

Sabroe oil recommendation

- Selecting lubricating oil for Sabroe compressors



Oil recommendation

Contents

1. Introduction to oil recommendation	3
1.1.1 Introduction to oil recommendation	3
1.1.2 Safety precautions definitions used in this manual	4
2. Selecting lubricating oil for Sabroe compressors	5
2.1.1 Recommended compressor oils	5
2.1.2 Oil types and oil companies	5
2.1.3 Selecting recommended compressor oils	6
2.1.4 Selecting oils from other oil companies	6
2.1.5 Charging Sabroe compressors with oil	7
2.1.6 Oil replacement intervals	7
2.1.7 Oil condemning limits	7
2.1.8 Changing oil type or brand on Sabroe compressors	8
2.1.9 Stratification of oil in liquid refrigerant (miscibility)	8
2.1.10 Use of mineral oil	8
2.1.11 Recommended compressor oils – part numbers	9
2.1.12 Recommended compressor oils - properties	10
2.1.13 Qualitative properties for compressor oils	11
2.1.14 Condemning limits for compressor oils	12
3. Diagrams for reciprocating compressors	13
3.1.1 Refrigerant R717	13
3.1.2 Refrigerant R22	16
3.1.3 Refrigerant R23	18
3.1.4 Refrigerant R134a	19
3.1.5 Refrigerant R404A	21
3.1.6 Refrigerant R407C	23
3.1.7 Refrigerant R410A	25
3.1.8 Refrigerant R507	26
3.1.9 Refrigerant R744	28
3.1.10 Refrigerant R290	29
3.1.11 Refrigerant R600	31
3.1.12 Refrigerant R600a	33
3.1.13 Refrigerant R1270	35
4. Diagrams for screw compressors	37
4.1.1 Refrigerant R717	37
4.1.2 Refrigerant R22	38

4.1.3 Refrigerant R407C	40
4.1.4 Refrigerant R23	42
4.1.5 Refrigerant R134a	43
4.1.6 Refrigerant R404A	45
4.1.7 Refrigerant R410A	47
4.1.8 Refrigerant R507	48
4.1.9 Refrigerant R290	50
4.1.10 Refrigerant R600	51
4.1.11 Refrigerant R600a	52
4.1.12 Refrigerant R1270	53

1. Introduction to oil recommendation

1.1.1 Introduction to oil recommendation

The purpose of this manual is to describe:

- How to select compressor oil
- Why to select recommended compressor oil
- Technical data for recommended compressor oils
- Part numbers for recommended compressor oils
- Scheduled maintenance tasks regarding compressor oil

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

- It is important that the operating personnel and the technical decision makers familiarize themselves with the contents of 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.

This manual does not describe:

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

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

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1.1.2 Safety precautions 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, etc. or portion thereof which is essential to highlight.

2. Selecting lubricating oil for Sabroe compressors

2.1.1 Recommended compressor oils

We have manufactured Sabroe compressors for all types of applications and refrigerants for more than 100 years.

Continuous research backed by 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 we recommend addresses the specific compressor and system requirements and our rigid specifications and quality control ensure that all the oils are produced to the highest quality standards for premium performance and durability.

By maintaining high standards of quality and product excellence, the recommended compressor oils have won approval 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

2.1.2 Oil types and oil companies

Due to the large number of oil companies worldwide dealing in oil for refrigeration plants, it is impossible for us to test all the different oil brands on the market.

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

We therefore only recommend using the specific oils listed in the following pages. They have all been developed in cooperation with a few recognised oil companies and are under continuous testing and 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



2.1.3 Selecting recommended compressor oils

There is a number of diagrams (listed at the end of this recommendation) for the selection of lubricating oils for Sabroe compressors operating with various refrigerants.

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

The part numbers for the recommended compressor oils are listed in section 2.1.11.

On plants comprising several different interconnected compressor types and makes, all 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 Johnson Controls Denmark.

2.1.4 Selecting oils from other oil companies

Caution!

Using oils other than the ones recommended for Sabroe compressors may cause oil related warranty claims to be rejected.

Note: As we have not tested any other oils than the ones listed in this recommendation, we cannot answer for the quality, the stability or the suitability of such oils. When selecting an oil not recommended in this oil recommendation, the supplying oil company in question has the sole responsibility for the quality and suitability of the "other oil" and in case of any problems with such "other oils" in the compressor or in the refrigeration plant, the oil supplier must be contacted directly.

If, however, you do select a lubricating oil from another oil company, please pay attention to the oil performance in the compressor as well as in the refrigeration plant as a whole.

Pay particular attention to the following aspects:

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 to 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.

2.1.5 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.

It is imperative to use oil from the original container only.

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

If you only use part of the oil, make sure that it is properly re-sealed in the original container and stored 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.

