

Secop is the first choice for partners searching for leading-edge refrigeration solutions and a premium customer experience.

Secop delivers advanced refrigeration compressors and controls, providing customers tailored sustainable solutions for light commercial, battery-driven, and special cooling applications.

Whitepaper

REFRIGERANTS POSITION BY SECOP



Natural
Refrigerants



Low GWP
Refrigerants



INTRODUCTION

Refrigeration has been in our lives for many years. It went through several developmental changes, starting with natural preservation using air, water, and ice before current technological solutions were implemented. Today, refrigeration has become even more essential in many areas of human life. Several industries are dependent on reliable, efficient, and safe refrigeration without interruptions.

For example, many segments of the food industry need stable refrigeration for food and beverage preservation. This is required to keep them fresh and safe for consumption.

Refrigeration has become extremely critical in the medical segment. This industry now depends heavily on safe storage, transporting, and handling that demand strict temperature tolerances. The accuracy and dependability of cooling equipment is essential to ensure the quality and usability of stored assets.

What was once a convenience in many regions is air conditioning. For comfort as well as health benefits, the process of removing heat and moisture indoors is fast becoming a necessity in many regions of the world.

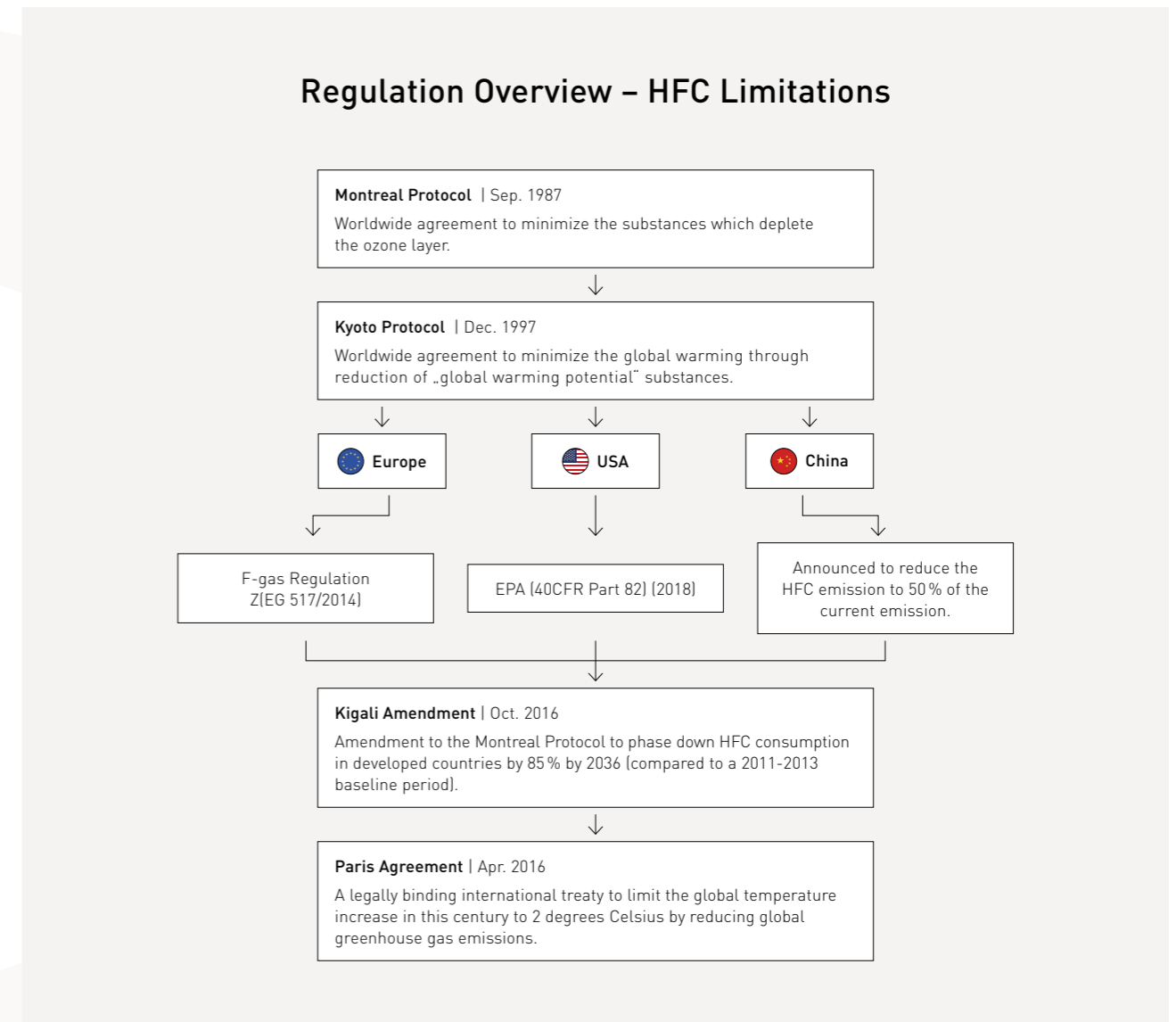
Secop has taken an active, responsible, and sustainable approach in environmental management. The company focuses on the development and market placement of products that comply with the latest safety, energy, and

