofluoroolefin gases (HFOs) and natural refrigerants. HFOs are a “fourth generation” refrigerant, which are a close relative to HFC gases but have far lower global warming potential.

HFOs are currently in the early stages of introduction. The first molecules being commercialized are “R1234yf” and “R1234ze.” R1234yf will initially be used as a replacement to R134a in automotive applications, then spread to other refrigeration and air conditioning applications. Further products will be released over the coming years.

Natural refrigerants are chemicals that

occur in nature’s biochemical processes. They do not deplete the ozone layer and make a negligible contribution to global warming. The most common natural refrigerants are R717 (ammonia), R744 (CO<sub>2</sub>), and hydrocarbons. Many of these products were used before the 1950s prior to fluorocarbon production and are now being used more extensively owing to their low impact on the environment.

## Supermarkets

In many ways, the food industry has been at the forefront of driving low global warming solutions. As a highly consumer-facing section of the refrigerants market, food companies are called upon to become ever more accountable for corporate sustainability matters, and this has led to many of these companies making a public stand against global warming by committing to the responsible use of refrigerant gases.

Black predicts that the food industry, with its consumer facing nature and its large corporate entities that are able to afford the capital investment required, is likely to lead the other industrial sectors in the introduction of new refrigerant gases.

“It’s worth noting that the food industry has always favored low GWP refrigerants. For example the industry has used ammonia systems for many years in industrial warehouses. These systems are very efficient and always have been, and the original choice to use them was taken based on their efficiency, before any environmental agenda came to the fore.”

Supermarket chains in many countries are now reviewing their carbon footprint and are focusing on refrigeration systems. Leakage is an important topic; however the choice of gas is also being reviewed.

In the short term, the use of HFC R404A, which has a very high GWP, is likely to decline. Alternative HFCs are available that have 50 percent lower GWP and often can be retrofitted into existing installations without the need for major capital expenditure.

As well as focusing on immediate impact, retailers are looking for longer term solutions

that use refrigerants with substantially lower GWPs. Examples include systems using natural refrigerants, HFOs, as well as combinations of gases—such as natural refrigerants and HFOs operating together to achieve the efficiency they need and to lower their overall GWP footprint in all climates.

In the United Kingdom, according to the Environmental Investigation Agency (EIA), supermarkets are the biggest source of HFC emissions, with leaking refrigerant gases accounting for about one-quarter of a retailer's carbon footprint. Leading UK retailer and supermarket chains are, however, following highly publicized initiatives to address the issues. A recently published EIA report that ranks retailers by their progress toward natural refrigerants, put Waitrose (a high-end chain of supermarkets in the UK) at the top of the ranking, followed by Tesco (a multinational grocery chain), and Marks & Spencer (a major British retailer).

Waitrose parent company John Lewis Partnership, has committed to moving away from HFC refrigerants. The supermarket chain operates a number of stores using hydrocarbon refrigerants, and also is currently testing the world's first HFO 1234ze chiller, with promising results associated with low GWP, safety in use, and energy efficiency. In the longer term, HFO 1234yf could also be tested, which has an even lower GWP and other potential benefits according to the chain's spokesperson.

Marks & Spencer has made a commitment to replace all HCFC refrigerants by 2014 and extend the roll-out of replacing R404A refrigerant with the lower GWP alternative, R407A. Since 2010 all new installations have used

CO<sub>2</sub> secondary systems wherever possible. The company has committed to progressively reducing its total refrigeration greenhouse gas emissions by 50 percent by 2015 and to removing HFC refrigerants from its refrigeration and air conditioning systems by 2030.

With HFCs comprising 16 percent of Tesco's global carbon footprint, this multinational grocery chain has also committed to finding alternatives. It has installed non-HFC "natural refrigeration" systems in Hungary and the UK, and in its existing stores in the UK, HFC emissions have been reduced by 15 percent compared to 2009/10. A natural refrigeration system also has been used on a trial basis in Turkey. In November 2010, along with other members of the Consumer Goods Forum, a global, parity-based industry network, Tesco pledged to begin phasing out HFC refrigerants as of 2015 where permitted by local and national regulations, and where it is possible to do so based on climate and store format. Tesco is actively looking at non-HFC systems that could also work in tropical climates like Malaysia and Thailand, and in smaller formats and existing stores.

In the United States, *Supermarket News* magazine reported that in an effort to reduce leaks of refrigerant gases that contribute significantly to global warming, the California Air Resources Board (ARB) is rolling out unprecedented state regulations on supermarkets and other facilities that use commercial refrigeration systems. The regulations, launched in January 2011 and scheduled to ramp up in 2012, apply to any business using more than 50 pounds of refrigerants with high GWP. These refrigerants include the HCFCs and HFCs commonly used by food retailers.

The initial regulations include periodic leak inspection (annually, quarterly, or monthly, depending on size), repairs, retrofit or retirement plans, required service practices, and recordkeeping and repair of any detected leaks within 14 days of discovery. Adding five pounds or more of refrigerant, or one percent or more, would trigger a leak inspection under these rules.

According to the report, the ARB rules target what it calls the largest source of highly potent greenhouse gases. For example, a leak of just 700 grams of an HCFC supermarket refrigerant like R-22 is equivalent to releasing a metric ton of CO<sub>2</sub>. By applying the rules, the ARB expects to eliminate 8.1 million metric tons of CO<sub>2</sub> by 2020, the equivalent of removing about 1.4 million cars from the road for a year. In addition to supermarkets, the regulations cover cold storage warehouses, food and beverage processors, and industrial cooling processes.

Small refrigeration units in food stores—the static display cases storing cold drinks and ice-creams—have historically operated with small volumes of HFCs such as 134a. Many leading consumer facing corporations, such as Coca Cola and Unilever, have pledged to invest in the development of alternative refrigeration systems using natural refrigerants such as R744 and hydrocarbons. Notably, the Coca-Cola Company and its bottling partners have committed to using HFC-free technology for all new vending machines and coolers by 2015. ■

*Linde Gases is a Division of The Linde Group. For more information on new refrigerants visit [www.linde-gas.com](http://www.linde-gas.com) or contact [press@linde-gas.com](mailto:press@linde-gas.com).*



Natural refrigerant gases are gaining in popularity, especially within the food industry.



Changes in chemical composition of refrigerants have been driven in part by the food industry.