Connected
Efficiency

CAREL

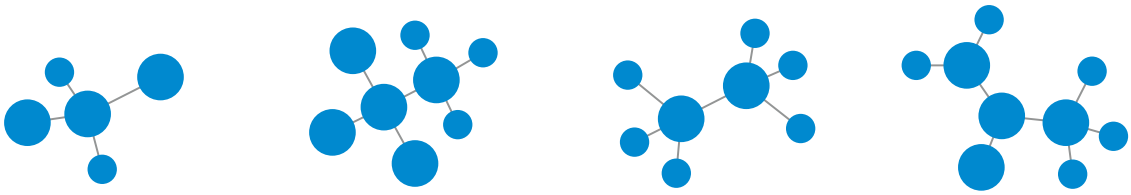
Application note

Highly-efficient and connected beverage coolers

The main target in the refrigeration market these days is to offer highly-efficient products, which bring benefits in terms of caring for the environment and reducing electricity bills, along with cooling the stored goods in the best possible way. In this respect, connectivity is an important advancement, as it allows systems to be optimised based on historical data. At the same time, increasing efficiency ensures compliance with the limits imposed by energy regulations, which are already in force in some countries and are being extended to others. The choice of the refrigerant is also relevant for the efficiency of refrigeration systems, and is moreover particularly affected by current regulations worldwide. In concrete terms, the restrictions for beverage coolers are very strict. This has led manufacturers to consider the option of using hydrocarbons, yet these are also affected by flammability standards and explosion-proof requirements.

Moreover, the main feature of beverage coolers with respect to other refrigerators is that their purpose is not to preserve products, but rather to cool them. This means that they are usually switched off when the shop is closed. Consequently, the time and effectiveness of the pull down stage is particularly important, being a crucial moment in terms of energy saving. The control system and benefits deriving from connectivity play a very important role in this stage. The seasonality effect is another important factor in the efficiency of beverage coolers. In this regard, correct selection of the compressor technology can greatly improve performance, especially at part loads.

In this scenario, appropriate selection of technology as well as the use of accepted and efficient refrigerants allows beverage coolers to achieve great results in terms of efficiency, while also meeting worldwide energy efficiency and refrigerant regulations. This document aims to describe a complete solution for beverage coolers that both fulfils market requirements and complies with current regulations.



