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

SERVICE ON HOUSEHOLD REFRIGERATORS & FREEZERS

GUIDELINE

1. INTRODUCTION

Within a foreseeable future, CFC refrigerants will become unobtainable. This is a situation that will effect the service possibilities on R12 systems in household appliances. In new production of household appliances R12 will be replaced by R134a or R600a.
Please note that this guide excludes service on commercial appliances.

1.1 Blends (mixtures of HFC)

Since the introduction of R134a, several "transitional substances" have appeared. They have a low ODP number and are intended for service only.
These refrigerants are interesting because they do not presuppose the use of polyolester oil.

1.2 R134a (HFC)

To ensure a satisfactory miscibility between refrigerant and oil, the application of R134a refrigerant presupposes the use of an R134a compressor charged with polyolester (POE).
This will complicate the future servicing when R12 refrigeration systems are to be changed over to R134a refrigerant, as it is difficult to prevent contamination by residues of the original refrigeration oil, typically mineral oil or alkyl benzene.
The presence of residual mineral oil or alkyl benzene is unfortunate because it does not become part of the R134a/POE mixture but circulates independently through the system. The effect can be negative if the system contains "oil pockets". After some time, the oil circulating in the system can collect in quantities which pass through the capillary tube relatively slowly. This will effect the refrigerant injection into the evaporator momentarily.

1.3 R600a (Hydrocarbon)

This refrigerant is flammable and only allowed for use in appliances which fulfil the safety requirements laid down in amendment TS 95006 to IEC 335 - 2 - 24 (To cover potential risk originated from the use of flamable refrigerants).

1.4 General

In principle there is no need to replace the refrigerant in operational hermetic refrigeration systems. Neither is there any point in replacing refrigerant when servicing, provided that the original refrigerant is available either as new or reclaimed. A precondition here is of course that the legislation of the country concerned is not restrictive in this respect.
Changing over to an alternative refrigerant is not without problems. Close consideration should be given to the economic justification of proceeding with the task. It is also appropriate to find out just what the user expects in terms of the operation and lifetime of the repaired system.
The choice of refrigerant for servicing R12 systems is between the transitional substances (blends) or R134a. Among the refrigerant mixtures offered are R401A and R401B which are marketed by DuPont. These blends are ternary mixtures (non-azeotropes) made of three single components, R22, R152a, and R124. Corresponding mixtures are also marketed by Atochem, R409A (Forane FX 56) and R409B (Forane FX57). They are based on the components R22, R142B, and R124 (table 1). The mixtures are interesting because they do not presuppose the use of polyolester compressor oil. They have a low ODP number and can be used for service when R12 refrigerant is prohibited.

ASHRAE No.	Components	Composition %	Trade name	ODP	GWP	Temp. glide	Oil type
R401A	R22 - R152a - R124	53 - 13 - 34	Suwa MP39	0.03	0.22	6.4	Alkyl benzene
R401B	R22 - R152a - R124	61 - 11 - 28	Suwa MP66	0.035	0.24	6.0	Alkyl benzene
R409A	R22 - R142B - R124	60 - 15 - 25	Forane FX56	0.05	0.31	8.1	Alkyl benzene
R409B	R22 - R142B - R124	65 - 10 - 25	Forane FX57	0.05	0.31	7.2	Alkyl benzene
R134a				0.0	0.28	0.0	Ester oil

Table 1. Refrigerants for servicing R12 systems

2.
SERVICING

2.1
Servicing with blends

The blends mentioned can be used for servicing, provided the following rules are observed,

- The original compressor can be used, provided that it is intact. But the compressor oil must be of the type alkyl benzene.
- If the original compressor contains mineral oil it has to be changed to alkyl benzene. The alkyl benzene must have more or less the same viscosity as the original oil.
- A viscosity of about 30 cSt is a suitable choice for household refrigeration compressors.

Table 2 shows the oil types used in compressors built under our former brand "Danfoss Compressors".

