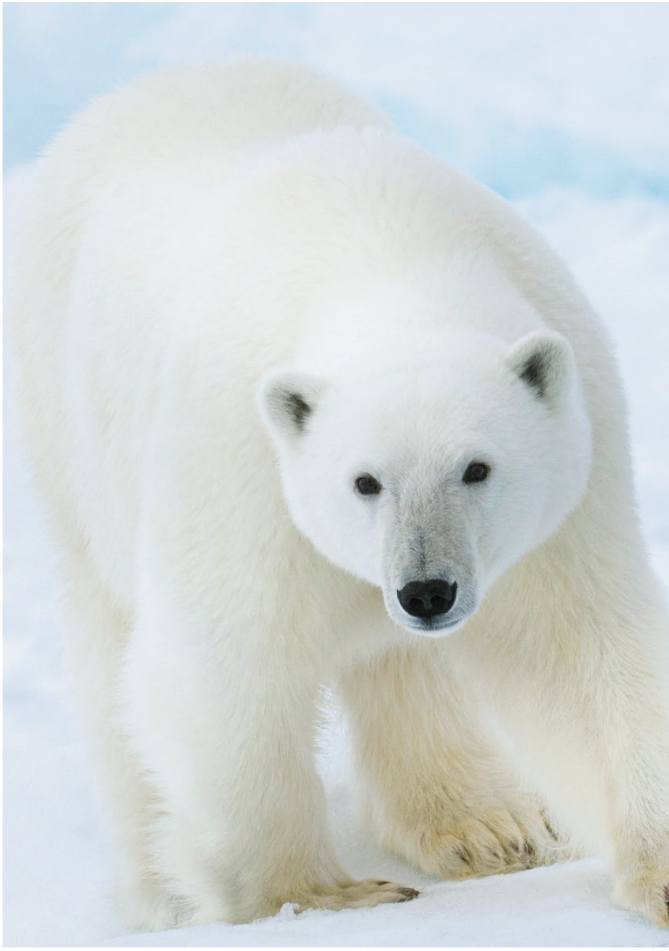
Guidelines EN

Sabroe oil recommendation

Selecting lubricating oil for Sabroe compressors



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Johnson Controls

Contents

1. Introduction

1.1 Introduction to the oil recommendation

The Sabroe oil recommendation describes:

- How to select the most suitable compressor oil
- Why it is important to use recommended compressor oils
- Technical data for recommended compressor oils
- Part numbers for recommended compressor oils
- Scheduled maintenance tasks regarding compressor oils.

This manual is primarily intended for operators and technical decision makers.

- The operating personnel and the technical decision makers must read and understand this manual to ensure proper and efficient operation of the equipment. Johnson Controls Denmark is not liable for damage occurring during the warranty period where this is attributable to incorrect oil selection or oil handling.

The manual does not describe:

- Safety when handling refrigerants and oils
- Charging and changing oil procedures in compressors or systems.

The manual covers the selection of compressor oils for all Sabroe compressors and systems.

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1.2 Safety precaution definitions used in this manual

Danger!

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

Warning!

Indicates a potentially hazardous situation or practice which, if not avoided, will result in death or serious injury.

Caution!

Indicates a potentially hazardous situation or practice which, if not avoided, will result in damage to equipment and/or minor injury.

Note: Indicates an operating procedure, practice, or portion thereof, which is essential to highlight.

2. Selecting lubricating oil for Sabroe compressors

2.1 Recommended compressor oils

The Johnson Controls Sabroe factory in Denmark has manufactured compressors for all types of industrial refrigeration applications and refrigerants for more than 125 years.

Continuous research backed by many years of experience has resulted in a series of recommended compressor oils, which meet the requirements for all refrigeration, HVAC and gas compression applications.

The range of compressor oils that we recommend addresses the specific compressor and system requirements, and our rigid specifications and quality control ensure that all the oils meet the highest quality standards for premium performance and durability.

By consistently maintaining high standards of quality and product excellence, the recommended compressor oils are recognised and acknowledged in the entire refrigeration industry.

The recommended oils provide:

- Proper operating viscosity for the specific application
- High chemical and oxidation stability at the specified operating conditions
- High resistance to temperature breakdown
- High flash points to ensure low oil carry-over
- Low moisture content
- Low ‘pour points’ to resist congealing in condensers and evaporators
- Low ‘floc points’ for preventing wax from precipitating
- Optimal solubility and miscibility properties at the specified operating conditions.

2.2 Oil types and oil companies

As there are many companies worldwide that produce and sell oil for refrigeration plants, it is not possible to test all the brands available on the market.

We know from experience that some oil brands may change character during use and thus no longer fit the specifications given by the oil companies. We have also seen changes in oil specifications, formulas and performance without receiving any information about these changes from the oil companies.

We therefore recommend using the oils listed in this manual only. They have all been developed in cooperation with a few recognised oil companies and are being tested continuously under strict quality control.

The compressor oils include the following oil types:

Code design	Oil types
M	Mineral oil, naphtenic base
A	Synthetic oils based on alkylated aromatics (alkyl-benzene)
AP	Synthetic oils blended from alkyl-benzene and poly-alfa-olefin base stocks
S	Semi-synthetic oils (hydro-treated mineral oil on paraffinic base)
PAO	Synthetic oils based on poly-alfa-olefin
POE	Synthetic oils based on polyol esters
PAG	Synthetic oils based on polyalkylene glycols
AN	Synthetic oil based on alkylated naphtalene

2.3 Selecting recommended compressor oils

This manual contains diagrams to help select lubricating oils for Sabroe compressors operating with various refrigerants.

Use the *Oil recommendation diagrams* to select the recommended compressor oil for your application.

The part numbers for the compressor oils are listed in section 2.12.

On plants with several interconnected compressors of different types and makes, all the compressors must use the same type and brand of oil. This is essential where automatic oil return systems are employed.

For applications not covered by this oil recommendation, please contact your Johnson Controls representative.

2.4 Selecting oils from other oil companies

⚠ Caution!

The use of other oils than the ones recommended for Sabroe compressors may cause oil related warranty claims, which will be rejected.

Note: As Johnson Controls Denmark has only tested the oils listed in this recommendation, we cannot answer for the quality, stability or suitability of any other oils. When selecting an oil, which is not recommended in this oil recommendation, the supplying oil company has the sole responsibility for the quality and suitability of that oil, and in case of any issues with the oil in the compressor or refrigeration plant, the oil supplier must be contacted directly.

If you do select a lubricating oil from an oil company not recommended here, please pay attention to the oil performance in both the compressor and the refrigeration plant as a whole.

The following require special attention:

1. Oil type, properties and quality
2. Refrigerant type
3. Compressor type
4. Plant type
5. Solubility and miscibility between refrigerant and oil
6. Operating conditions for the compressor
   - Evaporating temperature
   - Condensing temperature
   - Oil temperature
   - Discharge gas temperature
   - Vapour pressure in the oil reservoir
7. Oil viscosity in the compressor
   - Recommended viscosity range during operation: 20-50 cSt.
   - Max. permissible viscosity during start-up: 500 cSt.
8. Compatibility with elastomers.

Operating data for your specific application is available from Johnson Controls Denmark on request.

2.5 Charging Sabroe compressors with oil

Caution!

DO NOT MIX OILS *of different types, brands or manufacturers. Mixing oils may cause catastrophic compressor or plant failure.*

Mixing refrigerants may also cause severe chemical reactions resulting in compressor or plant failure.

Contact Johnson Controls Denmark if oils (or refrigerants) have been mixed by mistake.

Always use oil from the original container only.

Make sure the original container is properly sealed during storage to prevent moisture from the air being absorbed in the oil. Consequently, it is recommended to buy oil in containers with the amount needed for each charge.

If you are only using part of the oil, make sure to re-seal the original container properly and store it in a warm, dry place. Ideally, fill up the container with nitrogen to protect the oil from the air and keep the water content below 50 ppm.

Do not store oil for more than five years.

2.6 Oil replacement intervals

The oil replacement intervals are determined by oil analysis results.

As a rule of thumb, we recommend oil analyses:

- after the first 1000 hours of operation, and
- subsequently, every 6 months.

This will give a good indication of the compressor and plant condition and ensure consistent performance.

The part number for the Sabroe *Oil analysis kit* is listed in section 2.12.

2.7 Oil condemning limits

The oil condemning limits for compressor oils are listed in section 2.15. If a condemning limit parameter is exceeded, the oil must be replaced (or filtered, see section 2.15) and the cause must be identified to ensure further safe operation.

The condemning limits and the service life of the compressor bearings are closely linked. Keeping the values well below the condemning limits will significantly increase the service life of the compressor (compressors with ball or roller bearings especially).

Make sure to maintain the highest cleanliness of all the internals in a new plant before evacuating and charging the system.

Caution!

Pay special attention to the water content in the plant.

Many problems in compressors and plants are related to water contamination of the oil.

Careful evacuation procedures for the compressor and plant, for instance during service and maintenance, are extremely important.

All oils are hygroscopic and will therefore absorb moisture when exposed to the atmosphere. Especially ester and glycol oils are extremely hygroscopic and must be handled with extra care

(the water content condemning limit is reached within a few hours when the oil is exposed to the atmosphere).

Do not expose compressor oils to the atmosphere for more than maximum 4 hours to avoid water absorption (e.g. during installation or service).

Drying filters should be mounted in the plant (not in ammonia plants) to keep the water content at a low level during operation.

2.8 Changing oil type or brand on Sabroe compressors

⚠ Caution!

Changing from one oil type or brand to another should only take place after a careful procedure, including thorough drainage of the plant (repeatedly, if necessary) and monitoring of the oil quality for a period of time after the oil change.

Furthermore, the elastomers' (O-rings) reaction to the oil types must be considered to avoid leakage (some oils make the O-rings swell and others make them shrink).

Guidance on the selection of the optimal oil type and brand for your application and the corresponding procedure for changing the oil can be provided by Johnson Controls Denmark.

Please also contact Johnson Controls Denmark for advice and appropriate procedures if you are planning to convert your plant from one refrigerant to another.

2.9 Solubility of refrigerant gas into oil

Solubility refers to refrigerant gas diluted into the oil in the oil reservoir. When refrigerant gas is diluted into the oil, the oil viscosity will be lower than the viscosity of pure oil. It is therefore extremely important to consider the solubility when selecting the viscosity ISO VG grade of an oil.

If the amount of refrigerant gas that can be diluted into the oil (within the relevant pressure range) is below 1%, we refer to the oil as ‘non-soluble’ with the refrigerant, and the operating oil viscosity of the specific oil will only vary with the oil temperature.

If, however, the oil is soluble with the refrigerant, the operating oil viscosity must be found via a so-called VPT diagram (Daniel plot), where the pressure is also a parameter in addition to the temperature.

All recommended Sabroe soluble oils are based on the specific VPT diagram for the various refrigerants/oil combinations.

If selecting an oil from another oil company, note that the solubility must be found for this oil specifically via the oil company's own VPT diagram. Be aware that a VPT diagram may not be available as they are costly to establish.

In general, soluble oils are preferred in refrigeration systems, and non-soluble oils are preferred in compressors for gas transport. Ammonia (R717), however, is the one exception as no soluble oil with sufficient lubrication performance can be found for R717.

The reason soluble oils are preferred in refrigeration systems is the miscibility between the liquid refrigerant and the oil in the system (see subsection 2.10 below). Miscibility between the oil and the refrigerant makes it easier to return the oil to the compressor.

2.10 Miscibility between oil and refrigerant

Miscibility refers to liquid refrigerant mixed with the oil in the evaporator, condenser, receivers etc. in the system. If the oil is miscible with the liquid refrigerant, the mixture will be one uniform fluid. If the oil is non-miscible with the liquid refrigerant, the two liquids will stratify into two layers.

Miscibility is preferred in refrigeration systems to ensure that the oil in the system can be returned to the compressor.

Even though an oil is referred to as miscible with the liquid refrigerant, this only applies within a certain range of temperature, pressure and concentration. Especially the oil concentration must be kept sufficiently low in the evaporator, receivers, etc. to avoid stratification.

The max. limits for the oil concentrations are shown in the *Oil recommendation diagrams*, and the oil return system must be dimensioned in a way that ensures the stratification limit is not exceeded.

2.11 Use of mineral oil

Caution!

We have experienced several issues with naphtenic-based mineral oils, particularly in R717 plants.

Therefore, we do not recommend naphtenic-based mineral oil for Sabroe compressors.

The issues can be divided into two groups:

a. The oil changes viscosity within a few hours of operation
b. The oil becomes very black within a few hours of operation.

Both are clear indications of decomposing compressor oil, which may result in compressor and/or plant failure.

We are, however, aware that some customers have been using naphtenic-based mineral oils for many years without any issues. Customers, who wish to continue using this type of oil in existing compressors, can do so.

If you are using naphtenic-based mineral oil, it is important to monitor the plant closely, draw oil samples regularly (every 1-2000 hours) and check the condition/colour of the oil on a weekly basis.

2.12 Part numbers of recommended compressor oils

Oil brand	Oil code	Application (1)	Part no.	
		Refrigerant	20 litres	208 litres
Mobil Gargoyle Arctic 300	M68	(R717)(2)	1231.264	1231.296
Sabroe Oil AP68	AP68	R717(8)	1231.257	1231.260
Sabroe Oil S68(6)	S68	R717	1231.340	1231.341
Sabroe Oil PAO68(5)	PAO68	R717	1231.256	1231.259
Sabroe Oil PAO100(7)	PAO100	R717, R22(3)		
Mobil Gargoyle Arctic SHC 230	PAO220	R717	1231.284	1231.285
Mobil EAL Arctic 68	POE68	HFCs	1231.272	1231.273
Mobil EAL Arctic 100	POE100	HFCs	1231.274	1231.275
Mobil EAL Arctic 220	POE 220	HFCs	-	1231.279
FUCHS Reniso C85E	POE C85E	R744(9)	1231.304(4)	-
Shrieve ZEROL RFL 68 EP	PAG RFL-68-EP	R744(10)	1231.329	1231.332
CPI CP-1507-100	PAG 1507-100	R1270	1231.322	1231.323
CPI CP-1515-100	PAG 1515-100	R290, R600, R600a	1231.324	1231.325
CPI CP-1515-150	PAG 1515-150	R290, R600, R600a	1231.326	1231.327
CPI Icematic G220A	AN G220A	R717	1231.1009	
MobilServ Lubricant oil analysis kit	-	All	1231.2007	

(1) Use the *Oil recommendation diagrams* in chapters 3. and 4. to select the recommended oil for your specific application.

(2) Mineral oil on naphtenic base is no longer recommended but still available on request.

(3) R22 for evaporating temperatures above 0ºC only.

(4) 3 x 10 litres

(5) Category code: H1 (NSF reg. no. 147013)

(6) Category code: H2 (NSF reg. no. 147054)

(7) Category code: H1 (NSF reg. no. 155750)

(8) Blended oil from A-oil and PAO-oil is no longer recommended but still available on request.

(9) For use in reciprocating compressors with journal bearings only.

(10) For use in screw compressors with roller bearings. Can also be used in reciprocating compressors.

Caution!

DO NOT MIX OILS of different types, brands or manufacturers.

Mixing oils may cause excessive oil foaming, nuisance oil level cut-outs, gas or oil leakage, oil pressure loss or catastrophic compressor and plant failure.

Contact Johnson Controls Denmark if oils have been mixed by mistake.