environmental standards. These evolving standards have been implemented to decrease negative effects to the earth, such as the latest effort to curb greenhouse gas emissions. As far back as 1993, compressors designed for eco-friendly purposes that utilized natural refrigerants were introduced by the company. Since then, a wide range of environmentally friendly, more efficient hydrocarbon products have been developed. Some are designed for use with R600a (Isobutane) for the residential/household market as well as for mobile appliances. Other compressors were created to be compatible with R290 (Propane) for light commercial applications including food service, food retail, and medical devices.

This refrigerant position document is published with the objective to present Secop's contribution to improving the environment. Investments, development, and market placement of products that meet and often go beyond the latest environmental and safety requirements is top priority for the company. This document offers a preview of legislation standards and the Secop view on the refrigeration segment. It also anticipates Secop's readiness for natural hydrocarbon refrigerant charge increases.

The refrigeration segment is affected by a vast number of regulations designed to eliminate the use of environmentally hazardous substances as well as reducing the total electrical energy consumption.

Overview of International and National Regulations



Regulation Overview – HFC Limitations

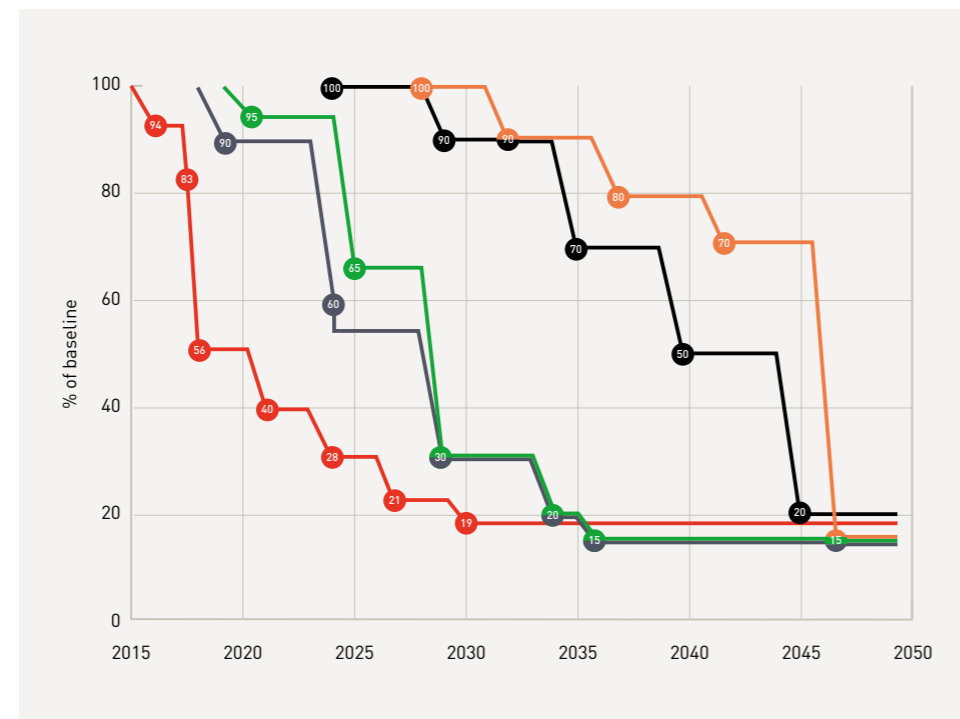
The Montreal Protocol on Substances that Deplete the Ozone Layer is a multilateral environmental agreement that regulates the production and consumption of chemicals referred to as ozone depleting substances (ODS). When released into the atmosphere, they damage the stratospheric ozone layer – Earth’s protective shield against ultraviolet radiation from the sun. This protocol regulates and phases down the consumption and production of ODS, like chlorine, which is contained in some refrigerants. Different timetables for countries specified under Article 5 of the Montreal Protocol were set to be developed by 2020 and by 2030.