Compressor type	Voltage V	Compressor displacement cm^3	Present oil type	Oil type for blend
TL-A	115	2 - 4	Synthetic	Unchanged
TL-A	220	2 - 4	Mineral	Alkyl benzene
TL-A	220	5	Synthetic	Unchanged
TLS-A	220	4	Mineral	Alkyl benzene
TLS-A	220	5	Synthetic	Unchanged
TLES-A	220	4	Mineral	Alkyl benzene
TLES-A	220	5	Synthetic	Unchanged
TFS-A	115	4 - 5	Synthetic	Unchanged
TFS-AT	220	4 - 5	Synthetic	Unchanged
TF-B	115	4	Synthetic	Unchanged
TL-B	220	2.5 - 3	Mineral	Alkyl benzene
TL-B	220	4	Synthetic	Alkyl benzene
NLE-A	115	6 - 7	Synthetic	Unchanged
NF-A	115	6	Synthetic	Unchanged
NL-A	220	6 - 7	Mineral	Alkyl benzene
NLE-A	230	6 - 7	Mineral	Alkyl benzene
FR-A	115	7.5 - 8.5	Mineral	Alkyl benzene
FR-A	220	7.5 - 10	Mineral	Alkyl benzene
FR-A	220	11	V-Oil 7041	Unchanged
FF-AT	220	6 - 10	Mineral	Alkyl benzene
FFS-A	115	7 - 9	Mineral	Alkyl benzene
FF-BK	115	6.5 - 8.5	Mineral	Alkyl benzene
FF-BX	115	6.5 - 8.5	Mineral	Alkyl benzene
FR-B	220	6 - 11	Mineral	Alkyl benzene
FR-H	220	7	V-Oil 7041	Unchanged
SC-A	115	12 - 15	Mineral	Alkyl benzene
SC-A	220	12 - 15	Mineral	Alkyl benzene
SC-A	220	18 - 21	V-Oil 7041	Unchanged
SC-AA	240	15	V-Oil 7041	Unchanged
SC-B	115/220	10 - 21	V-Oil 7041	Unchanged
SC-H	220	10 - 15	V-Oil 7041	Unchanged
SC-HH	220	10 - 15	V-Oil 7041	Unchanged

Table 2. Oil types

If the original compressor is defective, the choice is between an R12 compressor and an R134a compressor. The refrigeration capacity should be about the same as that of the original compressor. The R12 compressor oil must be changed over to alkyl benzene oil, provided that the original oil charge was mineral oil. The R134a compressor can be used directly charged with polyolester oil.
The filter drier must always be replaced. The new filter drier must contain a desiccant of the type XH9 (UOP) or Siliporite H3R (CECA)
The system components, especially the evaporator, will always contain some oil transferred from the original compressor. This is not critical if the new compressor contains alkyl benzene. But if a compressor containing polyolester is to be used, residues in the original oil must be kept to the lowest possible.

Normally, the limit is 10% of the original oil charge.
To ensure that the system is charged with a refrigerant mixture of the correct composition, the charge should be led to the charging device or charging valve as liquid.

The blends in table 1 are non-azeotropes. Therefore the composition changes during evaporation and condensation. This leads to temperature changes at constant pressure.
This condition is called "temperature glide". The extent of the temperature glide for the actual blends is given in table 1.
Fig. 1 shows a pressure - enthalpy diagram for non-azeotropic refrigerants. A temperature rise occurs from point "D" (inlet evaporator) to point "A" (outlet evaporator).
This phenomenon can result in a different temperature distribution in the appliance compared to the distribution with R12. The temperature at the outlet of the evaporator will always be higher than the temperature at the inlet of the evaporator. The difference corresponds with the temperature glide shown in table 1.
The influence of the storage temperature depends on the design of the refrigerating circuit and the location of the thermostat bulb.

