WITH MORE THAN 60 YEARS OF EXPERIENCE IN COMPRESSOR TECHNOLOGY AND HIGHLY DEDICATED EMPLOYEES, OUR FOCUS IS ON DEVELOPING AND APPLYING ADVANCED COMPRESSOR TECHNOLOGIES TO ACHIEVE STANDARD SETTING PERFORMANCE FOR LEADING PRODUCTS AND BUSINESSES AROUND THE WORLD.

SECOP

ADVANTAGES OF ADAPTABLE CAPACITY

WHITEPAPER

CCD® COOL CAPACITY DRIVE

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Glossary

t_0	evaporating temperature
t_C	condensing temperature
LBP	low back pressure
MBP	medium back pressure
R600a	refrigerant Isobutane
R290	refrigerant Propane
R134a	refrigerant Tetrafluoroethane
rpm	rounds per minute; compressor speed
LST	low starting torque
HST	high starting torque
DC	directed current
PWM	pulse width modulation
AEO	adaptive energy optimizer algorithm
COP	coefficient of performance

1.
WHY CHOOSE ADAPTABLE CAPACITY COMPRESSORS FROM SECOP

Summary of Technical Features

- Improved system efficiency thanks to higher t_0 and lower t_C — up to 40 % energy savings
- Dynamic speed range from 1:4
- Adjustable cooling capacity for actual system demand
- Smaller compressor in terms of displacement and size
- Lower noise emission thanks to low speed — up to 5 dB(A)
- Released for rough applications, unstable power supply, and tropical regions
- Bi-frequency at 220-240 V 50-60 Hz and 115 V 60 Hz
- 12 to 24 V and 48 V DC for mobile cooling
- R290 / R600a / R134a / R404A models available for household, commercial applications, and mobile cooling (LBP/MBP)
- HST features; no pressure equalization needed to start up the compressor

  Same compressor type for different markets!

Targets

The aim of all refrigeration appliance design is to define and optimize the essential functions such as: minimal cost, high performance, high efficiency, and minimized compressor size to enable larger internal cabinet volume, low noise levels, and stable cabinet temperatures at different operation loads.

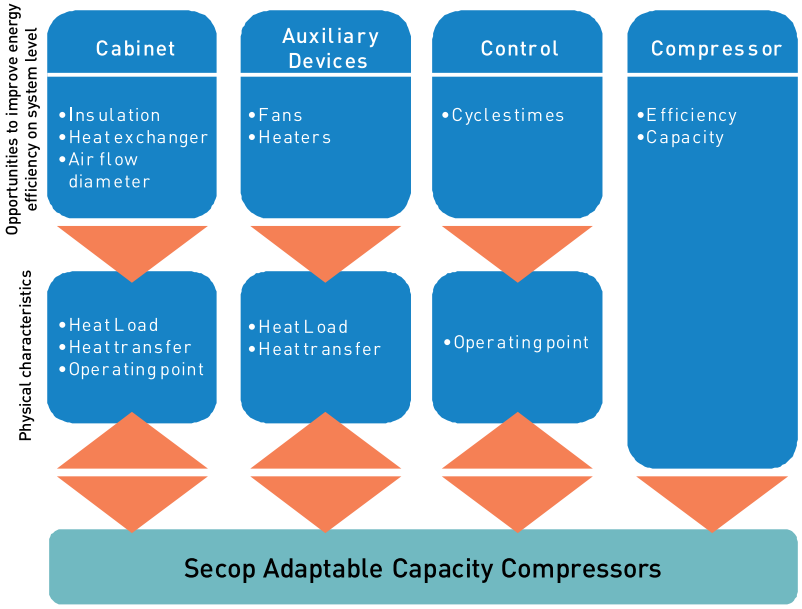
General

Secop adaptable capacity compressors offer the possibility to adjust the refrigeration capacity according to the desired need by controlling the motor speed of the compressor and therefore the cycle times of the piston. The compressors are highly optimized, offering very high motor and mechanical efficiency. Tests have shown improvements in energy consumption of up to 40 %, depending on the system design. The average noise level can be reduced by up to 5 dB(A). The compressors are small in volume which allows space for a bigger net volume for usage.