The result for the refrigeration segment was to phase down and eventually eliminate CFC (R12) and HCFC (R22) because they contain chlorine. They were replaced on the refrigeration market by commonly used HFC (R134a, R404A) refrigerants with an ODP of zero or close to zero. While not ozone-depleting, HFC refrigerants have high global warming potential. These HFCs contribute to greenhouse gases which can influence climate change. This effect was not discovered until after the adoption of the Montreal Protocol. It has been addressed more recently in 2016 by the Kigali Amendment.

The Kigali Amendment is an international agreement to gradually reduce the consumption and production of hydrofluorocarbons (HFCs) which became effective in January 2019. More than 130 countries including the USA (September 2022) and China (June 2021) signed and thus ratified the Kigali Amendment. All countries agreed on the gradual reduction of HFCs by 80-85% by 2050 which are widely used in both the air conditioning and refrigeration segments. It represents a strong move forward to preserve the environment and planet for future generations.

HFC phase down schedules and limits set by the EU, developed (Non A5) and developing (A5) countries of Article 5 are demonstrated in Figure 1.

- EU F-gas Reg.
- Non A5-1
- Non A5-2
- A5-1
- A5-2



EU F- Gas Regulation 517/2014

This regulation has been in force since January 1, 2015. The objective is to reduce emissions of fluorinated greenhouse gases by two-thirds by 2030 compared to 2014 levels. The F-gas Regulation contains bans of refrigerants with GWP above 2500 and above 150 where less harmful alternatives are available. Moreover, it limits the use of higher GWP refrigerants in some specific applications as well as requires leakage reduction and monitoring.

Important Deadlines of the Regulation:

January 1, 2020, on:

- Refrigerators and freezers hermetically sealed for commercial use (storage, display, distribution in both food retail and service) that contain HFCs with a GWP of 2500 (R404A, R507) or more are banned in all new installations.
- Stationary refrigeration equipment, that contain or whose functioning relies upon HFCs with a GWP of 2500 (R404A, R507) or more are banned. There is an exception for equipment designed to cool products to temperature below -50°C.

The use of HFCs with a GWP of 2500 or more is prohibited starting January 1, 2020, when used to service or perform maintenance on refrigeration equipment with a charge size of 40 tons of CO2 equivalent or more. The quantity is equivalent to more than 10.2 kg of R404A. The prohibition is not applied for reclaimed or recycled HFC gases which are still permitted for use until January 1, 2030.

January 1st, 2022, on:

- Refrigerators and freezers hermetically sealed for commercial use (storage, display, distribution in both food retail and service) that contain HFC’s (R134a, R513A, R448A, R449A, R452A) with a GWP of 150 or more are banned with new installations.

Refrigerants below 2500 GWP are still permitted for use in appliances not dedicated for commercial use in refrigerators and freezers but are subject to available quotas.

Refrigerants above 2500 GWP may still be used with appliances designed to cool products to temperatures below -50°C.

Regulation Revision

In March 2022 the European Commission published the proposal for a revision of the F-gas Regulation to replace the current regulation from 2014. It establishes an additional phase down quotas of HFCs, beyond the requirements of the Montreal Protocol, bringing a faster transition to natural refrigerants. In March/April 2023 the European Parliament and Council revised the proposal and added their amendments.

Commission Proposal COM(2022) 150 introduces important provisions to the refrigeration segment with a steeper HFC phase down (reduction of 98% HFCs by 2048 in comparison to 2015 levels) requirements. This is to be implemented in 2024 prohibiting products with a GWP of 150 or more for any self-contained refrigeration equipment, air-conditioners, and heat pumps that use higher GWP refrigerants. The EU provides some exceptions to the use of higher GWP refrigerants in some new appliances if there are no suitable alternatives currently available.