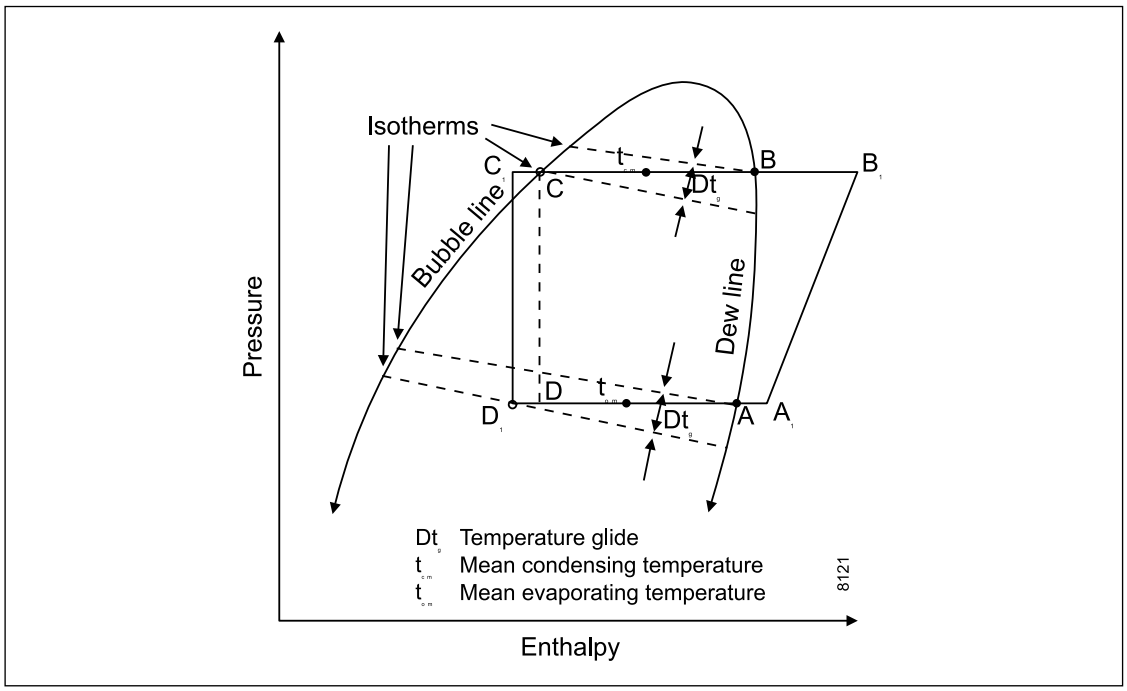


Fig. 1 Pressure - enthalpy diagram

2.2
Servicing with R134a

Even though the use of the "service blends" gives the least complicated procedure, the possibility of R134a is worth considering.
The main problem when changing from R12 to R134a is the oil problem. Any mixing with oil residues will give a negative influence on the function of the system, as described in the introduction.
The preconditions for changing over to R134a are:

- The compressor must be replaced with an original R134a compressor filled with an approved polyolester oil.
- The filter drier must be replaced with a new drier containing desiccant of the type XH7 (XH9) or Siliporite H3R (CECA).
- Oil residues in the system components must be kept on the lowest possible level. Up to 5% residues in the total oil charge can be accepted.
- Small hermetic systems are sensitive because of the use of capillary tube as the throttling device.

Therefore the aim is to achieve a still smaller content of residual oil.
The oil residues in household refrigeration systems are normally lower than 5% of the total oil charge. A bigger quantity may occur if the system contains oil pockets. If so it will be necessary to clean the system by carefully blowing out each component with dry N_2.

2.3 Servicing with R600a

R600a is a hydrocarbon. This refrigerant is flammable and is only allowed for use in appliances which fulfil the requirements laid down in amendment TS 95006 to IEC 335 - 2 - 24 (To cover potential risk originated from the use of flammable refrigerants). Consequently, R600a is only allowed to be used in household appliances which are designed for this refrigerant and fulfil the above-mentioned standard.
R600a is heavier than air. The concentration will always be highest at floor level.
The explosion limits are as follows,

- Lower limit: 1.5% by vol. (38 g/m^3)
- Upper limit: 8.5% by vol. (203 g/m^3)
- Ignition temperature: 460°C

2.3.1 General

In order to carry out service and repair on R600a systems the service personnel must be properly trained to be able to handle a flammable refrigerant. This includes knowledge on tools, transportation of compressors and refrigerant, and the relevant regulations and safety precautions when carrying out service and repair.

Warning: Do not use open fire!

2.3.2 Transportation of refrigerant and replaced compressors

The refrigerant must be stored and transported in approved containers. Max 2 x 500 g refrigerant is allowed to be transported in a service car.
Replaced compressors containing refrigerant residues must be sealed before being transported.