2.13 Properties of recommended compressor oils

Oil brand	Oil code	Viscosity			Spec. gravity	Flash point	Pour point of pure oil	Anilin point	Acid no.
		cSt 40°C	cSt 100°C	Index	g/ml at 15°C	°C	°C	°C	mg KOH/g
Mobil Gargoyle Arctic 300	M 68	63	6	14	0.910	202	-36	81	0.02
Sabroe Oil AP68	AP 68	64	9	103	0.858	211	-51	121	0.04
Sabroe Oil S68	S 68	63	9	106	0.890	226	-39	119	n/a
Sabroe Oil PAO68	PAO 68	66	10	136	0.835	266	< -45	138	0.03
Sabroe Oil PAO100	PAO 100	94	14	147	0.838	255	< -45	144	0.03
Mobil Gargoyle Arctic SHC 230	PAO 220	208	25	149	0.846	260	< -39	154	0.03
Mobil EAL Arctic 68	POE 68	68	8	96	0.971	251	-43	12	< 0.1
Mobil EAL Arctic 100	POE 100	97	11	92	0.967	268	-36	13	< 0.1
Mobil EAL Arctic 220	POE 220	226	18	90	0.964	290	-24	n/a	< 0.1
FUCHS Reniso C85E	POE C85E	81	11	116	9.993	246	-42	n/a	0.02
Shrieve ZEROL RFL 68 EP	PAG RFL-68–EP	68	16	213	0.998	>200	-46	N/A	<0.1
CPI CP-1507-100	PAG 1507-100	89	12	125	1.165	260	-37	n/a	n/a
CPI CP-1515-100	PAG 1515-100	103	19	200	1.043	210	-48	n/a	n/a
CPI CP-1515-150	PAG 1515-150	129	25	230	1.050	273	-42	n/a	n/a
CPI Icematic G220A	AN G220A	219	23	132	0.881	266	-42	NA	<0.02

Oil code	
M	Mineral oil, naphtenic-based
A	Synthetic oil based on alkylated aromatics (alkyl-benzene)
AP	Synthetic oil blended from alkyl-benzene and poly-alpha-olefins
S	Semi-synthetic oil (hydrotreated mineral oil on paraffinic base)
PAO	Synthetic oil based on poly-alpha-olefins
POE	Synthetic oil based on polyolesters
PAG	Synthetic oil based on polyalkylene glycols
AN	Synthetic oil based on alkylated naphtalene

Note: All Sabroe compressors are run tested from factory. Residuals of the used oil can be found in the compressor after the run test. The residual oil is compatible with all Sabroe recommended oils.

Caution!

Using oils other than the ones recommended for Sabroe compressors may cause oil-related warranty claims, which will be rejected.

2.14 Qualitative properties for compressor oils

Oil code	Oil carry-over (vapour)	Foaming tendency	Stability	Elasto vol. change	Viscosity index	Low temperature (drainage)
M	High	High	Low	Swelling	Low	Fair
A	Very high	Medium	Medium	Swelling	Low	Excellent
AP	Medium	Low	Medium	Neutral	Medium	Good
S	Low	Medium	Medium	Neutral	Medium	Good
PAO	Very low	Very low	High	Shrinking	High	Excellent
POE	Low	Low	High	Swelling	Medium	Excellent
PAG	Low	Low	High	-	High	Excellent
AN	Very low	Very low	High	Neutral/shrinking	High	Excellent

M	Mineral oil, naphtenic-based
A	Synthetic oil based on alkylated aromatics (alkyl-benzene)
AP	Synthetic oil blended from alkyl-benzene and poly-alpha-olefins
S	Semi-synthetic oil (hydrotreated mineral oil on paraffinic base)
PAO	Synthetic oil based on poly-alpha-olefins
POE	Synthetic oil based on polyolesters
PAG	Synthetic oil based on polyalkylene glycols
AN	Synthetic oil based on alkylated naphtalene

Table 1: Qualitative properties

Use this table as a guideline for oil selection when you have several oil types to choose from according to the *Oil recommendation diagrams*.

2.15 Condemning limits for compressor oils

Parameter	Unit	Method	Condemning limit
Viscosity @40°C	cSt	ASTM D 445	± 15%
TAN(1)	mg KOH/g	ASTM D 664	0.2
SAN(2)	mg KOH/g	ASTM D 665	0
Water, R717 plants	ppm(3)	Karl Fisher	100
Water, HFC plants with POE oil	ppm(3)	Karl Fisher	100
Water, plants with PAG oil	ppm(3)	Karl Fisher	500
Water, R744 plants	ppm(3)	Karl Fisher	50
Appearance	-	-	Report
Colour	-	ASTM D1500	Report
Pentane Insolubles	W%	MM 490 (5µm)	0.05
Oxidation	abs/cm	IR, 1700-1720/cm	5
Nitration	abs/cm	IR, 1627-1637/cm	5
Nitro compounds	abs/cm	IR, 1547-1557/cm	0.5
Micro-filtration	mg/l	Warning	200
	mg/l	Change oil	250
Metal content:			
Lead	ppm	ICP	10
Copper	ppm	ICP	10
Silicium	ppm	ICP	25
Iron	ppm	ICP	100
Chromium	ppm	ICP	5
Aluminium	ppm	ICP	10
Tin	ppm	ICP	10
1) TAN is only reported for non-ammonia applications			
2) SAN is only reported for non-ammonia applications			
3) ppm = Parts per million per mass (1E+6 kg water/kg oil). See also note below.			

Replace the oil if one of the condemning limit parameters above is exceeded.

However, if only one or more ICP limits are exceeded, the oil can be filtered through an externally mounted 3-micron filter (closed system connected directly to the compressor to avoid exposing the oil to the atmosphere).

The cause for increased values must always be identified.

Oil samples are taken from the reservoir (crankcase or oil vessel).

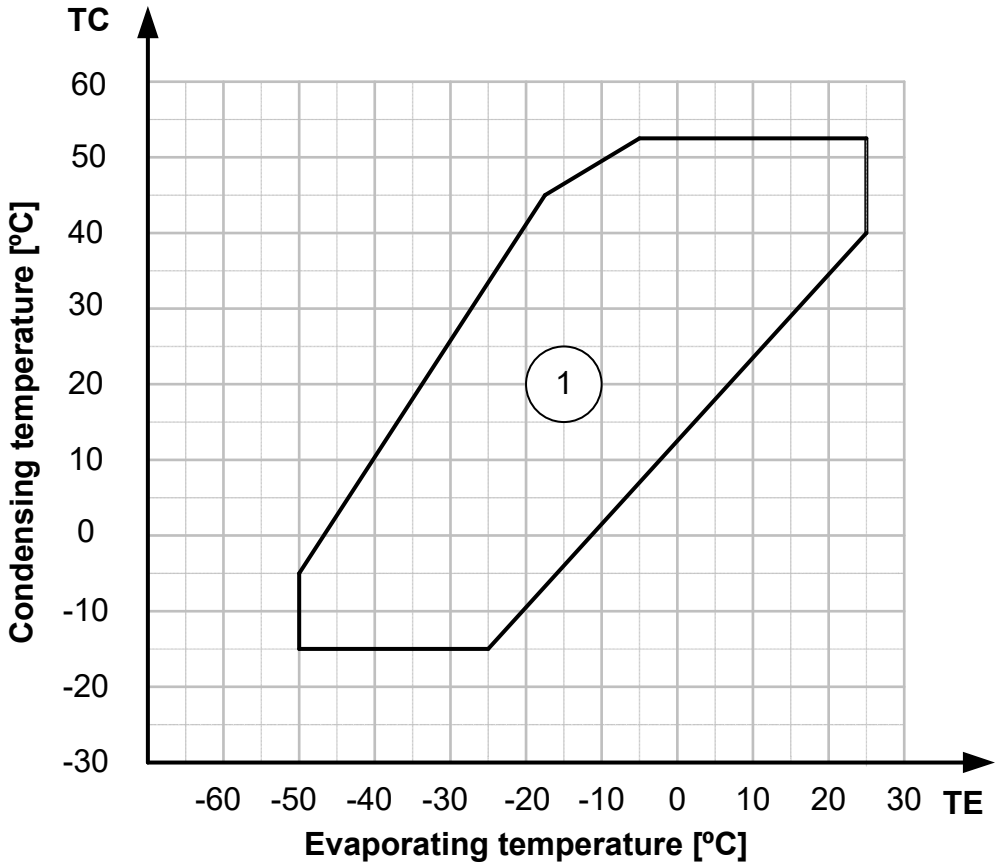
Note: The Mobil oil analysis reports the water content as Vol%.
0.01 Vol% corresponds to approximately 100 ppm by mass (depending on the density of the oil).

3. Diagrams for reciprocating compressors

Note: The *oil recommendation diagrams* in the following are guidelines only.
The exact recommendations can be found in the Engineering manual for each compressor type and in COMP1/Coolware.

3.1 Refrigerant R717 (ammonia)

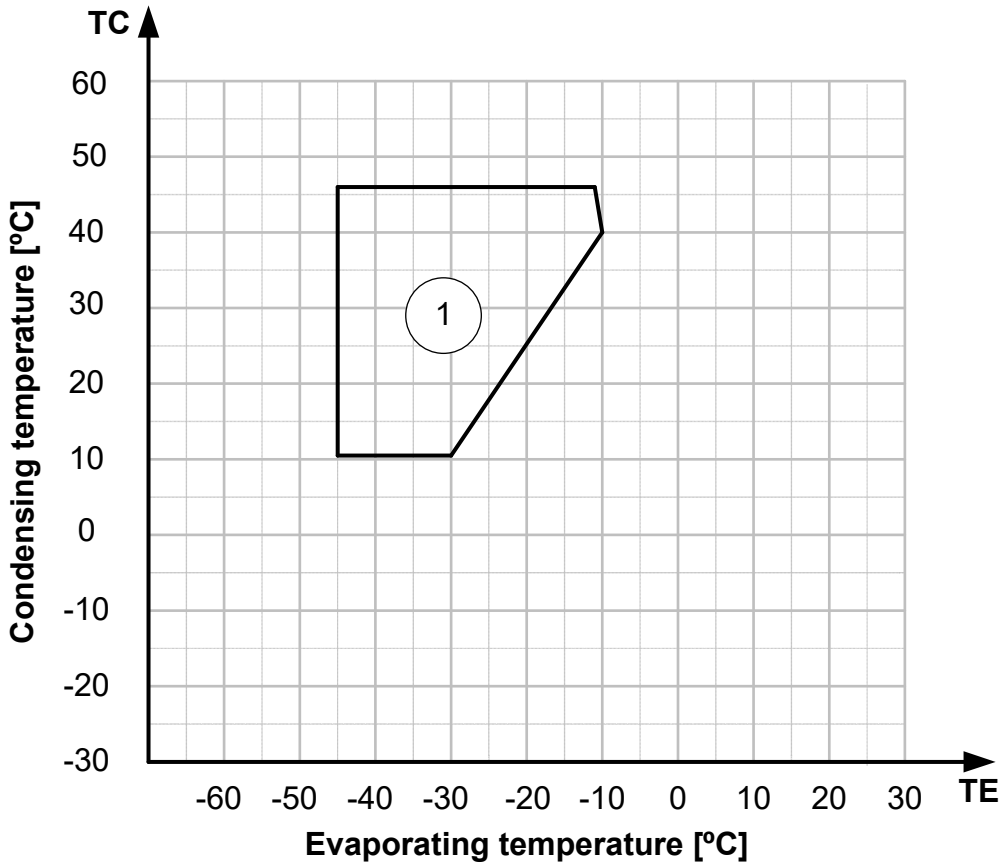
R717 - CMO and SMC single-stage reciprocating compressors



Code no.	Area no. 1
PAO 68	Δ ●
S 68	Δ Θ ●

Δ Very suitable for new plants
Θ If wishing to change from naphtenic mineral oil
● Non-soluble and non-miscible

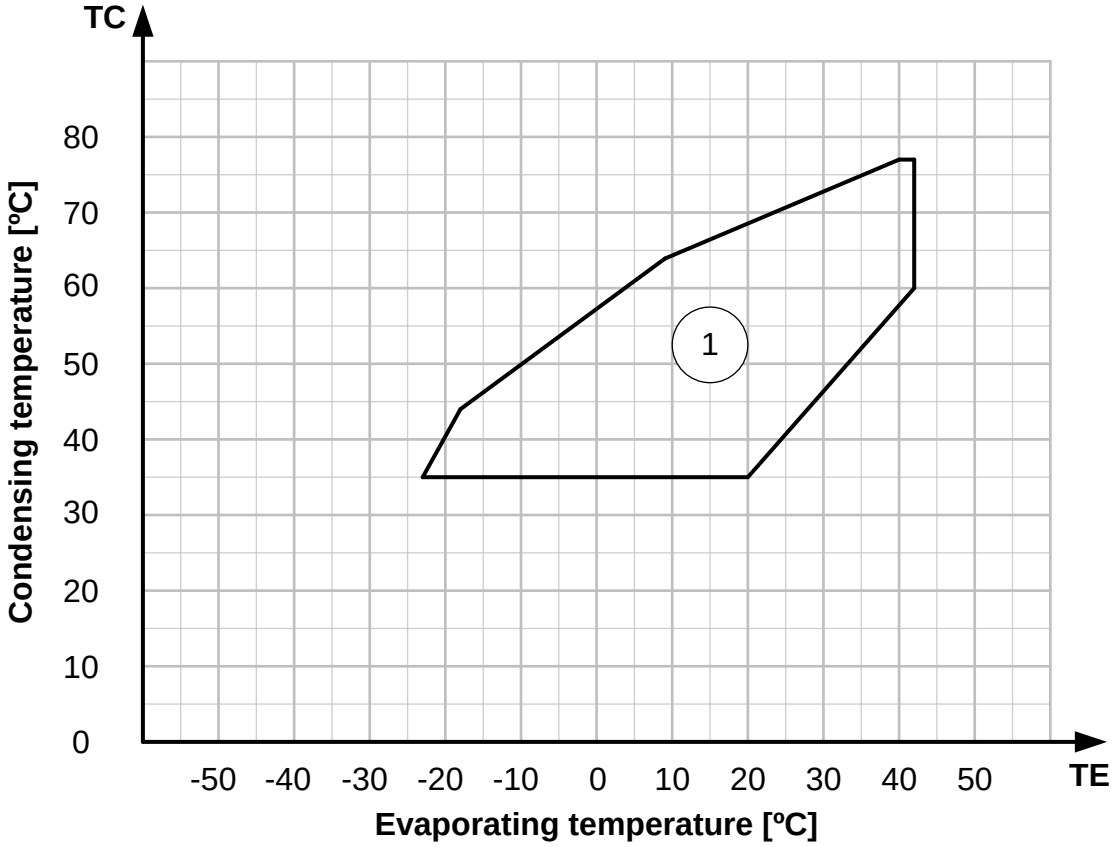
R717 - TCMO and TSMC two-stage reciprocating compressors



Code no	Area no. 1
PAO 68	Δ ●
S 68	Δ Θ ●

Δ Very suitable for new plants
Θ If wishing to change from naphtenic mineral oil
● Non-soluble and non-miscible