The European Parliament introduced a more ambitious plan, prohibition of appliances with F-gases (e.g. also R1234yf, R1234ze) and their complete phase down by 2050. In the refrigeration segment, the proposal is to ban equipment containing F-gases according to the following schedule:

- domestic refrigerators and freezers (2025), self-contained stationary refrigeration equipment (2025), equipment intended for application designed to cool product to temperatures below -50°C (2027)
- transportation refrigeration - vans and ships (2027), trucks, trailers, and reefer containers (2029)
- service and maintenance using GWP ≥ 2500 (2024), stationary refrigeration equipment with GWP ≥ 150 (2030)

The Council presented a more lenient HFC phase down timeline compared to the European Commission and European Parliament.

The European Commission, the European Parliament, and the Council of the European Union must agree on a final text before the review of the F-gas Regulation is adopted. The final document is expected to be issued in Q3/2023 and go into effect starting 2024.

This Secop interpretation and summary of the regulation revision was done with the public information available at the time. The final version may contain changes and adaptations.

Hydrocarbons

Commercial refrigeration as well as air conditioning and heat pumps are the main areas of the refrigeration segment in which fluorinated greenhouse gases (HFCs) have been used.

Hydrocarbon refrigerants have become a preferable sustainable natural solution thanks to their low GWP, zero ODP, and non-toxicity. They are considered an environmentally friendly, efficient, and price effective option to HFCs in a large segment of residential and commercial refrigeration as well as in some air conditioning, heat pump, or ultralow temperature applications. There are limits to the use of hydrocarbon refrigerants because they are classified as flammable (safety classification A3) and are subject to international safety guidelines and legislations.

The Secop HC range of compressors includes models that use Propane R290 and Isobutane R600a. These are approved for a wide range of applications. Refrigerant Ethane R170 is also approved for use in certain special applications in select markets such as the medical segment.

Refrigerant R600a is intended for use in smaller applications such as home refrigerators and freezers, minibars, and wine coolers due to cooling capacity limitations. It is also applicable for mobile cooling use including refrigerators and freezers for the automotive and maritime industry, portable refrigerated coolers as well as solar and/or battery-powered applications.

Refrigerant R290 is a good fit for light commercial appliances in food service and food retail due to its efficiency. This includes cold rooms, freezers, merchandisers, supermarket displays as well as many applications in the growing medical segment.

Ethane R170 another natural refrigerant with GWP 6 used mainly in medical and in the vaccine cold chain. It works well with very low temperatures (down to -86°C) for storing, transporting, and handling sensitive substances. Ultra-low temperature products can be found in both the stationary and mobile segment.

HC Charge Increase

The ongoing process of higher GWP refrigerant restrictions and bans mean higher charge limits of flammable refrigerants will be required. In 2019, the International Electrotechnical Commission (IEC) released a revision of standard IEC 60335-2-89:2019 that included increased charge limits of flammable refrigerants in self-contained commercial appliances.

The increased charge covers all safety classes of flammable refrigerants but with different limits. For single circuits, charge limits increased from 150 g to 500 g for refrigerants in safety class A3 (R290, R600a) and from 150 g to 1,200 g for safety class A2 and A2L (R1234yf, R454C, R455A). Safety classification is determined according to ISO817:2014.

The new revision also defines additional safety requirements and measures when higher charges are used to prevent added risk to the user. This includes hermetical sealing of the cooling circuit, protection of refrigerant containing parts against accessibility, application construction preventing excessive vibration, and appliance marking with the minimum floor area in which it is permitted to be installed.

Standard IEC 60335-2-89:2019 represents a global consensus and its use is voluntary. This standard is a required first that can allow adoption or integration by the regional bodies. It can be implemented in full or in part.

In Europe, the approval for higher refrigerant charge use is still in process. The final release will come when EN60335-2-89 harmonizes with the EU Machinery Directive. Systems requiring a higher charge than currently allowed by the specific standard must follow the recommendations and precautions of general standard EN378-1. The compressor technical limit (maximum allowed refrigerant charge) for safe compressor operation must be adhered to at all times. The values are listed in the technical documentation of the compressors.

Standard IEC60335-2-89 covers appliances like display and storage cabinets, coolers and freezers, top counter and under-counter units, blast chillers and blast freezers as well as commercial ice machines.

Household, industrial refrigeration, commercial dispensers, vending machines, ice cream makers, laboratory equipment, walk-in cold rooms, devices used in cars, boats, and mobile applications are not part of this standard and are covered by their own codes.