Alternatives for energy savings

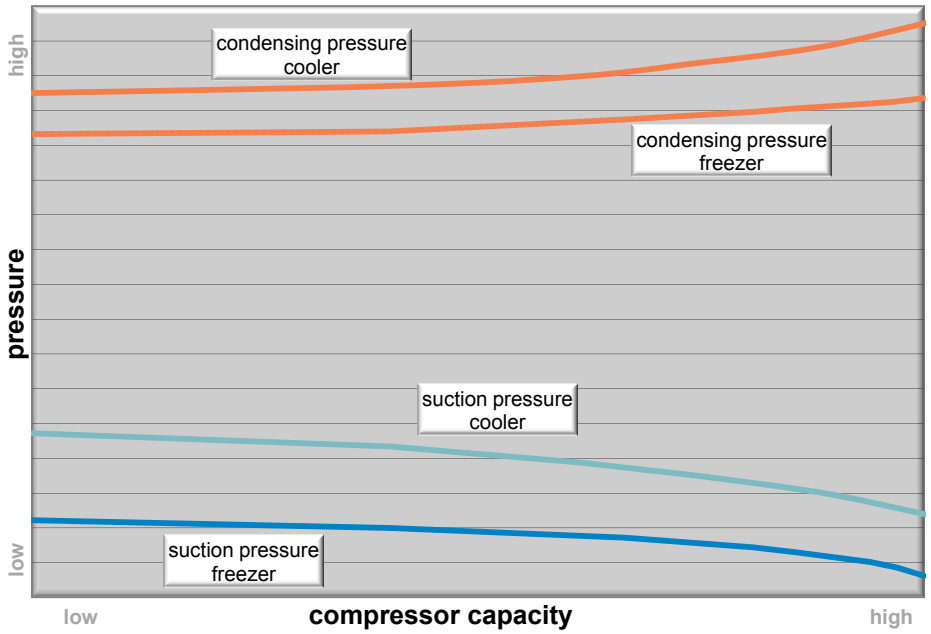
The most important advantage of adaptable capacity is reduced energy consumption, which is possible in different ways.

The easiest, most efficient, and most economical way to reach this target is to use adaptable capacity compressors.



2.
COMPRESSOR EFFICIENCY / SYSTEM EFFICIENCY

Secop adaptable capacity compressors are very efficient. By varying the speed, they also improve system efficiency. Secop adaptable capacity compressors are able to run so that condensing and evaporator temperatures are optimized = **S**ystem **E**ffective **C**oefficient **O**f **P**erformance.



Influences on operating points by speed variation

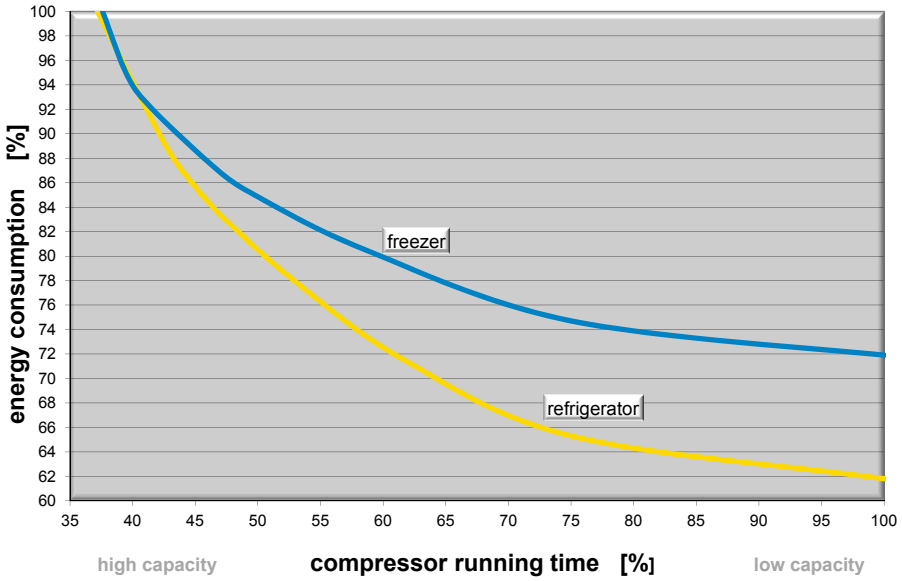
Application

The compressors are designed for nominal voltage 220-240 V and 115 V at frequency 50/60 Hz; also 12-24 V and 48 V DC and refrigerants R290 / R600a / R134a / R404A at medium to low evaporating temperatures (MPB/LBP) for light commercial and household appliances.