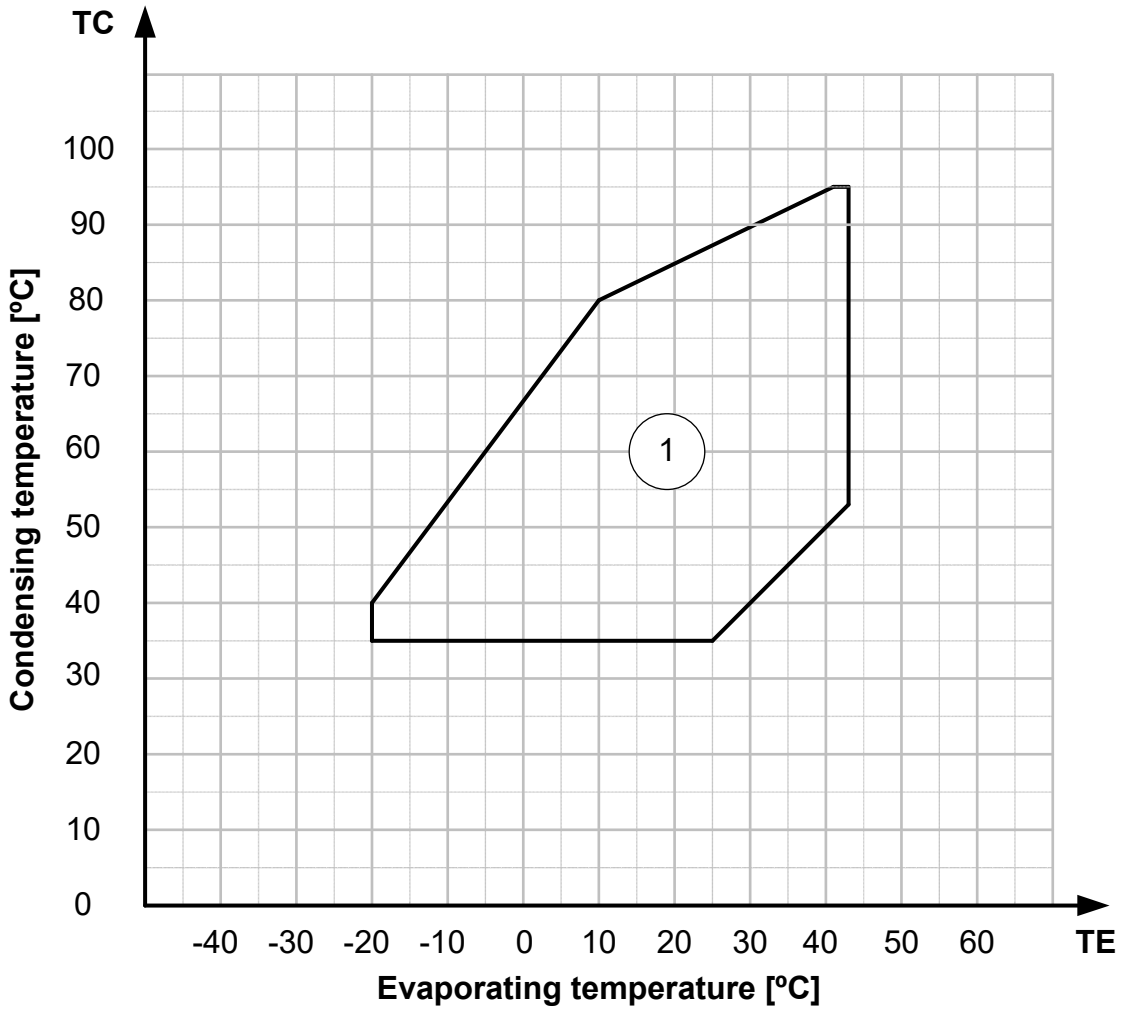
R717 - HPO and HPC reciprocating compressors



Code no.	Area no. 1
PAO 100	Δ ●

Δ Very suitable for new plants
● Non-soluble and non-miscible

R717 - HPX singe-stage reciprocating compressors

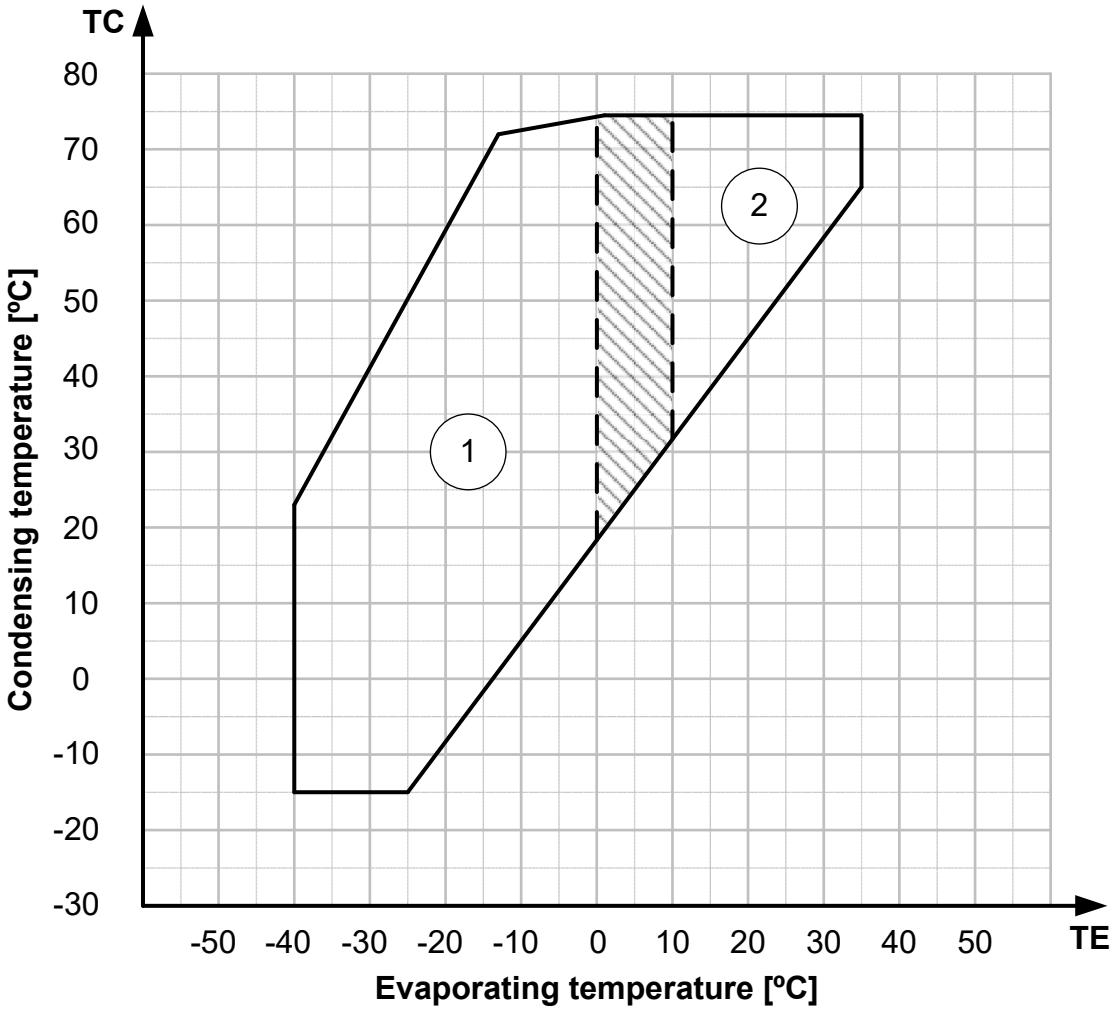


Code no.	Area no. 1
PAO 100	Δ ●

Δ Very suitable for new plants
● Non-soluble and non-miscible

3.2 Refrigerant R134a

R134a - single-stage reciprocating compressors



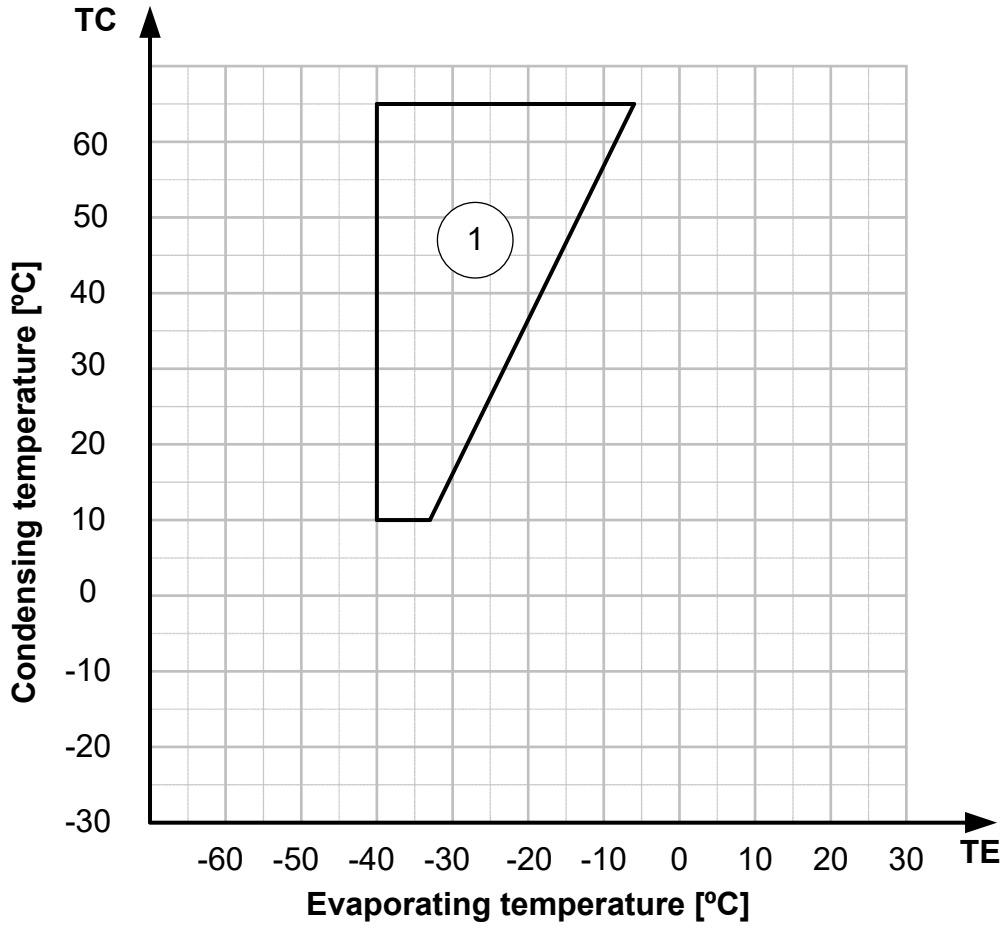
Code no.	Area no. 1	Area no. 2
POE 100	Δ □	
POE 220		Δ □

Δ Very suitable for new plants

Both oils are applicable in this zone

□ Soluble and miscible

R134a - two-stage reciprocating compressors

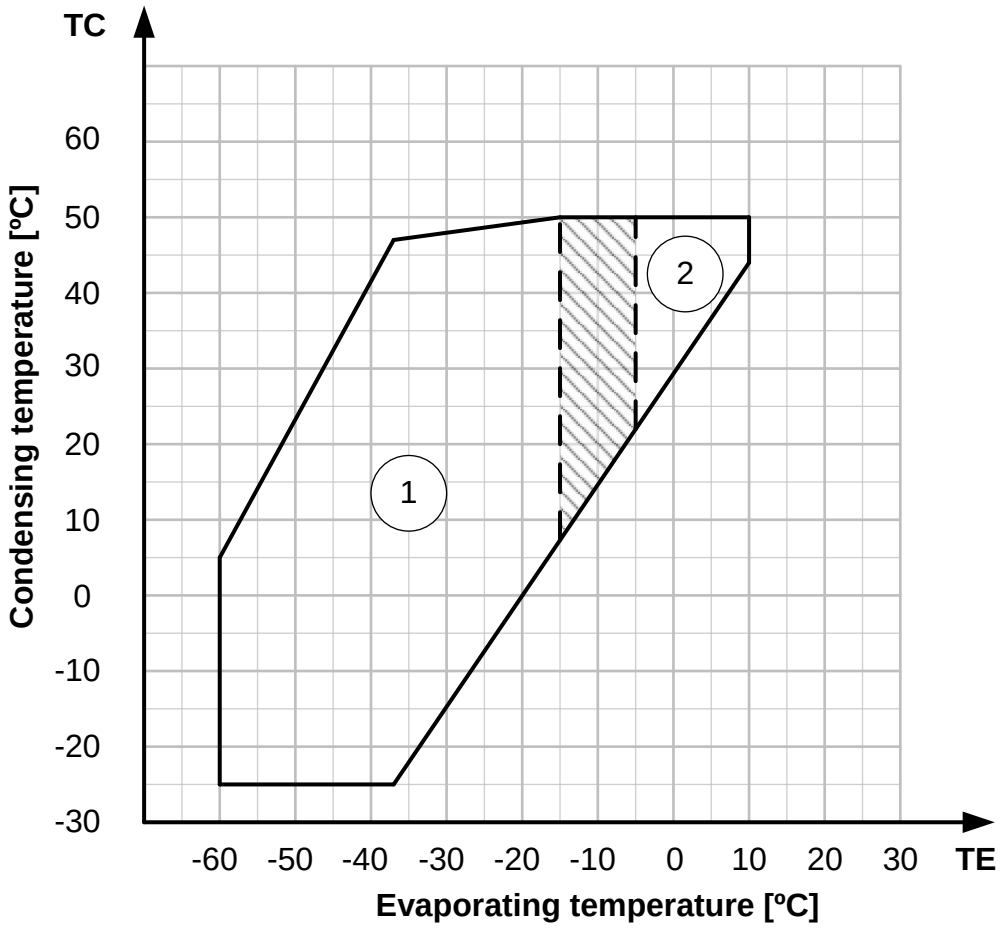


Code no.	Area no. 1
POE 100	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

3.3 Refrigerant R404A

R404A - single-stage reciprocating compressors



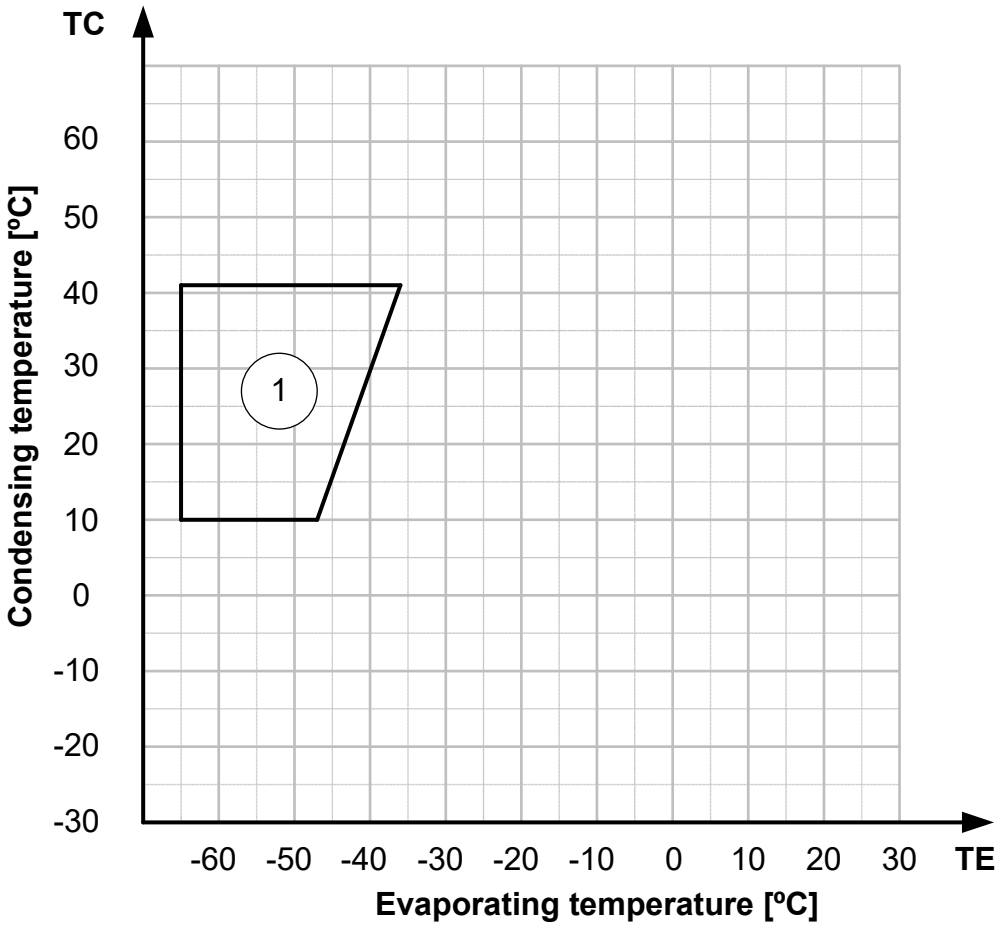
Code no.	Area no. 1	Area no. 2
POE 68	Δ □	
POE 100		Δ □