Alternative Refrigerants

The regulation of HFCs use and concerns with more flammable solutions being implemented is forcing chemical companies and appliance producers to look for other solutions to ease the transition from high to low GWP solutions.

Various new refrigerant types with lower GWP have been developed and marketed as a transitory solution since their GWP is able to meet the new regulations. Many have been considered as "drop-in" replacements in existing systems. The biggest advantage of these gases is that they can be used without major system changes, although system verification and optimization are recommended.

Verification of alternative refrigerants in existing Secop compressors were analyzed for their suitability and measured for their performance. Secop has approved some A1 safety class, non-flammable HFC refrigerants. These include R452A, R449A, and R448A for use in systems originally designed to utilize R404A/R507 as well as R513A for systems using R134a for certain models. The performance differences are as follows:

→ Refrigerants R448A and R449A result in a slightly lower cooling performance, higher internal temperatures of the motor and discharge line, and higher operating pressures compared to the original R404A refrigerant when no system optimization is performed.

Refrigerant charge and capillary tube size optimization can keep the efficiency and operating pressure at the same level as with the original R404A, while cooling performance remains lower and discharge gas temperature is higher.

The higher temperatures and pressures led to the limitation of the approved working conditions in MBP operation. LBP operation is not recommended at all with R448A and R449A due to very high internal temperatures during the normal load conditions.

→ Refrigerant R452A and R513A result in a lower cooling performance, higher energy consumption and higher operating pressures when no system optimization is conducted. Refrigerant charge and capillary tube size optimization keep the cooling performance, energy consumption, and operating pressures at the same level as the original refrigerants R404A and R134a respectively.

Operating limits have been kept the same for most of the models.

Refrigerants approved for use with Secop compressors and operating limits are listed in the data sheets or product bulletins available on the Secop website.

Although use of those transitory refrigerant replacements in new appliances is banned according to the GWP regulation effective from 2022, their usage for maintenance and service is still allowed until 2030, respecting available quotas.

Hydrofluoroolefins (HFOs) are unsaturated HFC refrigerants. They have a lower GWP and shorter atmospheric lifetime compared with HFCs and are considered to be possible alternatives to HFCs.

A2Ls marked as HFO are mildly flammable synthetic refrigerants that provide favorable performance and efficiency comparing to HFC's. Safety class A2L covers several refrigerants e.g. (R1234yf, R454C, R455A) with different GWP values (4 up to > 500) and does not have any impact on the ozone layer. However, some refrigerants in this group contain substances called PFAS (Per- and Polyfluoroalkyl) that have been linked to environmental contamination and negative health effects in humans. Also, they could potentially cause acid rain.

Referring to the ECHA (European Chemical Agency), HFO R1234yf and HFC R134a fall under the scope of PFAS as they break down in the atmosphere to TFA (trifluoroacetic acid), one of the PFAS substances. The breakdown of R1234yf is quicker and leads to a higher impact to ground water and drinking water than with R134a.

Authorities of five European countries agreed to prepare a joint REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) restriction proposal to limit the risk of PFAS in non-essential uses. The implementation date of entry into force is expected in 2025 (source ECHA – European chemicals agency <https://echa.europa.eu/-/echa-publishes-pfas-restriction-proposal>)

This restriction proposal may limit the adoption of some HFOs such as R1234yf and its mixtures and lead to its substitution by natural refrigerants.

A2L refrigerants are not considered as drop-in alternatives to existing systems with HFCs. Since A2Ls are mildly flammable, they must follow the same precautions, system design, and operation as systems utilizing HCs. Both can be used in new installations only.

A2L refrigerants have several other limitations such as higher discharge and motor temperatures. Also, when using A2Ls, the compressor working range in low temperature is restricted due to thermodynamic properties. They are classified as non-azeotropic refrigerants since they are mixtures of different refrigerants with different saturation temperature at the same pressure level. This leads to temperature glide that often requires system design modifications.

HC vs. HFO characteristics comparison

	HC	HFO (A2L)
Flammability	higher	lower
Toxicity	low	lower*
Environment	low GWP	low-medium GWP
Availability	available	limited
Refrigerant Charge	low	high
Cost	low	higher
Reliability	lower pressures	higher pressures
Operation Range	broad	limited (high isentropic peak T)
Efficiency	best, no T glide	medium with medium/high T glide

* Toxicity of some A2L refrigerants is currently under reevaluation by European Chemical Agency (ECHA).