2.3.3 Tools

In general: No open fire when troubleshooting and repairing.
The refrigeration circuit must be opened with a tube cutter or a special tool.
For tube connections, traction-stable compression fittings (e.g. socalled LokRing® connections) must be used.
Vacuum pumps must be explosion-safe. It must be possible to lead the discharge air from the vacuum pump into open air.
Leak detection cannot take place with normal halogen leak detectors, as they do not react on hydrocarbons. A special detector reacting on hydrocarbon must be used instead. Another possibility is to use a leak spray. Both solutions presuppose that the vapour pressure in the system is higher than 1 bar. Fig. 2 shows the saturated vapour pressure as a function of the temperature.
The pressure is lower than the normal atmospheric pressure below -11°C. Accordingly it is necessary to increase the pressure in the system in order to carry out a leak detection. This can be done by adding dry nitrogen until a pressure of max 10 bar has been reached. Then the leak detection can be carried out either using a leak detector for R600a or a leak spray.

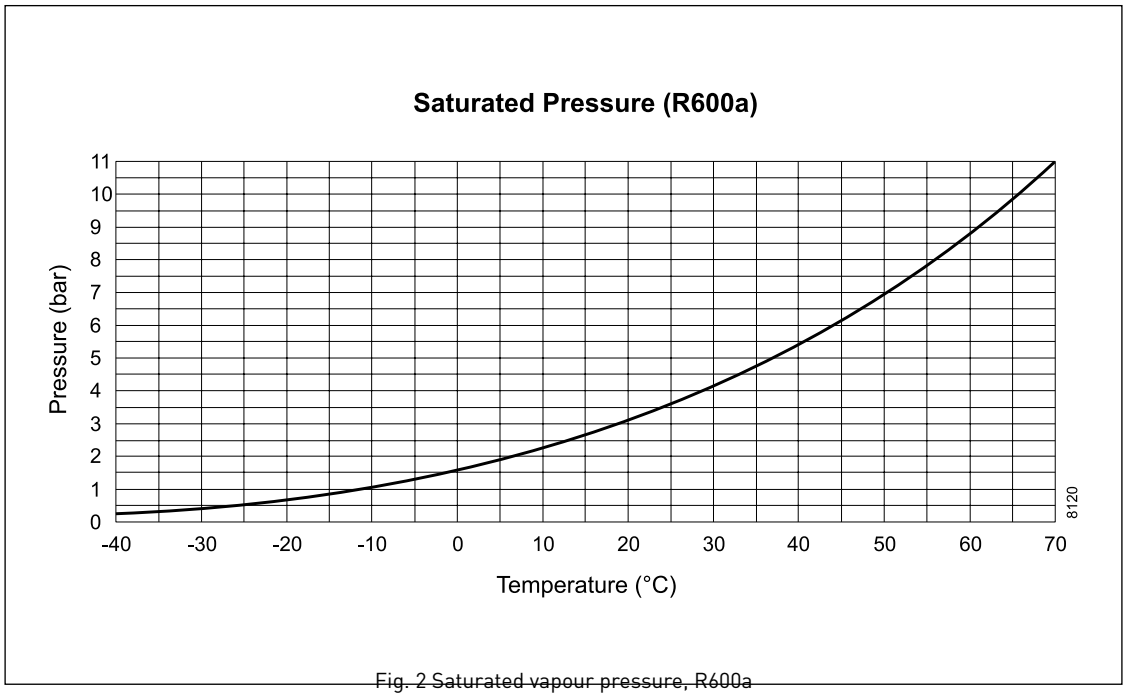


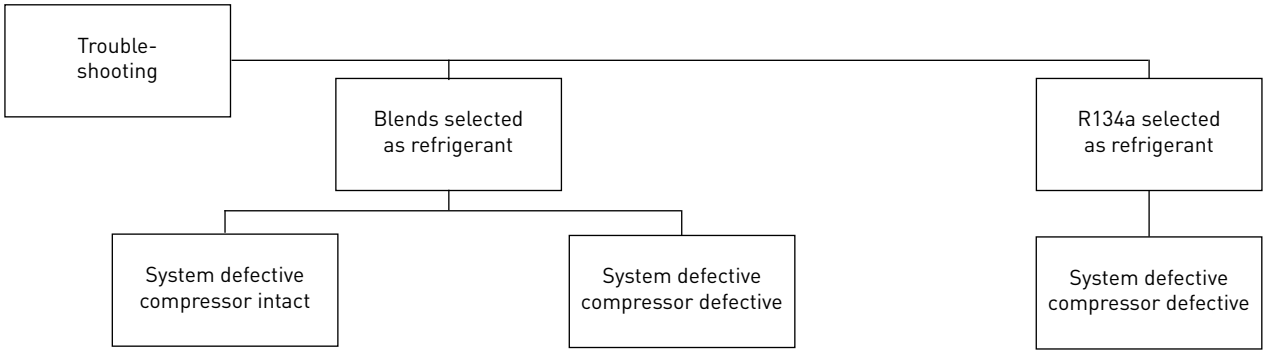
Fig. 2 Saturated vapour pressure, R600a

2.3.4 Additional information

For information please refer to Guidelines:

- Repair of hermetic Refrigeration Systems
- Mounting Instructions for hermetic AC Compressors
- Practical Application of Refrigerants R600a and R290 in small hermetic Systems

3.
REPAIR AND REFRIGERANT REPLACEMENT OF R12 SYSTEMS



1 System leakage
If the system has lost charge, the leakage must be localised and repaired.

2 Recover refrigerant
Fit a service valve, preferably on the process tube, and recover the system refrigerant charge. Equalise to atmospheric pressure using dry N_2.

3 Replace filter drier
Remove the filter drier. Blow the system components through with dry N_2. Repair the system. Fit a new filter drier containing desiccant XH9 or H3R.

4 Oil change (if necessary)
If the original compressor is charged with alkyl benzene it can be used unchanged. If it has been charged with mineral oil, this should be drained out in the best way possible. If necessary, detach the compressor from the system before pouring out the oil. Measure the collected oil in a gauge glass. Note: In connection with small compressors, some of the oil charge remains in the motor windings and on the surfaces. Collected oil (and recovered refrigerant) must be treated as special waste.
Refill the compressor with alkyl benzene in the same quantity as the collected mineral oil. Refit the compressor into the system.

5 Evacuation and charging
Evacuate and charge the refrigeration system with service blends. Fill the refrigerant mixtures as liquid. Because the optimum service blend charge is less than the original R12 charge, it is recommended that filling be started using about 75% of the original charge. The system can then be gradually filled until it is in balance.

6 End of system repair
Close the process tube. Check for leakage. Run the system. Mark the system with repair date, refrigerant type and amount, and oil type in the compressor.

1 Recover refrigerant
Fit a service valve on the process tube and recover the refrigerant. Equalilise to atmospheric pressure using N_2.

2 Remove the compressor and the filter drier
Blow the system through with dry N_2.

3 Compressor selection
Select a replacement compressor - either an Rl2 compressor charged with alkyl benzene oil or an R134a compressor charged with polyolester oil. The refrigeration capacity of the new compressor must correspond to that of the orginal compressor.

4 Fit new compressor and filter drier
Fit the new compressor. Fit a new filter drier containing UOP XH9 or Siliporite H3H.

5 Evacuation and charging
Evacuate and charge the refrigeration system with the service blend. Fill the refrigerant mixtures as liquid. Because the optimum service blend charge is less than the original R12 charge, it is recommended that filling be started using about 75% of the original charge. The system can then be gradually filled until it is in balance.

6 End of system repair
Close the process tube. Check for leakage. Run the system. Mark the system with repair date, refrigerant type and amount, and oil type in the compressor.

1 Compressor damage
If the defect is due to a "burnt out" compressor motor, the system must be scrapped

2 System leakage
If the system has lost charge, the leakage must be localised.

3 Recover refrigerant
Fit a service valve, preferably on the process tube, and recover the system refrigerant charge. Equalise to atmospheric pressure using dry nitrogen (N_2).

4 Remove the compressor and the filter drier
Flush all system components through with dry nitrogen (N_2).
Note: It is important that residues of mineral oil or alkyl benzene be kept to the lowest possible level.

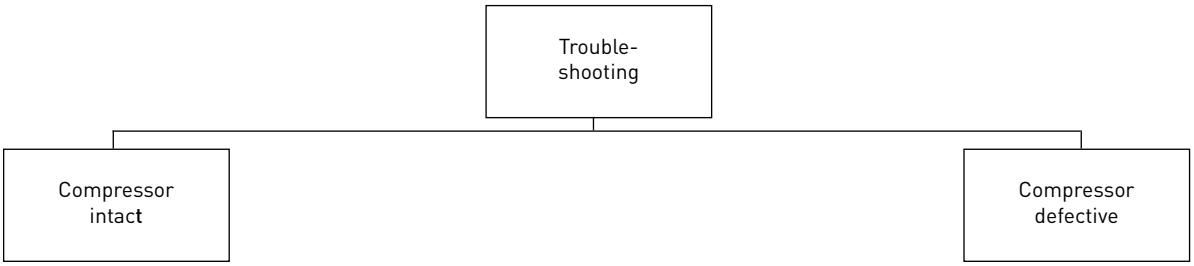
5 Compressor selection
Select the R134a replacement compressor (the original compressor cannot be used with R134a). The refrigeration capacity of the new compressor must correspond to that of the original compressor.

