MARKET UPDATE ON NATURAL REFRIGERANTS IN EUROPE

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ABSTRACT

The EU F-Gas Regulation is driving the uptake of natural refrigerants across Europe and beyond. The pace and level of adoption varies for different sectors and European regions as a result of a number of factors, such as technology advancements, investments in R&D, legislative incentives, barriers posed by standards, availability of trained technicians and others.

This presentation will outline the latest market and technology trends in adoption of CO_2, hydrocarbons and ammonia in key refrigeration and HVAC sectors. It will analyse the key factors underlying these trends, and review the main barriers that continue to prevent their wider uptake. Particular focus will be given on the standards as a barrier to adoption of hydrocarbons in larger applications and the impact of potential review that would increase the allowable charge limit.

Indicatively for commercial refrigeration, CO_2 transcritical is quickly becoming the mainstream technology for new stores, with over 20,000 stores using this technology globally today. In case of industrial refrigeration, ammonia has traditionally been used as a refrigerant of choice in larger applications. New technologies using low-charge ammonia and CO_2 are becoming increasingly popular for cold storage and other industrial applications.

Keywords: CO_2, ammonia, hydrocarbons, commercial refrigeration, industrial refrigeration, HVAC

1. INTRODUCTION

CO_2, ammonia, hydrocarbons have been used in a number of HVAC&R applications for many years, however, with the exception of a few sectors, their penetration in the market has been relatively low. The changing legislative landscape for fluorinated refrigerants, proactivity of influential end-users and decreasing costs of technologies are underpinning the market uptake for natural refrigerants in various sectors globally.

With their low impact on the environment, excellent energy efficiency performance, compliance with future legislation natural refrigerants are quickly becoming the preferred option for a growing number of end-users. As the adoption of HFC-free technologies increases, the competition between different natural refrigerant-based systems grows too.

2. MARKET TRENDS FOR CO_2 IN REFRIGERATION

Commercial refrigeration has been the most dynamic sector in terms of shift to natural refrigerants in recent years across different world regions. CO_2 has become one of the most interesting technologies for new systems and refurbishments for a number of major retailers who are leading this trend.

sheccoBase, the market intelligence arm of shecco, estimates there are at least 20,000 stores globally using CO_2 transcritical technology. The majority of these, around 16,000, are located in Europe, where they represent about 14% of the food retail market (food retail stores in the EU, Norway and Switzerland bigger than 400m^2). Following the adoption of the EU F-Gas Regulation in 2014 that will implement a ban on HFCs with GWP > 150 in supermarket refrigeration, the market for CO_2 has seen annual growth rates of 25-40%. The biggest momentum for natural refrigerants in this sector in Europe is expected in 2020-2022 timeframe, just before the HFC ban enters into force.

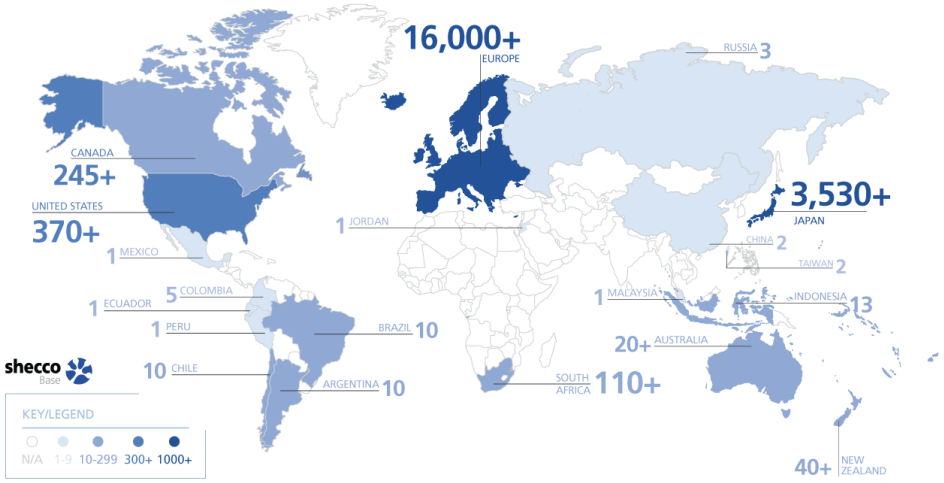

Figure 1: CO_2 transcritical stores globally, October 2018 (sheccoBase)