Conclusion

Taking into consideration these limitations, risks, higher refrigerant charges, and price, the potential of A2Ls as a long-term solution appear to be limited. This has led Secop to focus on hydrocarbons as the solution for the light commercial segment.

Secop does see some limited applications that can benefit from using A2Ls. For example, Secop has approved refrigerant R1234yf for specific BD products used in car air conditioning systems, minibars, and truck refrigerators.

Selecting a refrigerant should be done with respect to the environment, but the job does not end after choosing a low GWP solution. We also need to take into consideration the other characteristics that could lead to a negative environmental impact. Secop has adopted this complete approach – to not bring additional harm to the Earth and also be fully green by offering sustainable products that are able to utilize natural refrigerants.

Low GWP, better efficiency and a manageable cost to implement, predetermine HCs to be a preferable long-term solution in both low and medium pressure. There is a growing trend in the market for hydrocarbon use in the segment in which Secop has a strong product range. A future expansion of the refrigerant charge limit to 500 g will bring additional possibilities to the light commercial segment. This will allow higher cooling capacities in applications covered by IEC60335-2-89:2019. Higher charge limits will require a stronger focus on safety requirements and designs.

According to currently valid F-gas Regulation 517/2014, bans of high GWP refrigerants used with new appliances will continue in steps until 2025 and for service or maintenance until 2030. Use of refrigerants R452A, R448A, R449A, and R513a is now prohibited since January 2022 in refrigerators and freezers of commercial use but still allowed for use in stationary equipment.

We believe in a green future and a green future will drive the refrigeration market towards natural refrigerants.

Summary preview of the main refrigerants used in light commercial segment in which Secop has a range of products, classification based on EN378.

Item	R134a	R513A	R1234yf	R600a	R404A	R452A	R448A	R449A	R455A	R454C	R290
Type	HFC	HFO/HFC	HFO	HC	HFC	HFC/HFO	HFC/HFO	HFC/HFO	HFC/HFO/HC	HFC/HFO	HC
Main Application	MBP	MBP	MBP	LBP/MBP	LBP	LBP/MBP	LBP	LBP	LBP/MBP	LBP/MBP	LBP/MBP
GWP	1430	631	4	3	3922	2140	1387	1397	145	146	3
GWP/ODP - Ban EU	2022	2022	no ban*	no ban	2020	2022	2022	2022	no ban*	no ban*	no ban
Safety Class	A1	A1	A2L	A3	A1	A1	A1	A1	A2L	A2L	A3
Temperature Glide	no	no	no	no	0,7K	3K	max 6K	max 11K	max 13K	max 8K	no
Pressure Ratio	ref.	comp.	comp.	low	ref.	comp.	comp.	comp.	high	high	medium
Vapor Pressure	ref.	comp.	comp.	low	ref.	lower	lower	lower	high	high	medium
Volumetric Capacity	ref.	higher	higher	low	ref.	comp.	comp.	comp.	comp.	lower	comp.
Discharge Temp.	ref.	comp.	comp.	low	ref.	comp.	higher	higher	high	higher	low
Ideal Cycle Efficiency	ref.	comp.	comp.	high	ref.	comp.	comp.	comp.	low	lower	high

comp. = comparable | ref. = reference | Temp. = temperature

* Under PFAS evaluation.

SECOP GROUP: AROUND THE WORLD



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developments

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located in Austria,
Germany, Slovakia,
China, USA, and
Turkey

160
R&D engineers
and technicians







440
patents globally


50+
countries with
customer support




Secop is the expert for advanced hermetic compressor technologies and cooling solutions in commercial refrigeration. We develop high performance stationary and mobile cooling solutions for leading international commercial refrigeration manufacturers and are the first choice when it comes to leading hermetic compressors and electronic controls for refrigeration solutions for light commercial and DC-powered applications.

Secop was formerly known as Danfoss Compressors and is one of the founding fathers of modern compressor technology with years of experience that goes back to the beginning of the 1950s.

-  **Flensburg:** Sales and R&D
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-  **Turin:** Sales
-  **Tianjin:** Sales, R&D, Logistics, and Manufacturing
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 **Stationary Cooling**



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