6 Fit new compressor and filter drier
Fit the new compressor. Fit a new filter drier containing dessicant XH7, XH9 or H3R.

7 Evacuation and charging
Evacuate and charge the system with R134a. For LBP systems the optimum R134a charge will be less than the original R12 charge. Therefore begin by filling about 75% of the original R12 charge and then adjust up gradually until the system is in balance.

8 End of system repair
Close the process tube. Check for leakage. Run the system. Mark the system with repair date, refrigerant type and amount.

4.
REPAIR OF REFRIGERATION SYSTEMS WITH R600a



1 Preparation
Stop the compressor.

2 Check for leakage
Fit a service valve on the process tube. Increase the pressure in the system to max 10 bar by means of dry nitrogen (N_2). Check for leakage by means of a leak spray or suitable leak detector.

3 Repair the system
Release pressure into open air by means of a plastic tube. Repair the system. Fit a new filter drier.
Warning: Do not use open fire!

4 Evacuation
Evacuate the system. The discharge from the vacuum pump must be lead into the open air.

5 Charging
Charge the system with R600a. As some of the original charge is dissolved in the oil, it is recommended that the charging is started with about 90% of the original charging amount.

6 System check
Run the system and check the temperatures.

7 End of system repair
Close the process tube with a traction-stable compression fitting.
Warning: Do not use open fire!

8 Labelling
Mark the system with repair date. Place a warning label on the compressor. The label must be in accordance with TS (IEC 335 - 2 - 24).

1 Release refrigerant
Fit a service valve on the process tube and release the refrigerant into open air by means of a plastic tube.

2 Safety evacuation
In order to ensure that the defective compressor does not contain R600a residues, which may be a fire hazard when the compressor is scrapped, the system must be evacuated.
The discharge from the vacuum pump must be lead into the open air. Equalise to atmospheric pressure using dry nitrogen (N_2).

3 Remove the compressor and the filter drier
Close the compressor connectors with rubber plugs. Thoroughly blow through the system with dry nitrogen (N_2).
Warning: Do not use open fire!

4 Compressor selection
Select a new R600a compressor. The refrigeration capacity must correspond to that of the original compressor.

5 Fit new compressor and filter drier

6 Evacuation and charging
Evacuate and charge the system with R600a. The charge must correspond to the original charge. Start the compressor.

7 System check
Run the system and check the temperatures.

8 End of system repair
Close the process tube with a traction-stable compression fitting.
Warning: Do not use open fire!

9 Labelling
Mark the system with repair date. Place a warning label on the compressor. The label must be in accordance with TS (IEC 335 - 2 - 24).

OUR IDENTITY

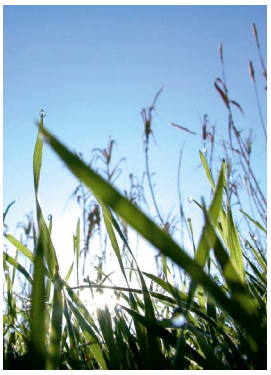
At Secop we are committed to our industry and are genuinely passionate about the difference we are able to make for our customers. We understand their business and objectives and the challenges of today's world of refrigeration and cooling systems.

We work in a straightforward way, being open, direct and honest because we want to make things clear and easy. Our people are committed to increasing value for our customers and constantly strive for better performance, knowing that our own progression and success is dependent on theirs.

A NEWCOMER WITH 60 YEARS OF EXPERIENCE

Formerly known as Danfoss Compressors, Secop is one of the founding fathers of modern compressor technology with an experience that goes back to the beginning of the 1950s.

For more than 25 years, Secop has been setting the standard in compressor technology by developing highly efficient variable speed compressors and by compressors working with hydrocarbons.



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.

Secop GmbH · Mads-Clausen-Str. 7 · 24939 Flensburg · Germany · Tel: +49 461 4941 0 · **www.secop.com**

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