On the technology side, CO_2 refrigeration systems have moved towards more compact, easy-to-install and service-friendly design. The growing commercial availability by a large number of suppliers and standardisation of CO_2 boosters have pushed the price of the technology down in the last few years. The cost of CO2 compressors is now on par or lower than the cost of equivalent HFC compressors (Skačanová et al., 2016). Depending on the market and technology, the total installation price is currently at the same level as conventional systems or in the range of 5-10% higher. Although the technology for warmer ambient climates using parallel compression and ejectors is currently higher in terms of initial cost, this is expected to go down as technology becomes more widespread (as has been proven for the standard booster system). Industry experts estimate that with ejector technology and parallel compression, the price of a system is a maximum 10% higher.

Innovations such as parallel compressor, ejectors, mechanical sub-cooling, and adiabatic/evaporative coolers, CO_2 transcritical technology is now suitable for climates up to 45°C (Danfoss, 2016).

Adding an adiabatic gas cooler to a CO_2 transcritical system in warmer climates offers additional annual energy savings of 8-12%. Parallel compression delivers 6-8% savings, and in combination with gas ejectors, savings can reach 8-10% compared to a transcritical system not using these enhancements (Schönenberger et al, 2014). Some experts in the

field believe that ejector technology is the solution to remove the CO_2 equator – a geographical line below which CO_2 systems were believed to be less energy efficient than their HFC counterparts.

2.1 Trends for natural refrigerants in small store formats

After becoming a standard for a number of retailers in new stores, CO_2 is also becoming an interesting option to fulfil the cooling needs in small store formats. A growing number of manufacturers offer the solutions for this market segment, including condensing units and mini boosters.

CO_2 condensing units have been an established technology in Japan with more than 8,500 running in the market by end of 2017. Based on data collected from system suppliers by sheccoBase, an estimated 6,000+ stores use CO_2 condensing units and mini boosters globally, with a growing number of suppliers offering such equipment. In Europe and other parts of the world, retailers that have gained experience with CO_2 in supermarket refrigeration push the manufacturers to commercialise and decrease the cost of CO_2 condensing units and miniboosters.

In the small store segment, CO_2 is facing a competition from another HFC-free option - hydrocarbons. There is an estimated 2.5 million hydrocarbon plug-in refrigerated showcases in use today globally. The main strength of these systems is that the initial costs are much lower compared to centralised systems, and their maintenance is cheap and easy, with the option to replace a stand-alone cabinet upon failure. On the other hand, the main disadvantage is that the condenser heat is released directly to the sales area, creating an additional heat load to the supermarket and increasing the energy costs (AC requirement).

To tackle the heat disadvantage, innovative waterloop solutions have been developed and rolled onto the market using hydrocarbons, mainly propane and propylene. The waterloop systems are designed so that every cabinet has its own self-contained refrigeration unit. The heat generated is not released to the surrounding environment of the store, as it is carried outside by a waterloop to a simple dry cooler. Based on a recent data collected from system manufacturers, there are more than 1,900 hydrocarbon waterloop systems globally, with 90% installed in Europe (Zolcer Skačanová et al., 2018). A manufacturer reports around 16% better energy performance with hydrocarbon waterloop technology compared to similar HFC models (Williams et al., 2016).

3. INDUSTRIAL REFRIGERATION: GROWING COMPETITION AMONG HFC-FREE TECHNOLOGIES

Ammonia has traditionally been used in the industrial refrigeration market along with HFCs for smaller installations. Today more than 90% of large industrial refrigeration facilities in Europe use ammonia as a refrigerant (Skačanová et al., 2016). Nevertheless new technologies, such as CO_2 transcritical and low-charge ammonia and disrupting the traditional market in a way it was never seen before.