CFCs HCFCs HFCs HFOs

High ODP
High GWP

Low ODP
High GWP

Zero ODP
High GWP

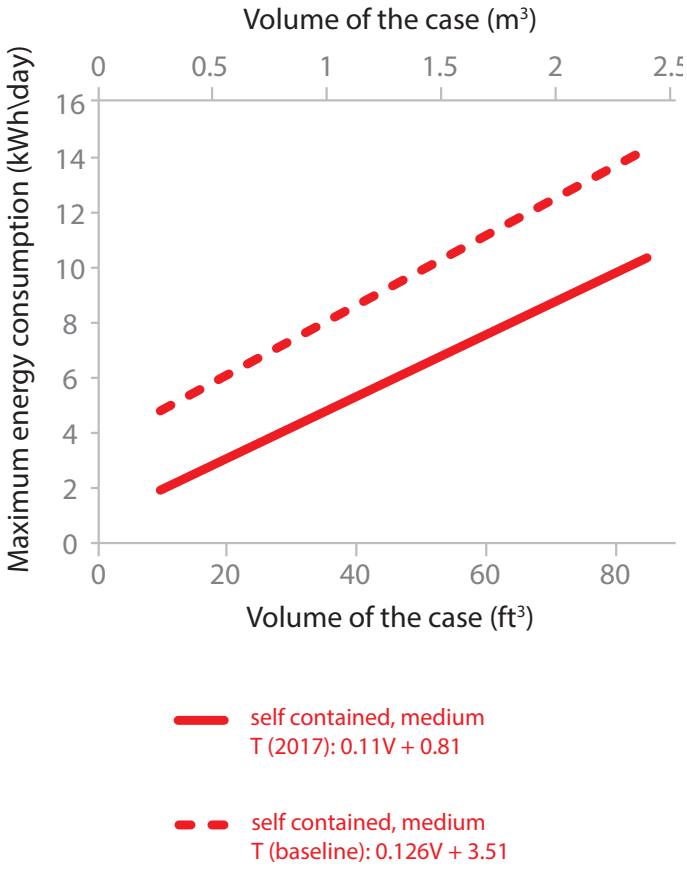
Zero ODP
Low GWP

Background

The Kigali amendment to the Montreal Protocol was signed less than one year ago, in which worldwide countries agreed to phase down greenhouse gases with the aim of reducing global warming. However, actions to reduce the use of fluorinated refrigerants (HFCs) had already begun in most developed countries. In the European Union, the F-gas regulations were published in 2014, establishing restrictions on the use of HFC refrigerants according to their global warming potential (GWP). In the case of beverage coolers, the GWP limit is 2500 starting from 2020, and 150 starting from 2022, considering that these are included in the category of hermetically sealed commercial refrigeration units. In the United States, the EPA SNAP rules dictate which refrigerants are allowed in each application. Some of the refrigerants listed for stand-alone units are R-744 (CO_2), R-290 (propane) or R-513A.

The alternatives to high GWP refrigerants are generally slightly flammable, such as most pure hydrofluoroolefins (HFO) and their mixtures, or flammable, such as hydrocarbons. In these cases, charge limits and explosion-proof requirements have to be taken into account, which are regulated by both international standards and local rules. For instance, the ATEX Directive is the European Union legislation that defines the minimum safety requirements for equipment and protection systems intended to be used in potentially explosive atmospheres. Moreover, EN 378 states the maximum charge per circuit for propane to be 0.008 kg/m3 × room volume, up to a maximum of 1.5 kg. In the United States, UL 471 establishes a limit of 150 g of flammable refrigerant per circuit for commercial refrigerators and freezers. Both in Europe and the United States, flammability requirements are under revision to possibly increase the charge limits and facilitate the transition to lower GWP refrigerants.

Efficiency is another important regulatory aspect in developed countries today. Ecodesign and Energy Labelling Directives in Europe define new regulations for energy-using and energy-related products. What's new with regard to the previous rules is that the energy efficiency classification tends to consider not only the energy consumption at nominal conditions, but rather all year around, weighing the seasonality effect. In the United States, the Department of Energy (DOE) energy conservation standards for commercial refrigeration equipment came into force last March, and include limits for pull-down cabinets. It should be noted that the new limits are very close to the Max-Tech values, which correspond to the estimated minimum energy consumption that can be reached for each unit using the best technology available. The reduction in the limits with respect to the previous standard is also notable. For example, the maximum energy consumption of a 40 ft3 (1.1 m3) medium temperature pull-down cabinet has been reduced from 8.6 to 5.2 kWh/day compared to the previous standard, which means a 39% decrease. The following graph shows the baseline and the new standards for pull-down cabinets according to case volume:



This regulatory framework, that includes fluorinated refrigerants, flammability and energy efficiency requirements, comes at a time in which connectivity is at the fore. Gartner, a famous research and consulting firm, estimates that 8.4 billion connected things will be in use in 2017, a 31 % increase over 2016. In the field of refrigeration, interconnection allows systems to be optimised by improving control through the knowledge of historical data. This development is an excellent opportunity to improve processes, reduce the costs and times of services that are already offered today, and introduce value-added services for end users.

Challenges

The refrigeration industry needs to respond to the challenges marked by technological development, regulations and the connectivity evolution, which at the same time are creating new marketing strategies. Clearly, saving money and being friendly to the environment are key factors nowadays. On the one hand, the market situation has changed with respect to the past: consumers no longer look solely at the initial price of equipment, but also at the electricity costs they will have to pay throughout its life. On the other hand, environmental impact is now becoming more relevant at the time of buying an appliance.

In this sense, beverage coolers have to be designed with a focus on reducing consumption while maintaining or even improving performance. The use of variable-speed compressors and electronic expansion valves, as well as improvements in control and supervisory systems are some of the trends that considerably help achieve this objective.

Moreover, the use of low-GWP HFO and natural refrigerants is being expanded due to fluorinated gas regulations all around the world. In small systems such as beverage coolers, hydrocarbons are specified as the most appropriate refrigerants due to their high performance. The low refrigerant charge in these applications allows compliance with flammability limits and explosion-proof requirements. Furthermore, the environmental image of natural refrigerants is becoming a marketing claim.

The combination of a very low GWP refrigerant in hermetically-sealed equipment (with the consequent decrease in leaks), with a variable-speed compressor and the right choice of the other components, allows great results to be obtained in terms of energy efficiency and consequently reduction in CO_2 emissions into the environment.

Nevertheless, there is still a possibility to further improve beverage coolers: make them smart.