Δ Very suitable for new plants

Both oils are applicable in this zone

□ Soluble and miscible

R404A - two-stage reciprocating compressors

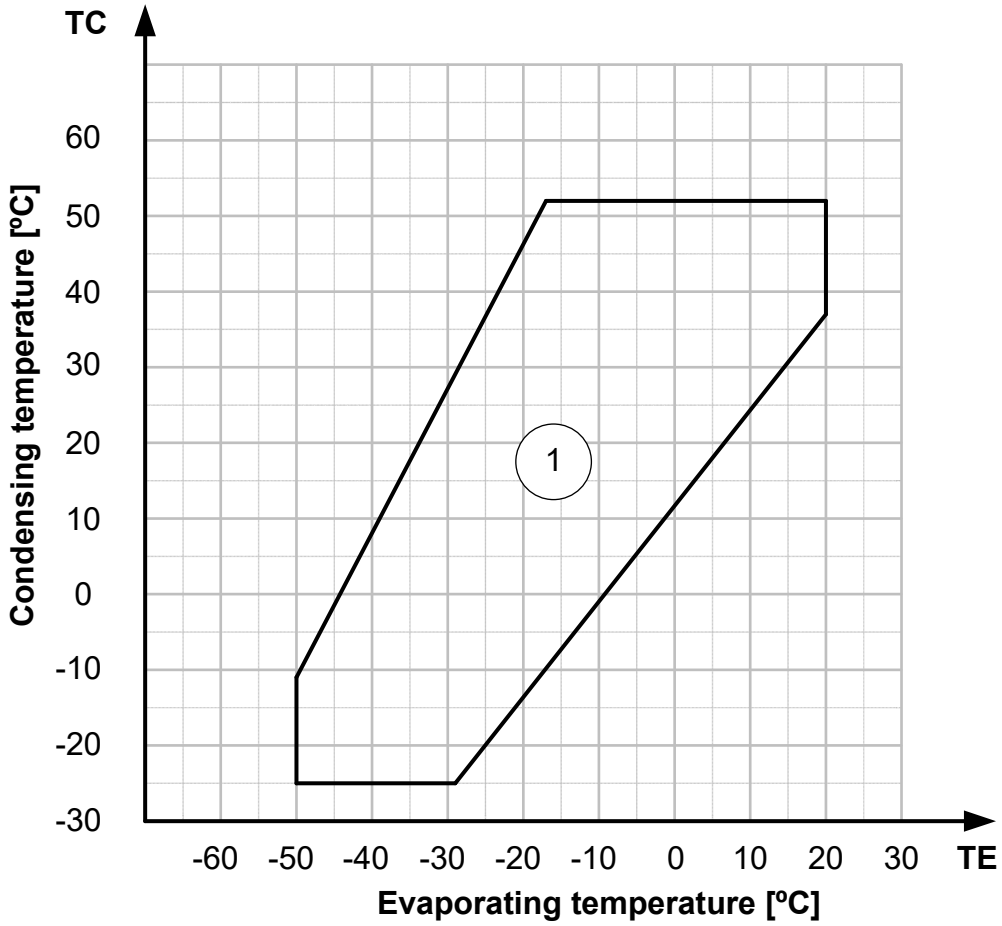


Code no.	Area no. 1
POE 68	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

3.4 Refrigerant R407C

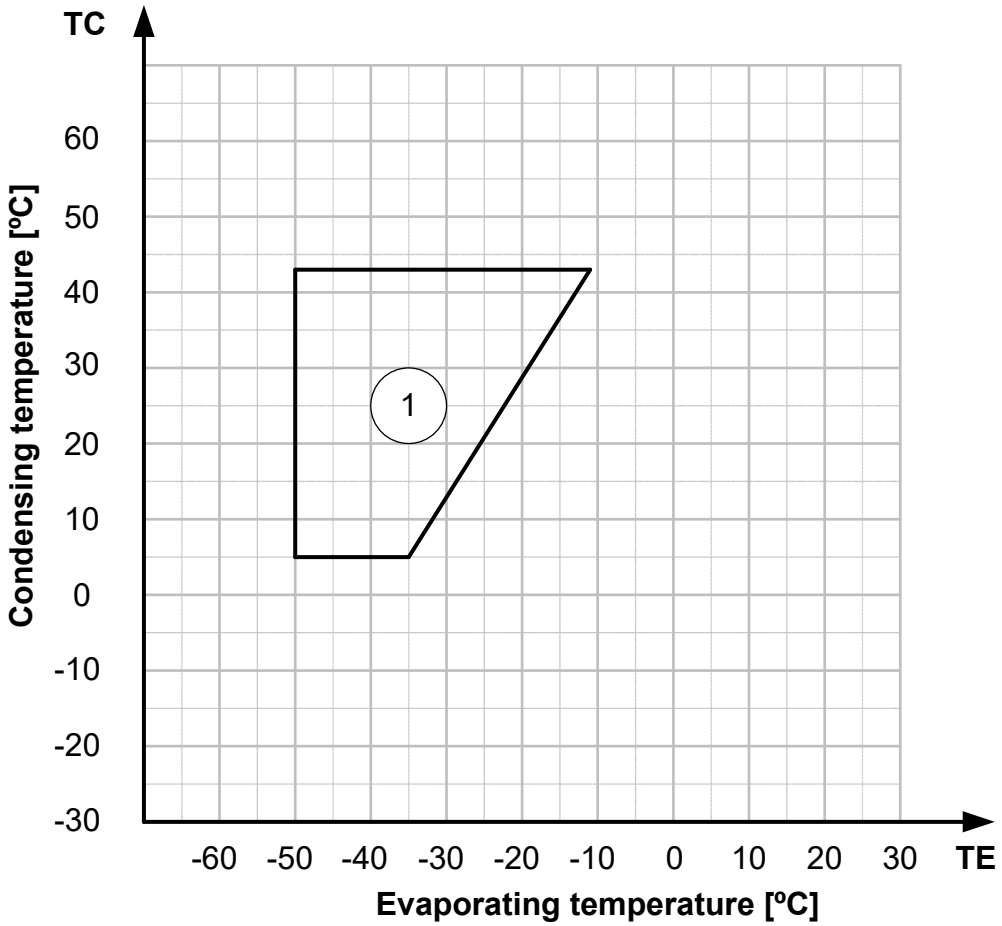
R407C - single-stage reciprocating compressor



Code no.	Area no. 1
POE 68	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

R407C - two-stage reciprocating compressors

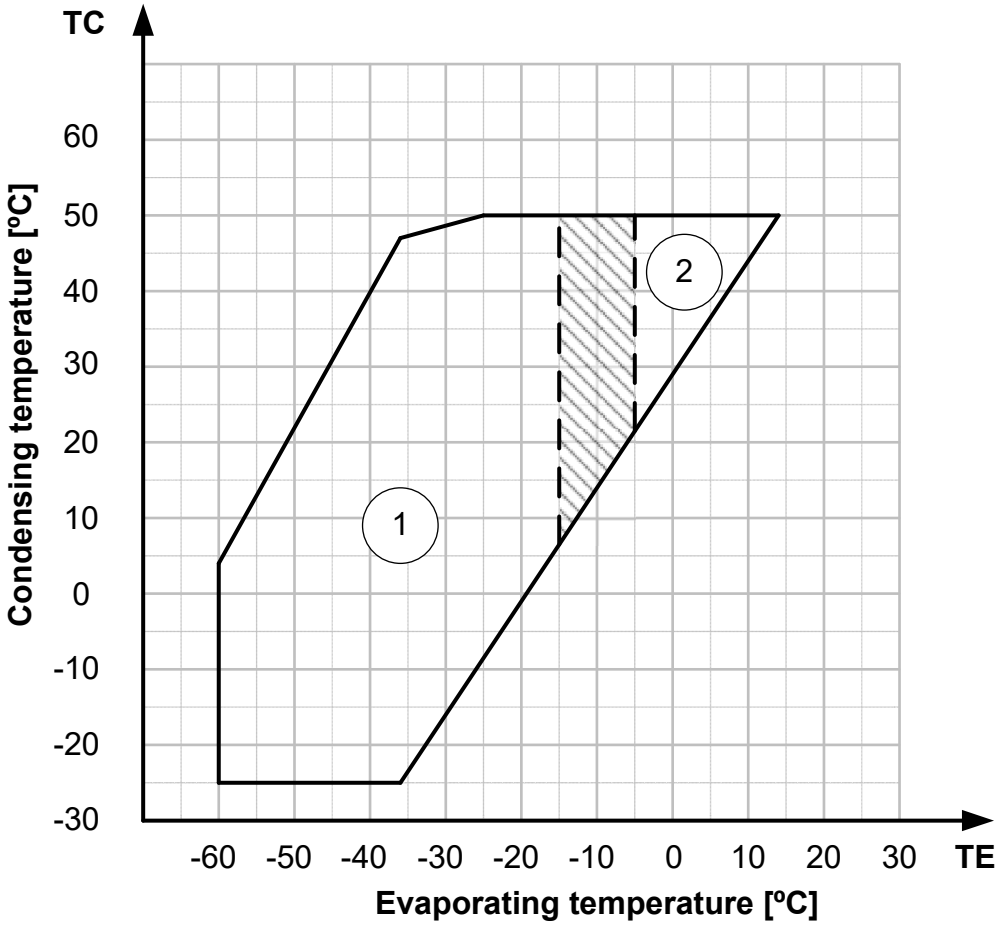


Code no.	Area no. 1
POE 68	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

3.5 Refrigerant R507

R507 - single-stage reciprocating compressors



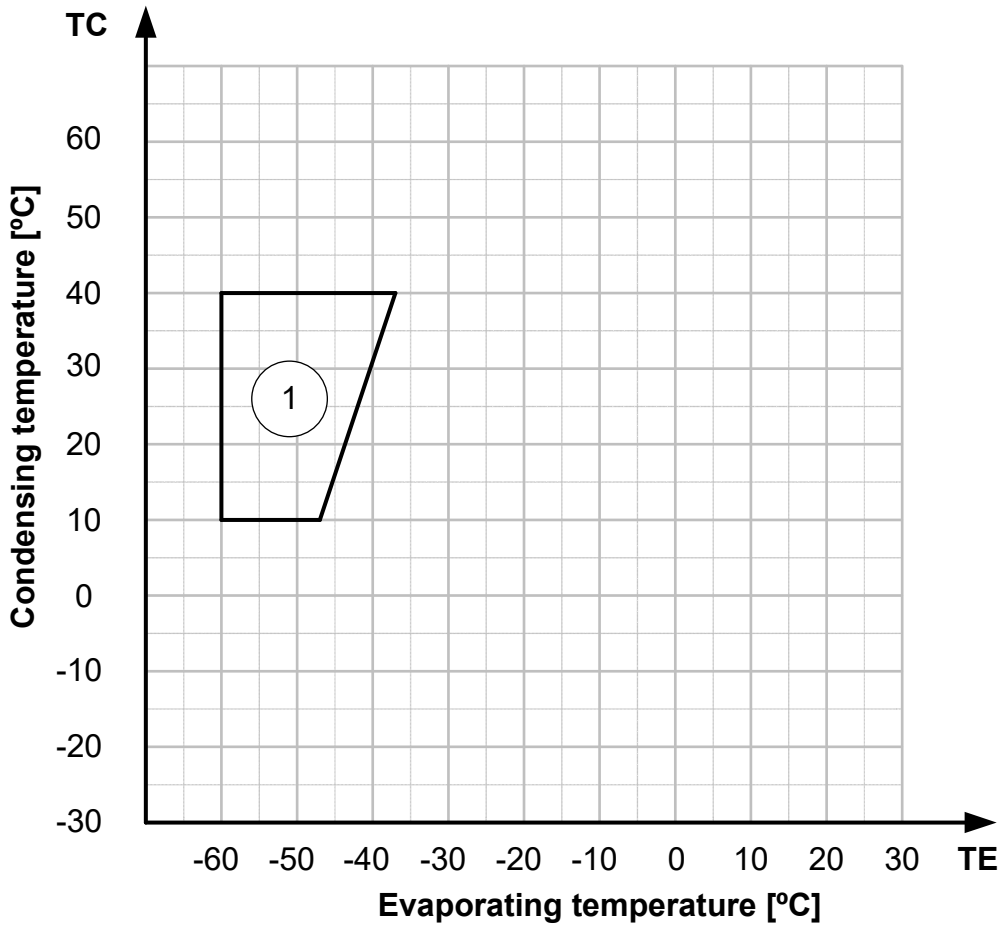
Code no.	Area no. 1	Area no. 2
POE 68	Δ □	
POE 100		Δ □