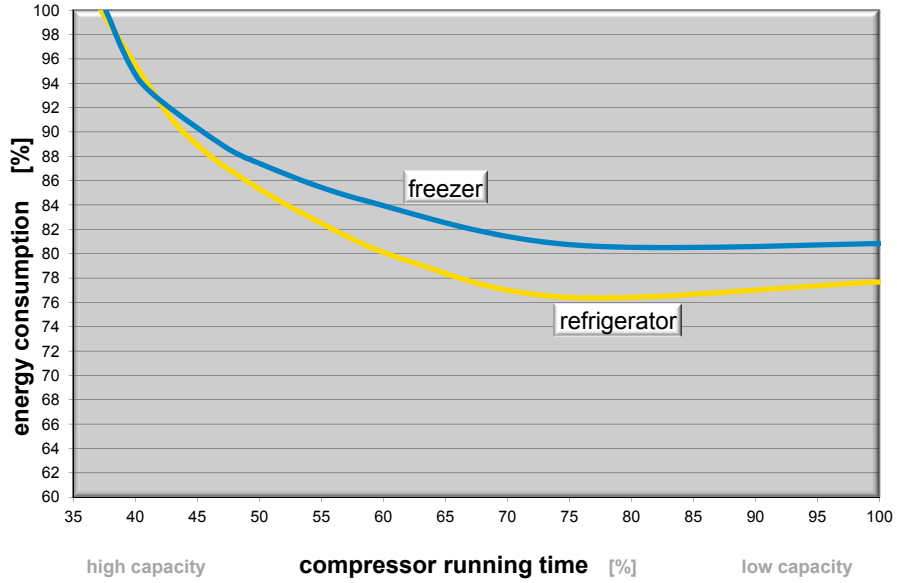
The start performances of Secop adaptable capacity compressors are very high. The actual voltage ranges at start can be higher than with fixed-speed compressors.

3.
APPLIANCE DESIGN

The advantage in energy savings can be influenced by the appliance design; in particular auxiliary consumers greatly influence energy savings.
System efficiency can also be increased thanks to the appliance's smart design throughout, e.g. fan units run on full speed in fixed speed systems, adaptable capacity compressor systems, can expect lower heat dissipation. Therefore lower fan speeds are used to transfer the heat load.

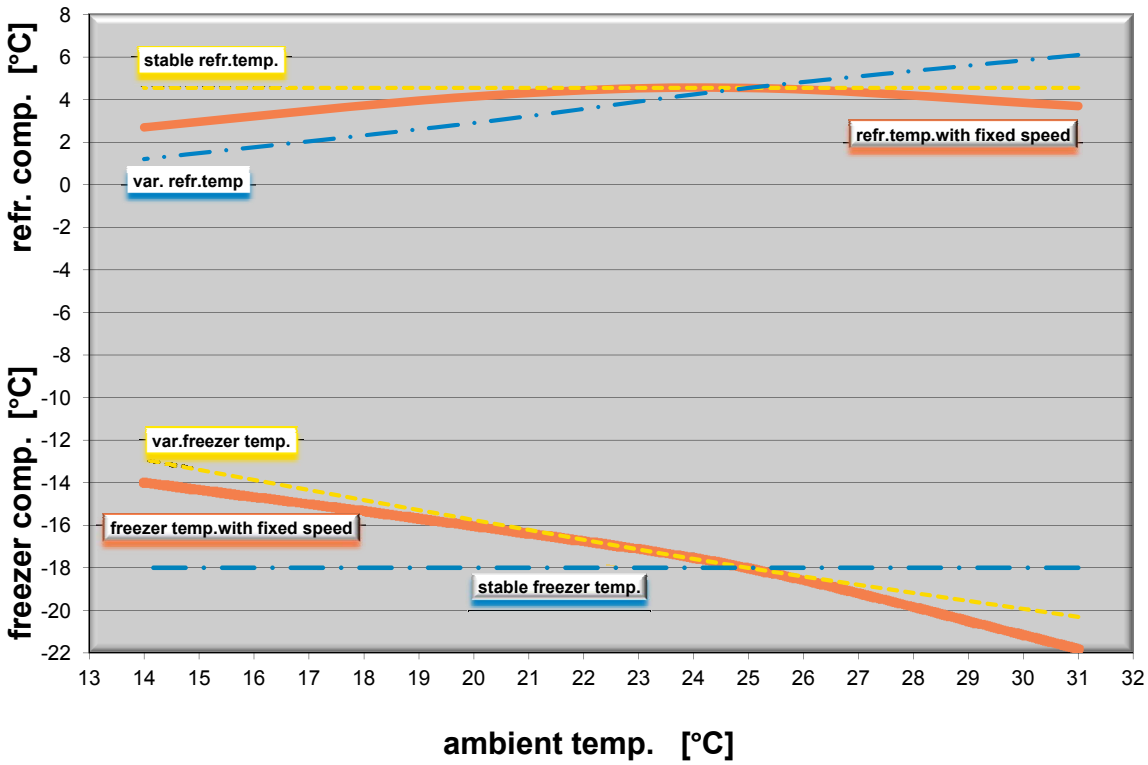


Reduced energy consumption by reduced capacity with optimized Secop adaptable capacity compressors, without any auxiliary consumers