2.1.6 Oil replacement intervals

The oil replacement intervals are determined by oil analysis results. The specific intervals for making oil samples can be found in the maintenance manual for your specific application.

In general we recommend to carry out oil analyses after:

- The first 1000 hours of operation and
- Subsequently every 6 months.

This will provide a good indication of the compressor and plant condition and ensure continuous performance.

The part number for the Sabroe *Oil Analysis Kit* is listed in section 2.1.11.

The service of monitoring your compressor and plant by regular oil analyses can be provided by Johnson Controls Denmark.

2.1.7 Oil condemning limits

The oil condemning limits for compressor oils are listed in section 2.1.14. If a condemning limits parameter is exceeded, the oil must be replaced (or filtered, see section 2.1.14.) and the cause must be identified to ensure further safe operation.

There is a close relationship between the condemning limits and the service life of the bearings in the compressor.

Keeping the values well below the condemning limits will significantly increase the service life of your compressor (this particularly applies to compressors with ball or roller bearings).

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



Caution!

Pay particular 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 eg 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 the oil from absorbing water (eg during installation or service).

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

2.1.8 Changing oil type or brand on Sabroe compressors



Caution!

Changing from one type or brand of oil to another should only take place in connection with a careful procedure including thorough drainage of the plant (repeatedly, if necessary) and surveillance 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 concerning 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.

2.1.9 Stratification of oil in liquid refrigerant (miscibility)

It should be noted that in certain plants, particularly with HFC (and HCFC) refrigerants, the oil may stratify into layers in the refrigerant receivers and evaporators at certain operating conditions and oil concentrations.

The *Oil recommendation diagrams* for Sabroe compressors indicate the stratification limits for the recommended compressor oils.

The oil concentrations stated in these diagrams must not be exceeded, thus the oil return systems from the receivers and evaporators must be dimensioned according to the compressor unit oil carry over.

2.1.10 Use of mineral oil



Caution!

Previously we have experienced a number of problems with naphthenic based mineral oils, particularly in R717 plants.

We therefore no longer recommend naphthenic based mineral oil for Sabroe compressors.

The problems 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 the compressor oil decomposing which may result in compressor and/or plant failure.

We are however aware that several customers have been using naphtenic based mineral oil for many years without problems. Customers who wish to continue using naphtenic based mineral oils in existing compressors can do so.

If you are using naphtenic based mineral oil, it is important that the plant is monitored very closely, that oil samples are taken regularly (every 1-2000 hours) and that the condition/ colour of the oil is checked on a weekly basis.

2.1.11 Recommended compressor oils – part numbers

Oil brand	Oil code	Application (1)	Part no.	
		Refrigerant	20 litre	208 litre
Mobil Gargoyle Arctic 300	M 68	(R717)(2)	1231-264	1231-296
Sabroe Oil A100	A 100	R22	1231-263	1231-262
Sabroe Oil AP68	AP 68	R717	1231-257	1231-260
Sabroe Oil S68 (6)	S 68	R717	1231-340	1231-341
Sabroe Oil PAO68 (5)	PAO 68	R717	1231-256	1231-259
Mobil Gargoyle Arctic SHC 228	PAO 100	R717, R22(3)	1231-282	1231-283
Mobil Gargoyle Arctic SHC 230	PAO 220	R717	1231-284	1231-285
CPI Solest LT32	POE LT32	R23	1231-320	1231-321
Mobil EAL Arctic 68	POE 68	R404A, R407C, R410A, R507	1231-272	1231-273
FUCHS Reniso C85E	POE C85E	R744	1231-304 (4)	-
Mobil EAL Arctic 100	POE 100	R134a, R404A, R407C, R410A, R507	1231-274	1231-275
Mobil EAL Arctic 220	POE 220	R134a, R404A, R407C, R410A, R507	-	1231-279
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
Refguard oil analysis kit	-	All	1231-250	

(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 is still available on request.

(3) R22 for evaporating temperatures above 0°C only

(4) 3 x 10 litre

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

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



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.



2.1.12 Recommended compressor oils - properties

Oil brand	Oil code	Viscosity			Spec. gravi-ty g/ml at 15°C	Flash point °C	Pour point °C	Anilin point °C	Acid no. mg KOH/ g
		cSt 40°C	cSt 100°C	Index					
Mobil Gargoyle Arctic 300	M 68	63	6	14	0.910	202	-36	81	0.02
Sabroe Oil A100	A 100	97	8	13	0.860	195	-33	78	0.05
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
Mobil Gargoyle Arctic SHC 228	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
CPI Solest LT32	POE LT32	33	6	112	0.965	192	-52	n/a	< 0,05
Mobil EAL Arctic 68	POE 68	68	8	96	0.971	251	-43	12	< 0,1
FUCHS Reniso C85E	POE C85E	81	11	116	9.993	246	-42	n/a	0.02
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
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
Oil code									
M	Mineral oil, naphthenic 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 (hydro treated mineral oil on paraffinic base)								
PAO	Synthetic oil based on poly-alpha-olefins								
POE	Synthetic oil based on polyol esters								
PAG	Synthetic oil based on polyalkylene glycols								

Caution!