Δ Very suitable for new plants

Both oils are applicable in this zone

□ Soluble and miscible

R507 - two-stage reciprocating compressors

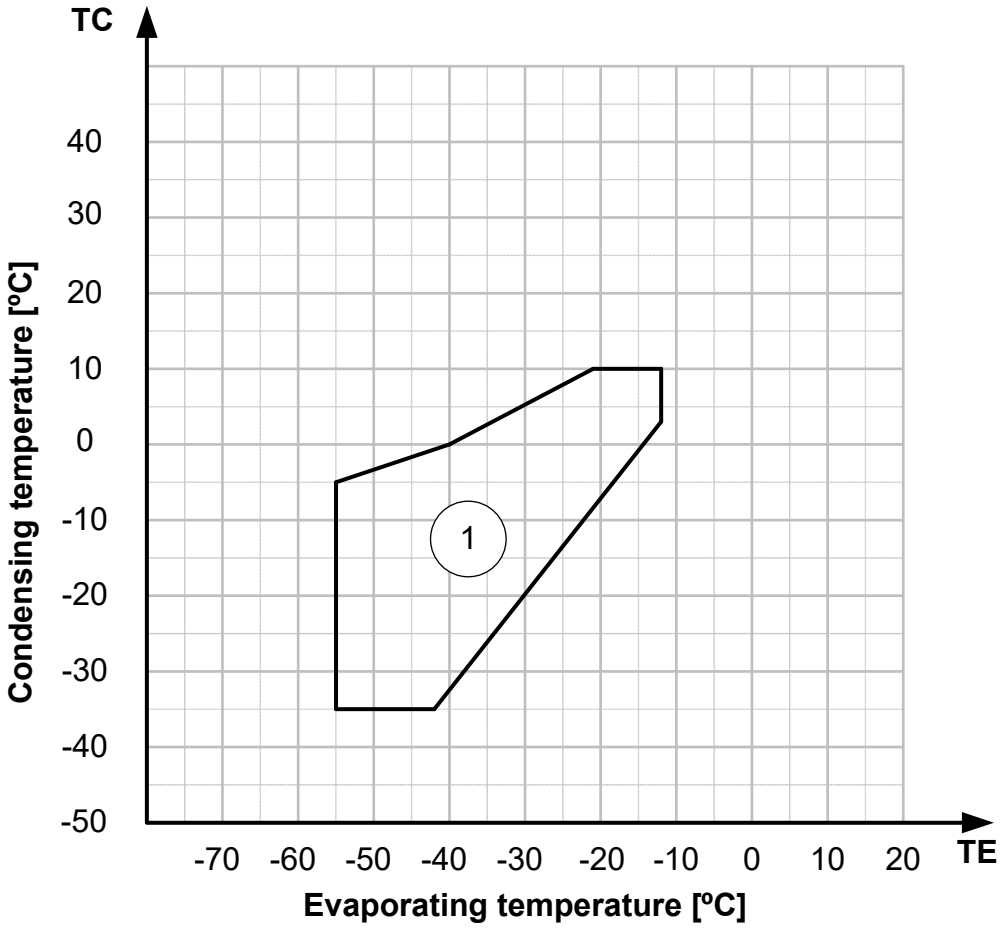


Code no.	Area no. 1
POE 68	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

3.6 Refrigerant R744 (CO_2)

R744 - HPO and HPC reciprocating compressors



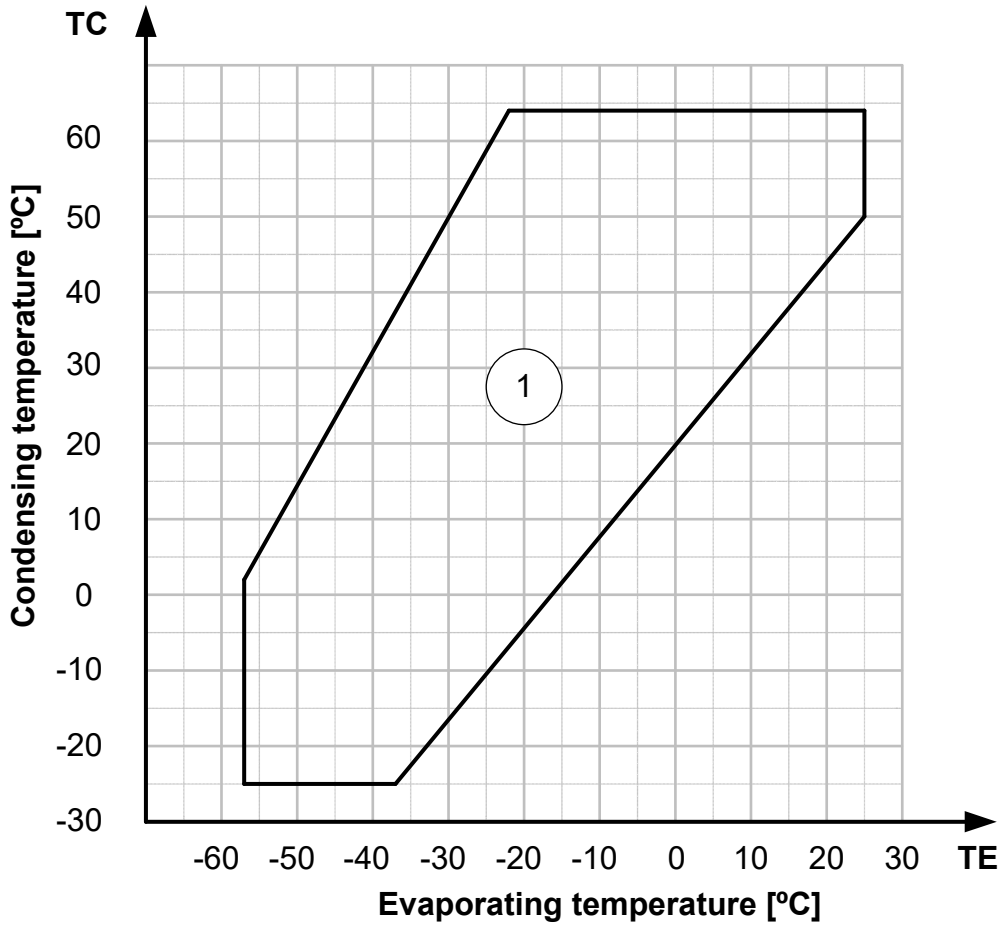
Code no.	Area no. 1
POE C85E	Δ □ ●
PAG RFL-68-EP	Δ □ *

Δ Very suitable for new plants
□ Soluble and miscible
● Used in plants with recips only
* Used in plants with both recips and screws

Note: For R744 gas transport: use PAO 68 (non-soluble and non-miscible with R744).

3.7 Refrigerant R290

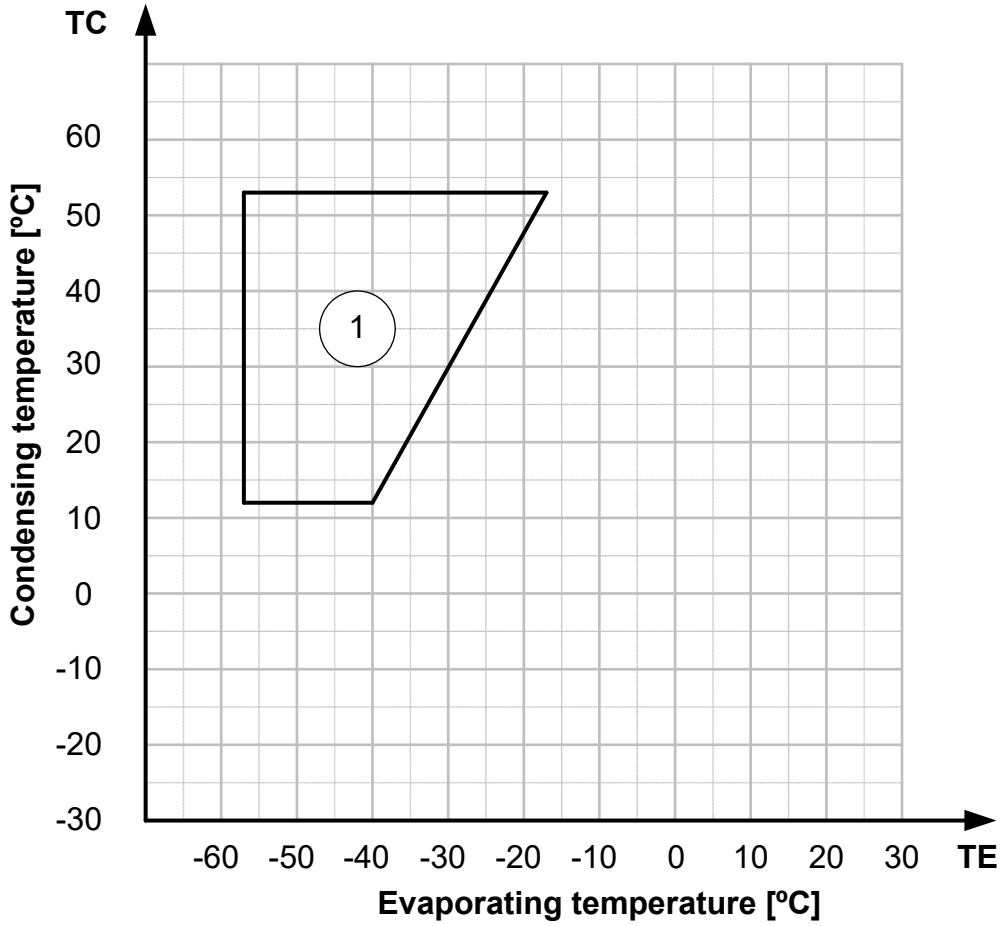
R290 - single-stage reciprocating compressors



Code no.	Area no. 1
PAG 1515–100	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

R290 - two-stage reciprocating compressors

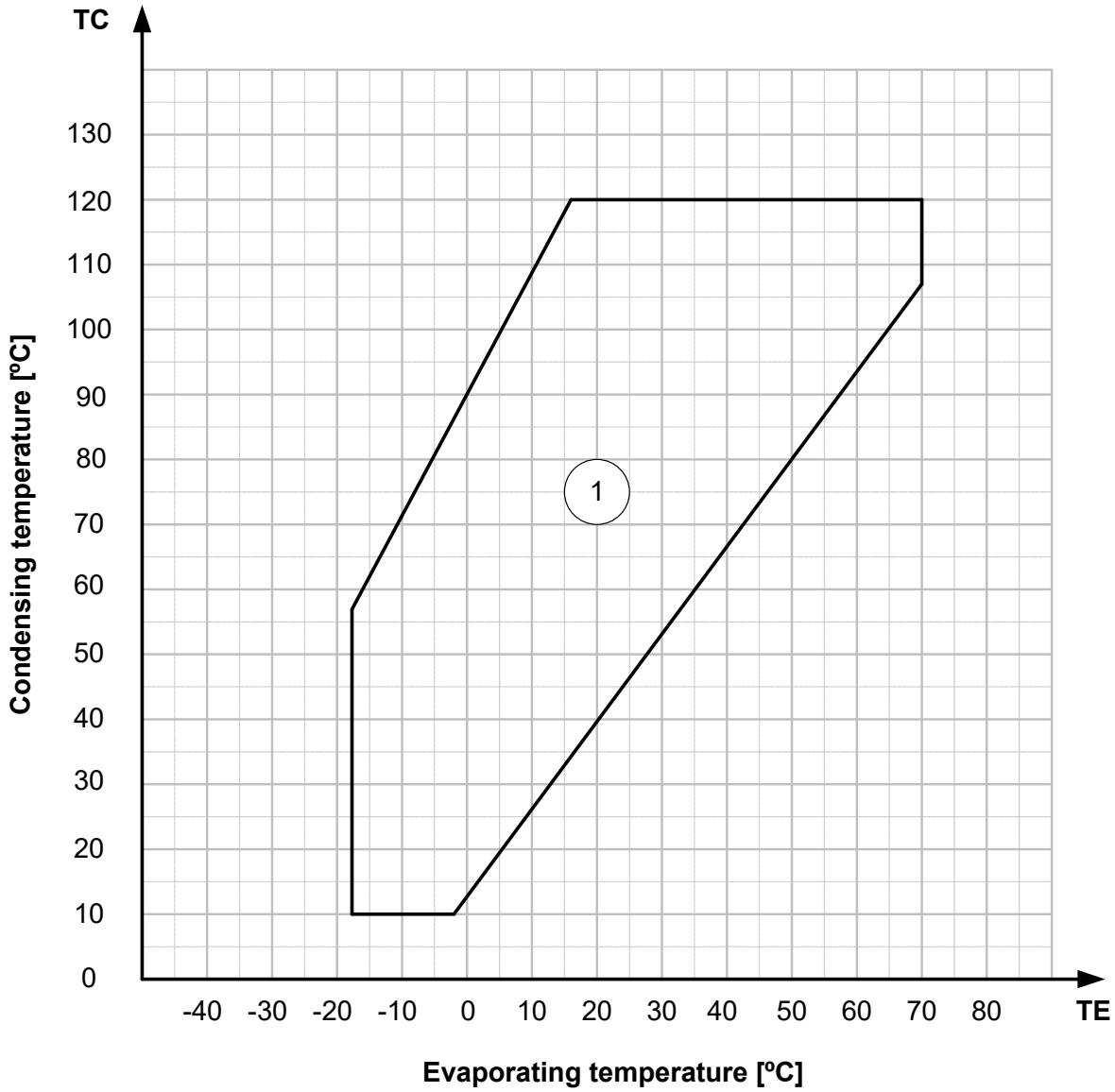


Code no.	Area no. 1
PAG 1515-100	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

3.8 Refrigerant R600

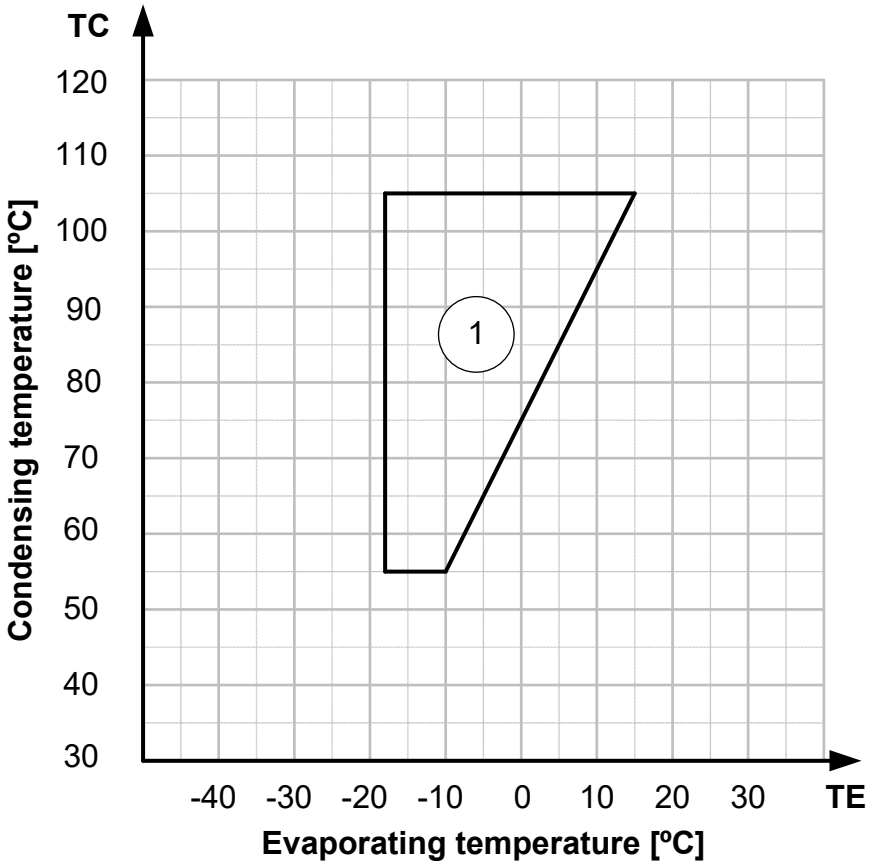
R600 - single-stage reciprocating compressors



Code no.	Area no. 1
PAG 1515-100	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

R600 - two-stage reciprocating compressors

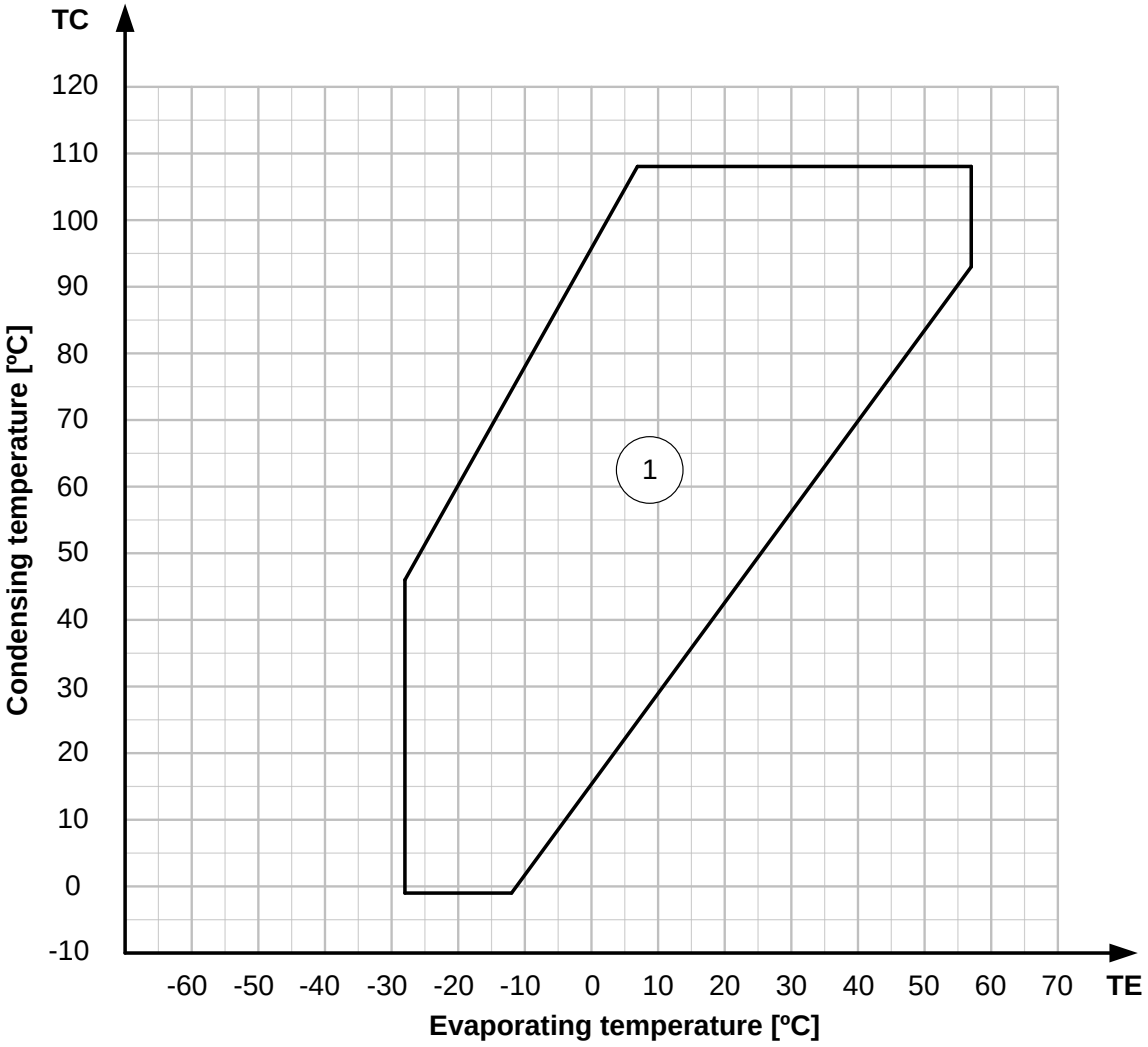


Code no.	Area no. 1
PAG 1515-100	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