Reduced energy consumption by reduced capacity with optimized Secop adaptable capacity compressors, auxiliary consumers are used which run parallel to the compressor

With some appliance types, the design must be modified slightly. For example, using a similar capillary, or possibly a smaller size as it is used for the fixed speed compressors in the same cabinet.
Cabinets with two different temperature compartments, designed with one evaporator system, should be modified so that the different evaporator sizes can be adapted for longer running times. The ratio of the evaporator sizes in the cooling and the freezing compartments must be newly adjusted due to the longer running times on average.
If the heat load varies the adaptable capacity compressor can be controlled in a way that the compartment temperatures will become more stable.



Temperature changes with a fixed speed compressor and possible settings with a Secop adaptable capacity compressor with 2 refrigerator compartments and one cooling system

Influence to ambience

The use of electronically controlled compressors generally has a very positive affect on the environment. Due to the highly efficient motor design, the heat dissipation to the ambience is reduced, which in many areas will reduce the expenses for additional air conditioning of the rooms.
In addition, the lower compressor speed results in lower sound pressure to surroundings, which for household and commercial compressors is of high importance.

How to select the right compressor

Controlling the compressor speed means that the compressor selection is different to standard compressors. The model is chosen according to the capacity at max. speed. This capacity will cover the load at max. ambient temperature or at pull down, etc. This max. capacity is chosen similar to the rated capacity of a standard fixed speed compressor for the same appliance.
During normal cycling operation, the compressor typically runs at minimum speed, offering the best efficiency, and during peak load operation maximum capacity.
The advantages of this are:

- A smaller compressor, in terms of displacement is needed
- Longer running periods at normal load conditions with higher evaporation temperature and lower con densing temperature, offering higher compressor efficiency. Overall system efficiency increases.
- Lower rpm means lower noise level
- More stabilized cabinet temperatures at some applications

4.
DESIGN CONCEPT

Electrical
The compressors are equipped with permanent magnet rotors (PM motor) and **3 identical stator windings**. The electronic unit can be mounted directly on the compressor as well as externally and control the PM motor.

Mechanical
All other components are based either on our conventional compressor types or new developments.

Design limits
In order to secure the lifetime of the compressors, the appliances must meet certain design criteria.
The compressor must start and work properly during pressure peaks obtained in the highest ambient temperature and lowest obliging voltage. At this peak load, the condensing temperature must not exceed 70 (R404A = 60) °C.
At stable operating conditions the condensing temperature must not exceed 60 (R404A = 55) °C.
These limits are the same for our fixed speed compressor ranges and ensure protection of valves, gaskets, oil, and motor insulation.

Electronic unit
The adaptable capacity compressor motors are electronically controlled. No attempt must be made to start the compressor without a complete electronic unit, as specified in the data sheet for the compressor types in question.
The electronic unit has a built-in overload protection as well as thermal protection. When this protection is activated, the electronic unit will protect the compressor motor as well as itself. In addition, the electronic unit will automatically restart the compressor after a certain time.
Depending on the different compressor designs, the electronic unit provides the compressor with different starting torques, LST, or HST application.

Power supply connections
Mains power is connected to the controller and transformed into a variable DC voltage, which is supplied to the adaptable capacity compressors. In the event of unstable voltage supply, the electronic switch "Power Supply" mode will adapt the need to the compressor. This ensures that start problems due to under voltages are avoided. For the same reason it is not necessary to invest in an additional external voltage stabilizer.
Moreover, the electronics include an under voltage protection, which cuts off the mains in situations in which the supply voltages are out of the pre-defined working limits.

Programming Software TOOL4COOL®
Tool4Cool® is a unique PC software tool that enables you to precisely configure your Secop compressors to your cooling systems.
Via microprocessor-based controllers, Tool4Cool® gives you easy access to all parameters.
These can be changed, monitored, downloaded, or uploaded to get the optimum performance out of your cooling system.
For more information, please visit:
https://www.secop.com/solutions/application-detail/tool4cool-software/

5.
DETERMINING THE CORRECT SPEED

The capacity controlled compressors from Secop have different capacity controls, depending on the chosen model.

External reference signal
If customers want to control the compressor capacity using their own controllers, it is possible to connect a reference signal to the compressor controller.