Polls at ATMOsphere conference (Figure 2) held in different world regions in 2018 revealed that while most believe CO_2 transcritical has the biggest potential for industrial refrigeration over the next 5 years, ammonia/ CO_2 cascade and other types of low-charge

ammonia systems are expected to take an important share in the market. In the U.S. in particular, low-charge ammonia is expected to be more popular than CO_2 transcritical.

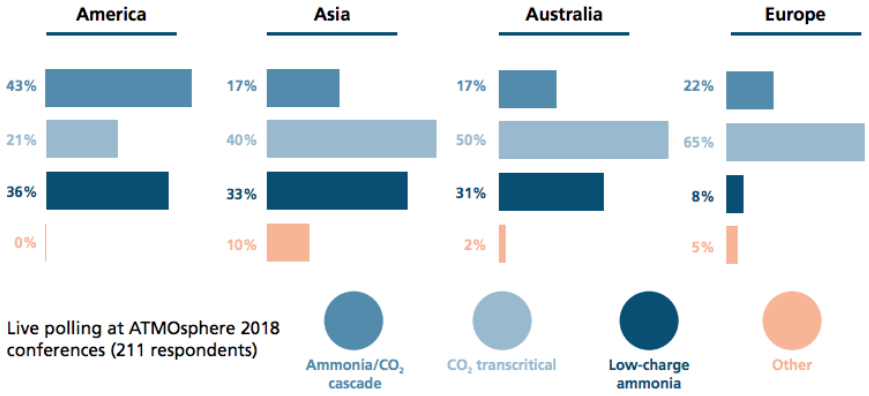

Figure 2: Live polling on the potential of HFC-free technologies for industrial refrigeration in the next 5 years

CO_2 is becoming increasingly prevalent – and competitive – in industrial refrigeration applications, especially in small and medium-sized installations. New technological developments, particularly for compressors, have allowed CO_2 transcritical systems to reach higher capacities and capture a part of the industrial refrigeration market. Some customers in this market are moving towards CO_2-only systems, partly due to the safety and technical challenges of using traditional ammonia systems (with their higher refrigerant charge). According to engineering experts, CO_2 compressors can have as equally long lives as ammonia ones, without the need for special components.

Low-charge ammonia technology has been developing at an increasingly fast pace over the past decade, with the market now seeing competition between more technology providers. This trend will continue to spur innovation, to the overall benefit of the global marketplace.

On a component level, the development of optimised heat exchangers, advanced controls and novel system architectures is driving innovation in this newly formed and competitive market. Manufacturers are taking advantage of this to develop modular, packaged ammonia systems as well as optimised, distributed systems with a variety of designs.

The increased popularity of low-charge ammonia raises the need for a better distinction compared to traditional ammonia systems. Initial results of the on-going research (*World Guide to Low-charge Ammonia*) indicate that more than 1,650 installations are already operating today worldwide, with cost being identified by many experts in the field as the biggest barrier to wider adoption of low-charge technology.

4. CONCLUSIONS

In light of growing legislative pressure on fluorinated refrigerants globally, natural refrigerants such as CO_2, hydrocarbons and low-charge ammonia emerge as leading alternatives for refrigeration and air-conditioning applications. On the market side, there is a growing competition between natural refrigerants across different applications. CO_2 has already gained market presence in commercial refrigeration in certain parts of the world. With the growing number of suppliers, the focus is now on improving energy efficiency of systems especially in warmer climates, reducing the cost, as well as integrating the refrigeration system with air-conditioning and heating (space and water).

The development of large compressors and other key system components make it possible to deliver CO_2-based systems for different sizes of industrial refrigeration installations, with cooling capacities of up to 2-3MW. As CO_2 is entering into areas where it was previously not used, the technologies will see a growing competition with other natural refrigerant-based systems.

Hydrocarbons are already widely used in commercial refrigeration plug-in units and this trend will continue as the technology is reliable, proven and delivers high energy efficiency. In addition there are other applications where hydrocarbons are seeing increasing attention especially in Europe, such as heat pumps and chillers, with a growing number of companies investing in production of such equipment.

Advanced component designs and control systems have led to the development of modern, innovative, low-charge ammonia systems. The growing competition in the low-charge ammonia space is driving innovation and this will help to drive down costs, further increasing the rate of adoption.

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