3.9 Refrigerant R600a

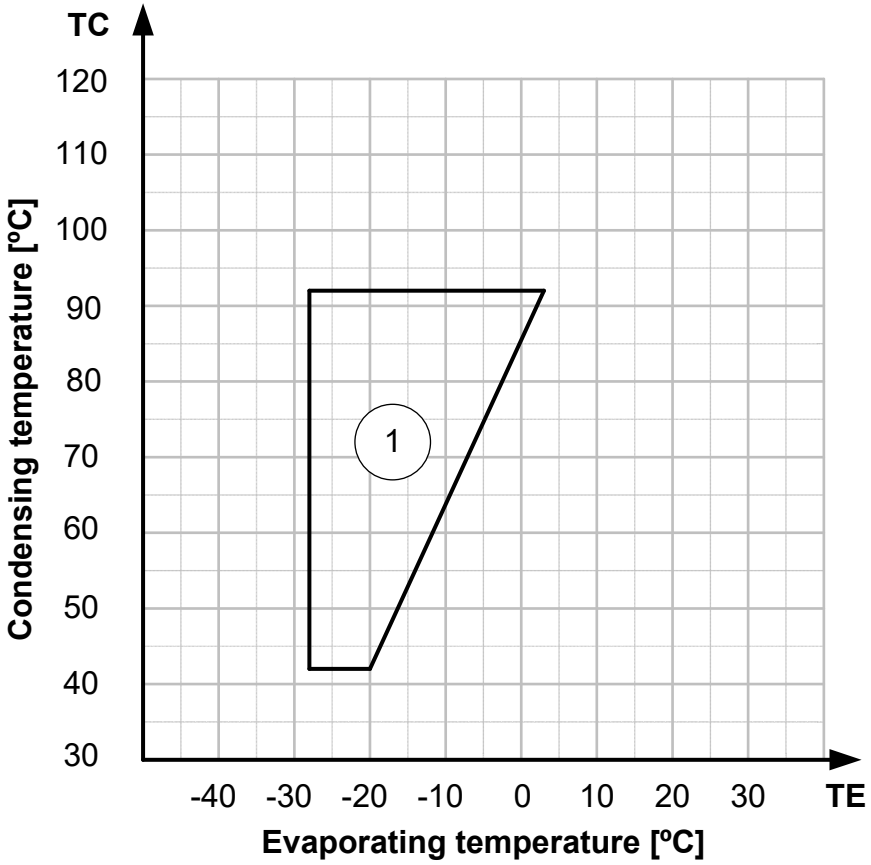
R600a - single stage reciprocating compressor



Code no.	Area no. 1
PAG 1515-100	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

R600a - two-stage reciprocating compressor

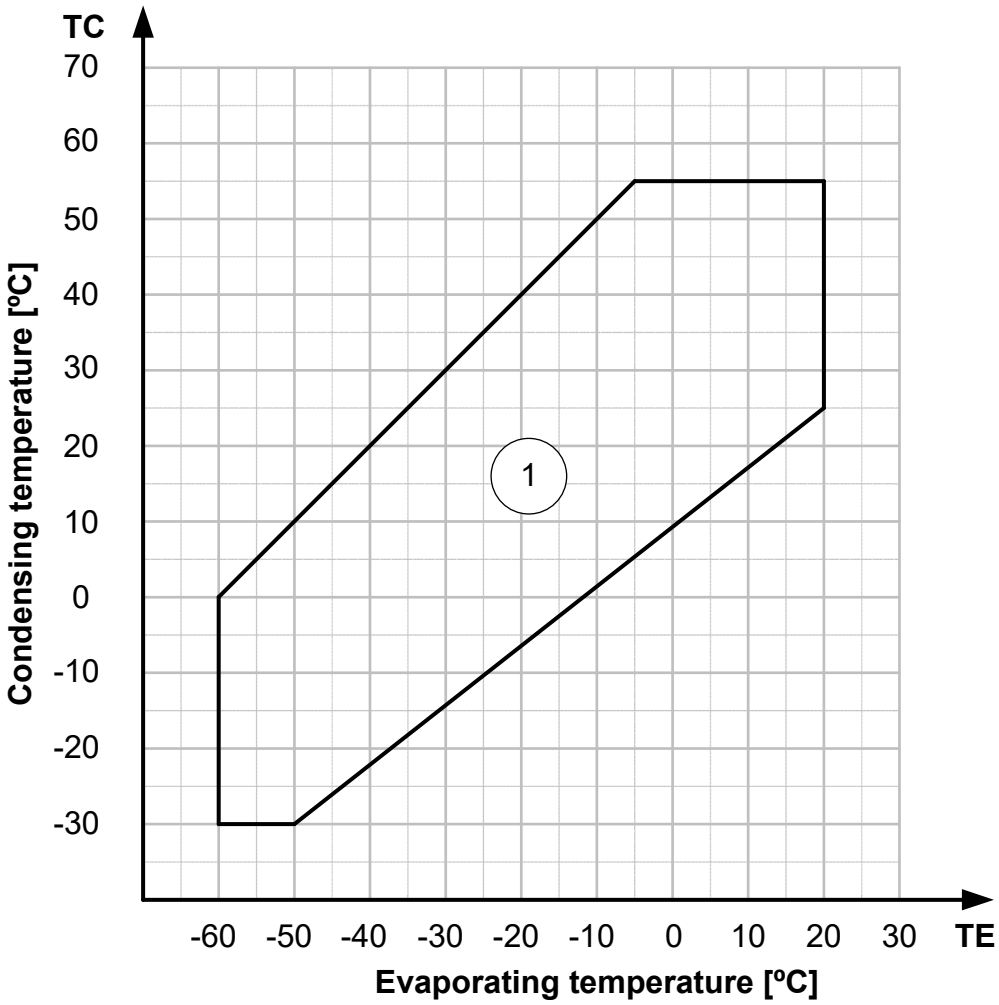


Code no.	Area no. 1
PAG 1515-100	Δ □

Δ Very suitable for new plants
□ Soluble and miscible

3.10 Refrigerant R1270

R1270 - single-stage reciprocating compressor



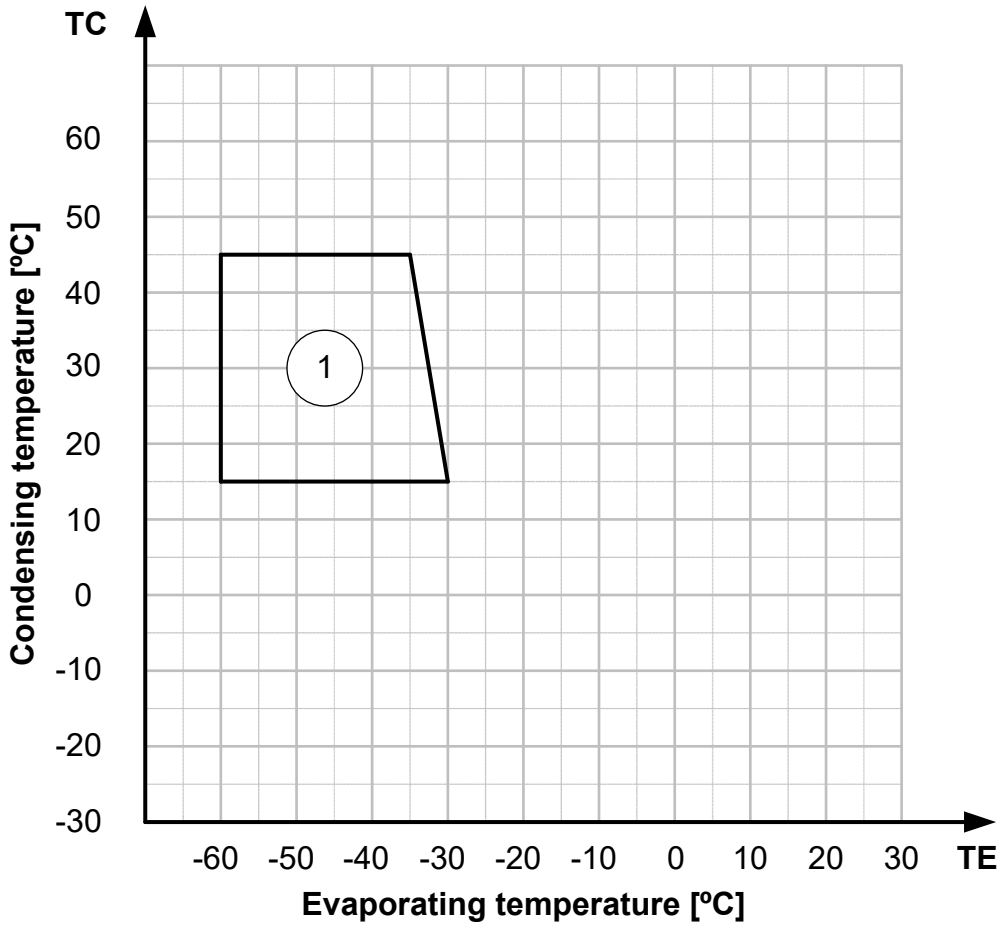
Code no.	Area no. 1
PAG 1507-100	Δ ●

Δ Very suitable for new plants
● Non-soluble and non-miscible

Note: Elastomer: Viton is recommended.

Note: For R1270 in refrigeration plants: use PAO 100 (soluble and miscible with R1270).

R1270 - two-stage reciprocating compressor



Code no.	Area no. 1
PAG 1507-100	Δ ●

Δ Very suitable for new plants
● Non-soluble and non-miscible

Note: Elastomer: Viton is recommended.

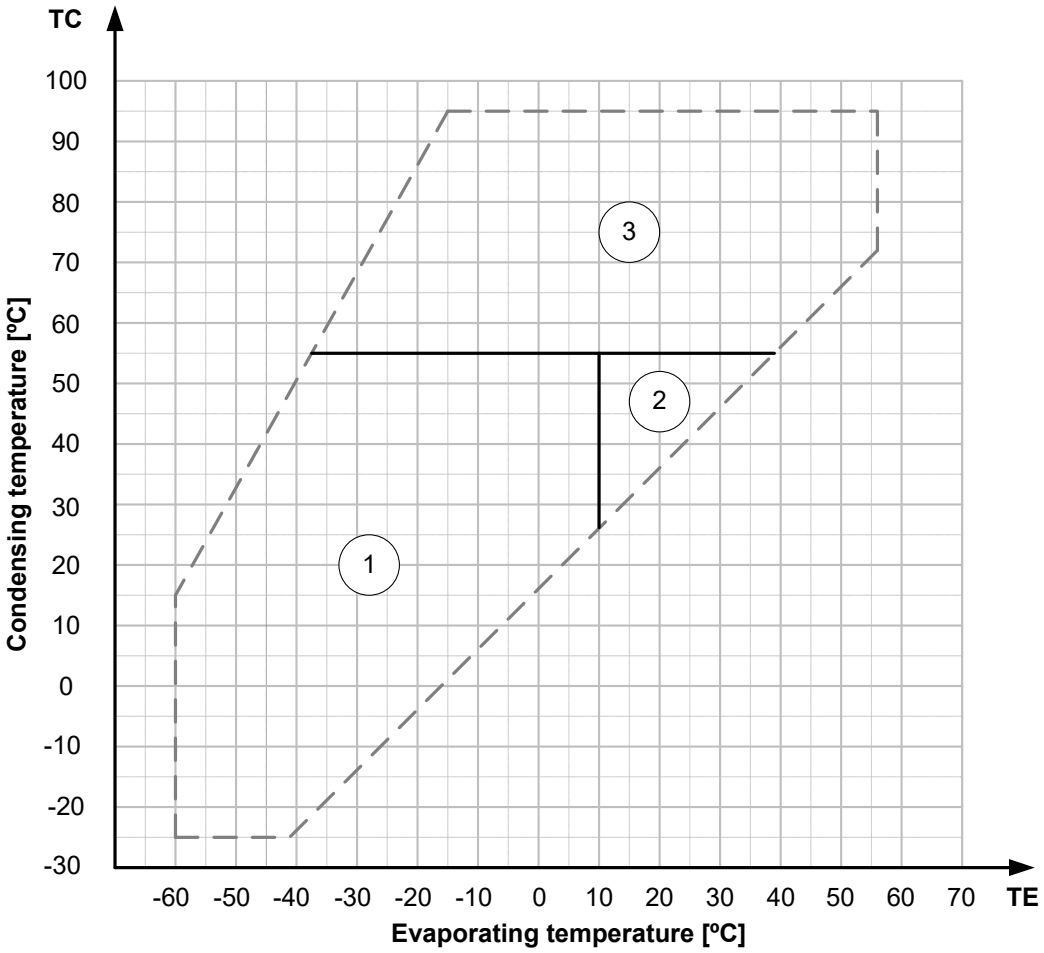
Note: For R1270 in refrigeration plants, use PAO 100 (soluble and miscible with R1270).

4. Diagrams for screw compressors

Note: The *oil recommendation diagrams* in the following are guidelines only.
The exact recommendations can be found in the Engineering manual for each compressor type and in COMP1/Coolware.