IoT ("internet of things") allows systems to be improved based on knowledge and analysis of historical data, which is acquired by interconnecting different units over the internet. Data is transformed into information, information into knowledge, and knowledge into value, and this is why it is called intelligence data. The object becomes smarter and consequently repeats the procedures that allowed it to obtain the best results. In the refrigeration sector, the first steps regarding IoT and intelligence data have already been taken, and beverage coolers can benefit from these.

Connected efficiency is the sum of all these elements, which can be joined together to achieve the perfect solution for the current market.

Heez

Heez is Carel's solution for the control and management of beverage coolers, guaranteeing high energy efficiency and great performance while reducing the environmental impact. The synergic use of continuous modulating devices allows beverage cooler operation to adapt to different situations. Moreover, energy efficiency is optimised during both steady operation and pull-down, achieving good performance and energy savings. Integrated IoT connectivity complete the Heez solution enabling digital marketing activities and strategies, and improving maintenance activities. The components and features of this new Carel solution are briefly described below.

The choice of the compressor responds to the need to increase efficiency, required by both regulations and the end user, as well as the desire to reduce the volume of the refrigeration circuit, leaving more space for the goods. Indeed, DC rotary technology ensures the highest energy performance due to the very wide range of modulation, as well as high reliability and stability, lower noise and more compact dimensions. The increase in unit COP at part load ensured by DC technology is particularly important for beverage coolers for two reasons: cooling demand increases on the warmest days due to higher temperatures, when use of the cabinets also increases, meaning the doors are opened and closed more often. Moreover, rotary compressors, the alternative to traditionally-used reciprocating hermetic compressors in beverage coolers, brings the benefit of being much smaller with a very competitive production cost.

The rotary DC inverter compressor is a fundamental and innovative component of the Heez proposal and has been exclusively designed based on CAREL's specifications by world-class compressor manufacturer Qingan, an affiliate of AVIC (Aviation Industry Corporation of China) and based in the Xi'an Hi-tech Development zone.

Another important component for energy saving is the expansion valve. In particular, the use of electronic expansion valves allows adaptive adjustment of control characteristics during operation, as well as operation with a lower pressure difference, meaning a more significant decrease in condensing temperature. This increases both system energy efficiency and reliability.

Full variable speed fans for both evaporator and condenser sections are also part of the proposal. Compared to traditional systems, these do not typically operate with "on and off" cycles, but rather efficiently vary their capacity so as to adapt to instant requirements, guaranteeing energy savings, higher reliability and stability, lower noise and more compact dimensions.

The incredible increase in temperature pull-down performance is one of the main results achievable with Heez. This ensures the beverages are always at the desired temperature, thus ensuring optimal sales conditions.
In line with regulations worldwide, propane is the refrigerant selected for this solution, which also brings the benefit of a very high performance.
Moreover, the Heez user interface is wireless connected. This guarantees the interaction with CAREL APPLICA application for mobile devices and the access to all the information and relative documentation, always updated and available on the cloud. Service operations are easier with parameters setting from smartphone and safe with an advanced profiles management.

Finally, responding to the last technology trends, connectivity has been implemented with the use of NFC and Bluetooth technology.
The software includes self-adaptive logic that adjusts operating conditions by learning from user habits, and can moreover be used to identify when to operate in high efficiency conditions, or on the other hand when to switch to very high performance mode.
Thermodynamic cooler behaviour and sales performance data are collected and processed by CAREL Armilla portal in order to present graphs and dashboards as support for beverage companies and their partner in planning marketing and service activities.

APPLICA
Smartphone application

Conclusions

The latest technology allows the construction of very efficient and connected beverage coolers, both fulfilling market requirements and complying with regulations. Heez is Carel's beverage cooler solution that meets these challenges, using DC rotary compressor, electronic expansion valve, full variable speed fans, self-adaptive logic and propane as the refrigerant. All of this guarantees high energy efficiency and great cooling performance, while reducing environmental impact. Wireless connectivity allows a new use experience through the interaction with mobile device and cloud platform enables digital marketing activities and improve maintenance service.

Efficiency

Performance

Reliability

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Headquarters ITALY

CAREL INDUSTRIES HQs
Via dell'Industria, 11
35020 Brugine - Padova (Italy)
Tel. (+39) 0499 716611
Fax (+39) 0499 716600
carel@carel.com

Sales organization

CAREL Alfaco Polska - www.carel.pl
CAREL Asia - www.carel.com
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