0-5 Volt signal
A DC signal (0-5 Volt) can be connected to the compressor controller, from 0% to 100% requested compressor capacity. To secure an appropriate lubrication of the compressor, the motor speed is limited downwards. If the requested compressor capacity is less than the minimum speed, the compressor will be PWM (pulse width modulation) controlled at minimum speed, within a pre-defined period of time.

Frequency signal
A variable, square shaped frequency signal can be connected to the controller, representing the band from minimum to maximum speed. Secop offers different compressor controller types, so please contact Secop for design details concerning the frequency control.

Standard mechanical thermostat control or low voltage ON /OFF signal (AEO)
The compressor is controlled in an "Adaptive Control" mode, where the controller in the electronic unit takes over the RPM management by using the built-in AEO (Adaptive Energy Optimizer) algorithm. This strategy aims for the lowest possible speed at which the refrigerating system will work properly since the COP is highest at low capacity.

- The initial start speed of the compressor after the power supply is connected will be at a higher rpm when the thermostat is cut in.
- In the succeeding cycles the compressor will start with a speed slightly below the previous cycle, as long as the thermostat cut out has been reached within the defined run time.
- If cut out cannot be reached within the defined run time, the compressor speed will be increased slowly, against max speed, until cut out is achieved.
- The next cut in will be slightly below last cut out.

PI control:
The determination of the actual requested compressor capacity is based on an integrated PI controller, which compares the actual cabinet temperature with a reference temperature. The bigger the deviation between the set point and the actual cabinet temperature, the faster the controller adapts to the compressor capacity. If the requested compressor capacity is lower than the minimum speed, the compressor will be PWM (pulse width modulation) controlled at minimum speed, within a pre-defined period of time. Depending on the requested temperature stability, the period time can be modified. The shorter the period time, the more stable the temperature control. However there are more start and stops and in worst-case scenarios, reduced life time and less energy savings.
Due to different load profiles, the settings for the PI controller can be adapted to offer a more stable temperature control.

6.
DIFFERENT LEVELS OF FUNCTIONALITY

Although the main energy savings are achieved by using the adaptable capacity technology, Secop offers different control functionalities, integrated into the compressor controllers. These vary from simple external reference, as mentioned above to complete cabinet control as:

- Integrated thermostat
- Alarm thermostats
- Display for temperature read out and daily operation
- Defrost control, electrical or hot gas
- Up to 5 free programmable relays for fans, light, alarms, defrosting, etc.
- Remote monitoring via Modbus
- PC based service tool (Tool4Cool®)

ADAPTABLE CAPACITY WITH SECOP VARIABLE-SPEED DRIVE COMPRESSORS

Secop variable-speed compressor motors are electronically controlled. Full load operation is extremely rare in most cooling applications, restricted to a few days per year.
This unique technology makes capacity automatically adapt to your actual requirement. The compressor runs at low speed most of the time, minimizing energy consumption.
On top of this, system efficiency is greatly improved thanks to reduced loss when less heat is transferred via the evaporator and condenser. Altogether, substantial energy savings can be obtained.
Secop variable-speed compressors are designed for refrigeration systems using the designated refrigerants R600a (isobutane) and R290 (propane).
TOOL4COOL® is a unique PC software tool that enables you to precisely configure your Secop's Cool Capacity Drive inverter compressors (°CCD®) to your cooling systems.

TOOL4COOL®
Flexible control settings




OUR JOURNEY SO FAR

1956
Production facility and headquarters in Flensburg, Germany founded.

1958
Start of production for PW compressors.

1970
Introduction of SC compressors.
The birth of a standard-setting platform in the light commercial market.

1972
Introduction of FR compressors.

1977
Introduction TL and BD compressors.

1990
Introduction of NL compressors.

1992
Introduction of PL compressors.

1993
Start of production with natural refrigerant R600a (isobutane).
Production facility in Crnomelj, Slovenia founded.

1999
Start of production with natural refrigerant R290 (propane).

2002
Production facility in Zlate Moravce, Slovakia founded.

2005
Introduction of GS compressors.

2008
Production facility in Wuqing, China founded.

2010
Introduction SLV-CNK.2 and SLV-CLK.2 variable-speed compressors.
Introduction BD1.4F Micro DC compressor.
Introduction of DLX and NLU compressors.

2013
Introduction of the XV compressor - opening a new chapter in refrigeration history.
Secop acquires ACC Fürstenfeld, Austria.

2015
New generation of energy-efficient propane compressors.
New variable-speed platforms for household and light commercial applications.

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