4.1 Refrigerant R717 (ammonia)

R717 - screw compressors with roller bearings only



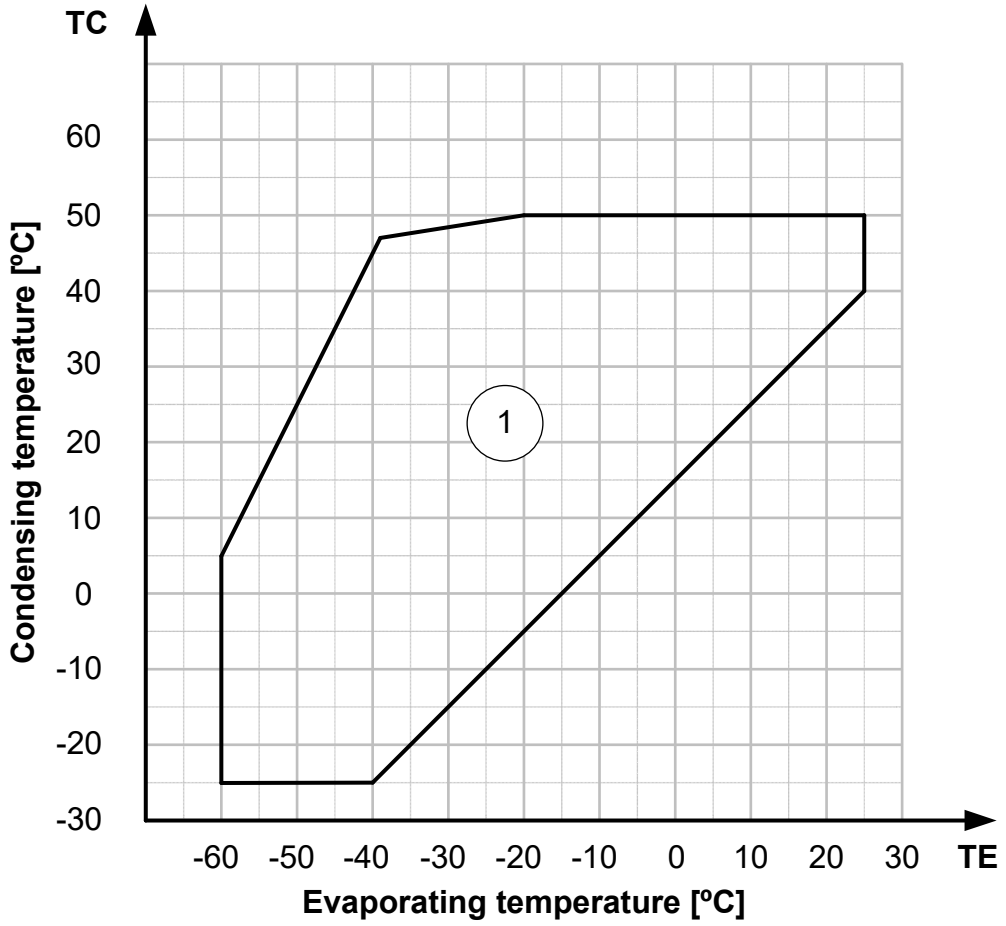
Code no.	Area no. 1	Area no. 2	Area no. 3
Temperature	T_{oil} < 70°C	T_{oil} < 85°C	T_{oil} < 105°C
PAO 68	Δ ●		
S 68	Δ Θ ●		
PAO 100		Δ ● ◊	
PAO 220			Δ ● ◊
AN G220A			Δ ● ◊

The diagram is only valid for oil selection.

Δ Very suitable for new plants
Θ If wishing to change from naphtenic mineral oil
● Non-soluble and non-miscible
◊ Diluted oil viscosity needs to be checked, see *2.9 Solubility of refrigerant gas into oil*.

4.2 Refrigerant R407C

R407C - screw compressors with roller bearings only

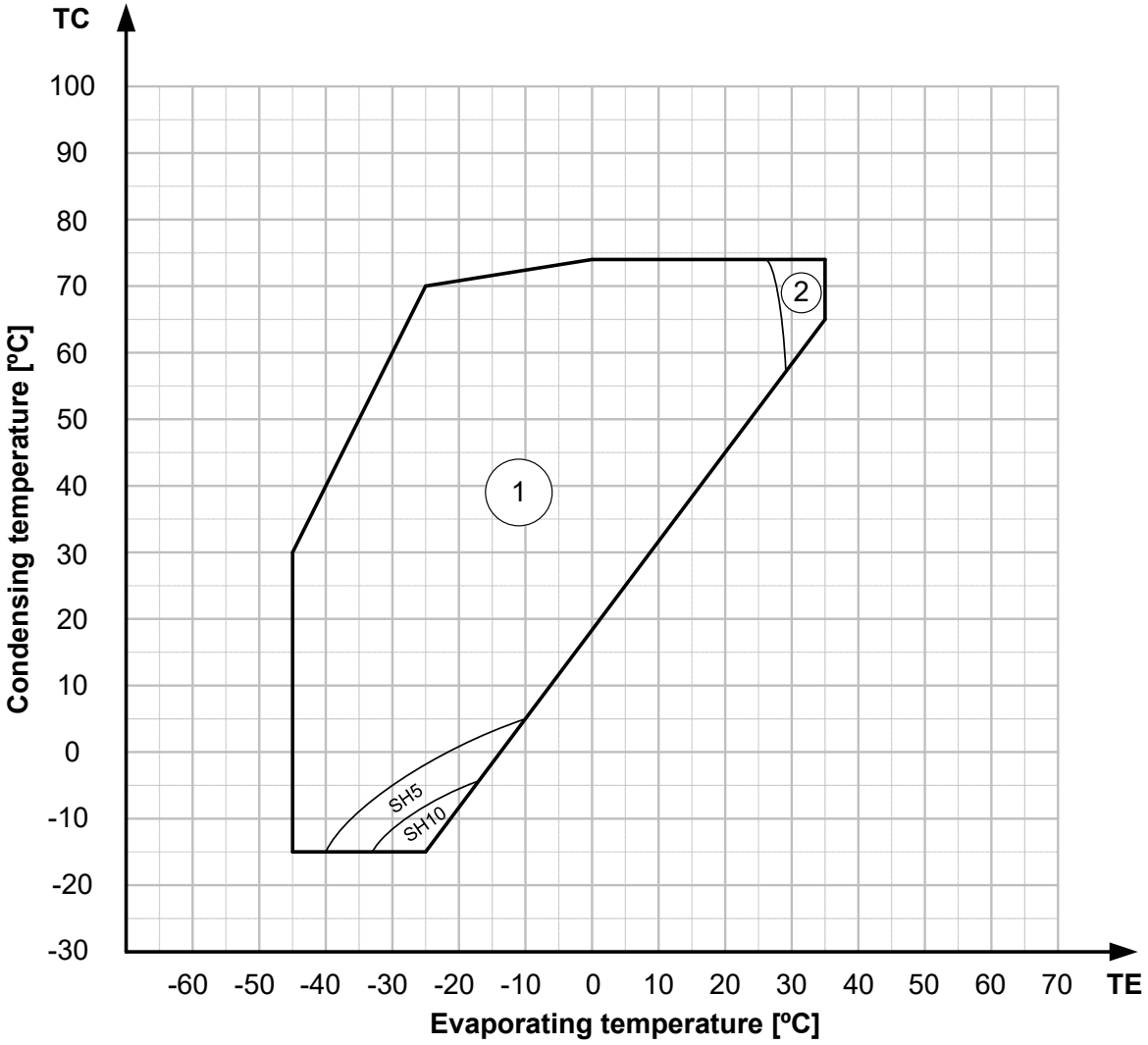


Code no.	Area no. 1
POE 68	Δ □

Δ Very suitable for new plants
SH Suction gas superheat, K (Kelvin)
□ Soluble and miscible

4.3 Refrigerant R134a

R134a - screw compressors with roller bearings only

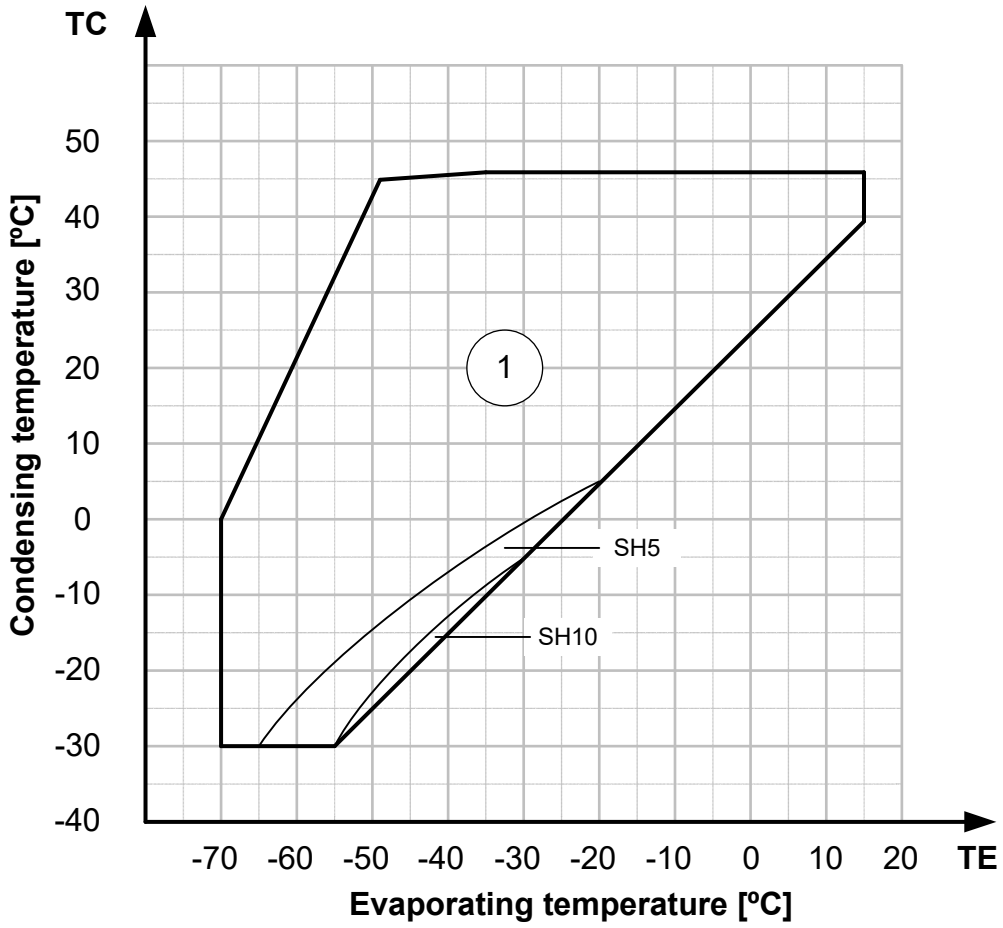


Code no.	Area no. 1	Area no. 2
POE 100	Δ □	
POE 220		Δ □

Δ Very suitable for new plants
SH Suction gas superheat, K (Kelvin)
□ Soluble and miscible

4.4 Refrigerant R404A

R404A - screw compressors with roller bearings only

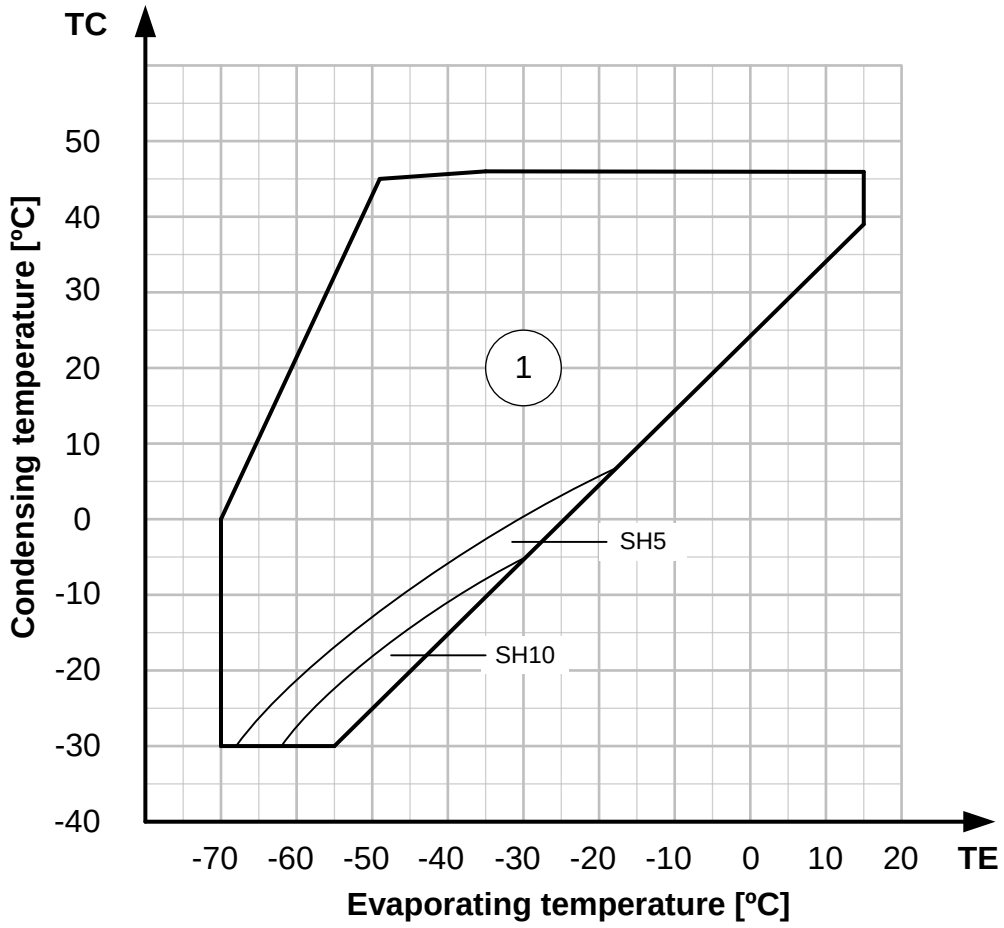


Code no.	Area no. 1
POE 68	Δ □

Δ Very suitable for new plants
SH Suction gas superheat, K (Kelvin)
□ Soluble and miscible

4.5 Refrigerant R507

R507 - screw compressors with roller bearings only

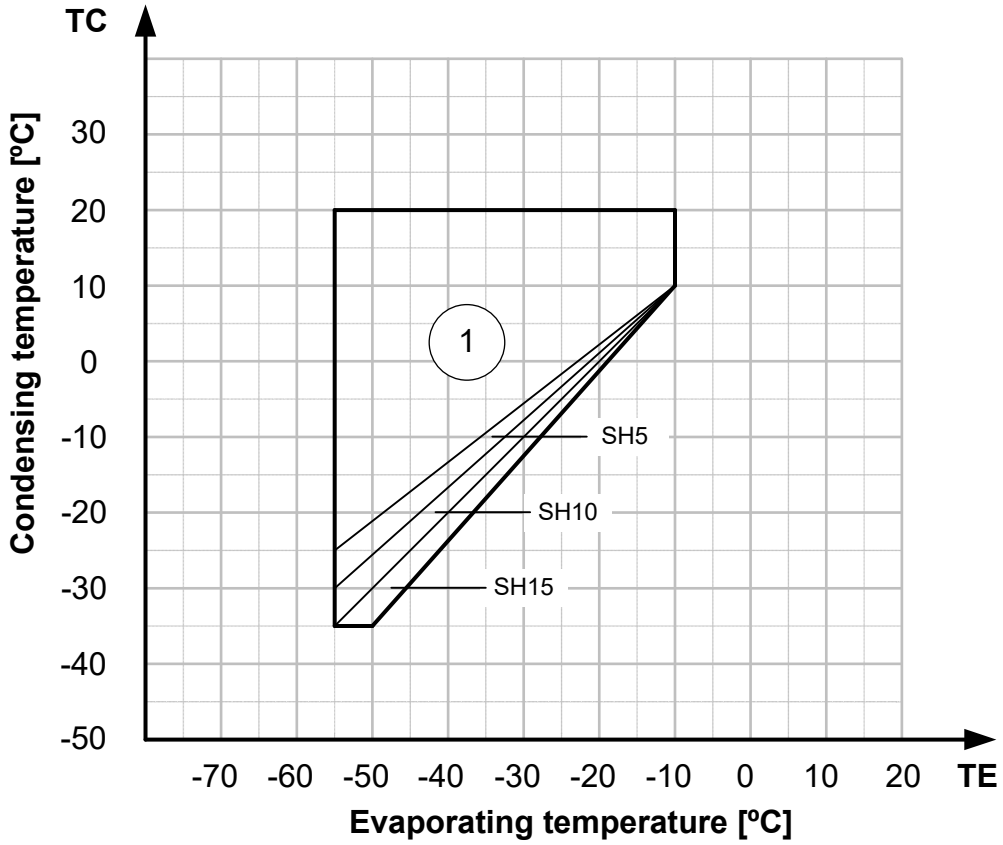


Code no.	Area no. 1
POE 100	Δ □

Δ Very suitable for new plants
SH Suction gas superheat, K (Kelvin)
□ Soluble and miscible

4.6 Refrigerant R744 (CO_2)

R744 - screw compressors with roller bearings only



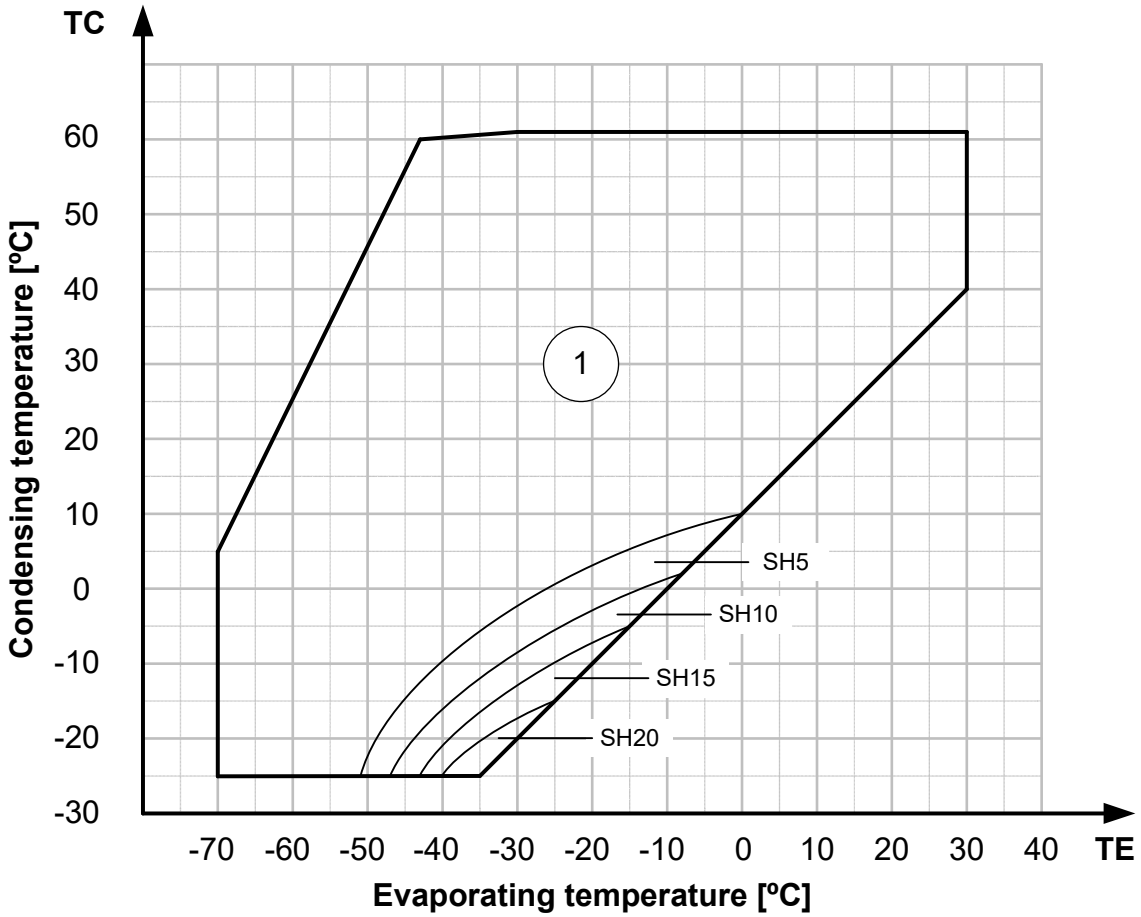
Code no.	Area no. 1
PAG RFL-68-EP	Δ □

Δ Very suitable for new plants
SH Suction gas superheat, K (Kelvin)
□ Soluble and miscible

Note: For R744 gas transport, use PAO 68 (non-soluble and non-miscible with R744).

4.7 Refrigerant R290

R290 - screw compressors with roller bearings only

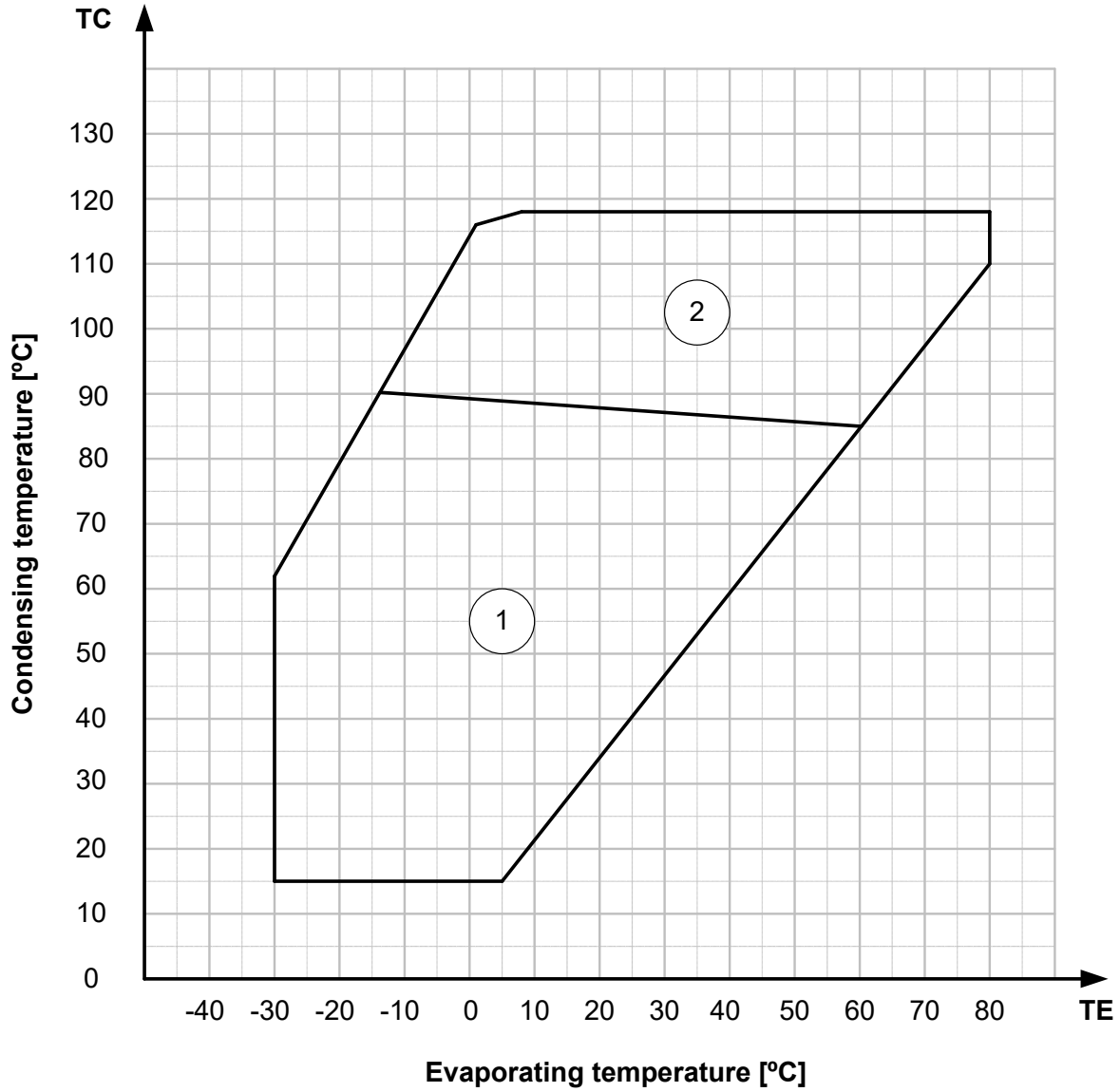


Code no.	Area no. 1
PAG 1515-100	Δ □

Δ Very suitable for new plants
SH Suction gas superheat, K (Kelvin)
□ Soluble and miscible

4.8 Refrigerant R600

R600 - screw compressors with roller bearings only

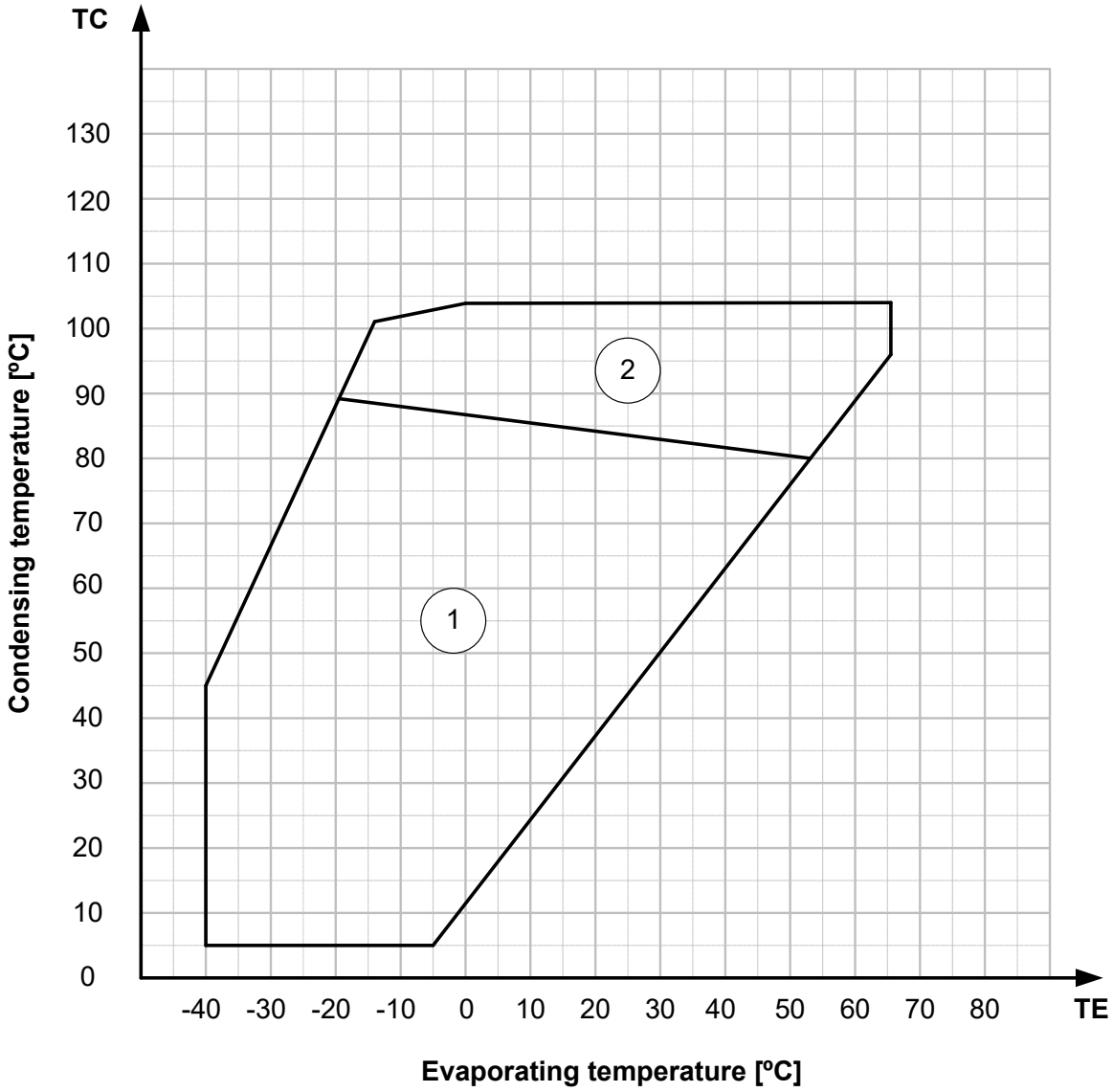


Code no.	Area no. 1	Area no. 2
PAG 1515-100	Δ □	
PAG 1515-150		Δ □

Δ Very suitable for new plants
□ Soluble and miscible

4.9 Refrigerant R600a

R600a - screw compressors with roller bearings only

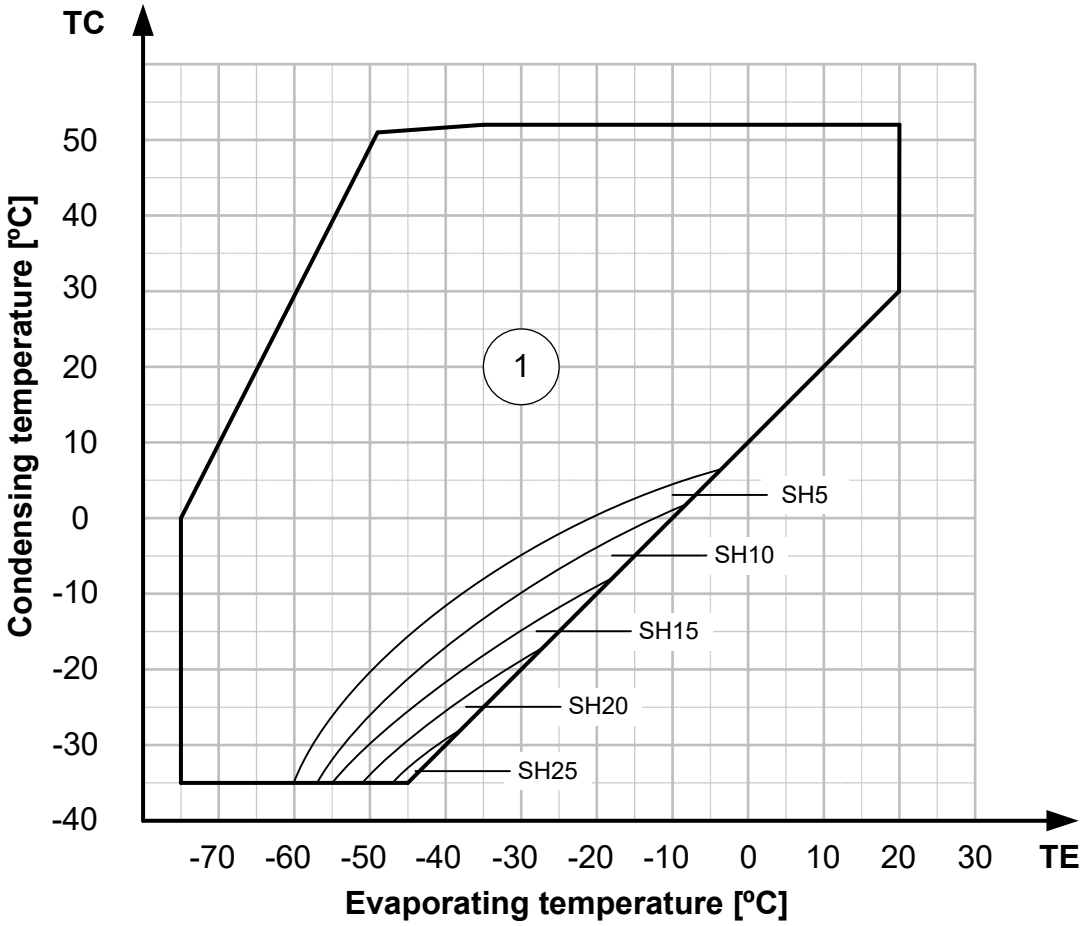


Code no.	Area no. 1	Area no. 2
PAG 1515-100	Δ □	
PAG 1515-150		Δ □

Δ Very suitable for new plants
□ Soluble and miscible

4.10 Refrigerant R1270

R1270 - screw compressors with roller bearings only



Code no.	Area no. 1
PAG 1507-100	Δ ●

Note: Elastomer: Viton is recommended.

Δ Very suitable for new plants
SH Suction gas superheat, K (Kelvin)
● Non-soluble and non-miscible

Note: for R1270 in refrigeration plants: use PAO 100 (soluble and miscible with R1270).

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Version 2