Using oils other than the ones recommended for Sabroe compressors may cause oil related warranty claims to be rejected.

If selecting compressor oil from another oil company, please note that data equivalence to the above alone does not qualify the oil to be used in Sabroe compressors.

2.1.13 Qualitative properties for compressor oils

Oil code	Oil carry over (vapour)	Foaming tendency	Stability	Elasto vol. change	Viscosity index
M	High	High	Low	Swelling	Low
A	High	Medium	Medium	Swelling	Low
AP	Medium	Low	Medium	Neutral	Medium
S	Low	Medium	Medium	Neutral	Medium
PAO	Very low	Very low	High	Shrinking	High
POE	Low	Low	High	Swelling	Medium
PAG	Low	Low	High	-	High
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 (hydro treated mineral oil on paraffinic base)				
PAO	Synthetic oil based on poly-alpha-olefins				
POE	Synthetic oil based on polyol esters				
PAG	Synthetic oil based on polyalkylene glycols				

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

2.1.14 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	ppm	Karl Fisher	100
Water R744 plants	ppm	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
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			

Replace the oil if one parameter of the condemning limits above is exceeded.

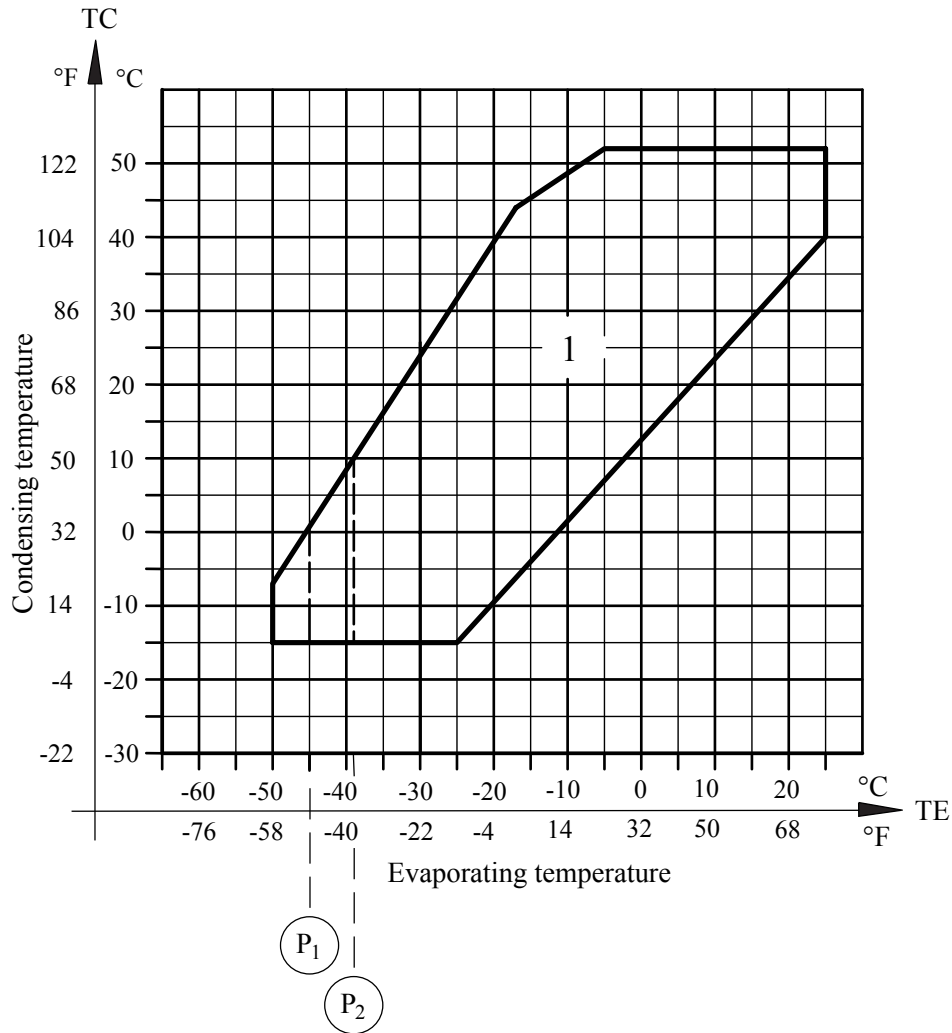
However, if only one or more ICP limits are exceeded, the oil can be filtered through an externally mounted 3 micron filter (closed system connected directly to the compressor to avoid exposing the oil to the atmosphere).

Note: The cause for increased values must always be identified.

3. Diagrams for reciprocating compressors

3.1.1 Refrigerant R717

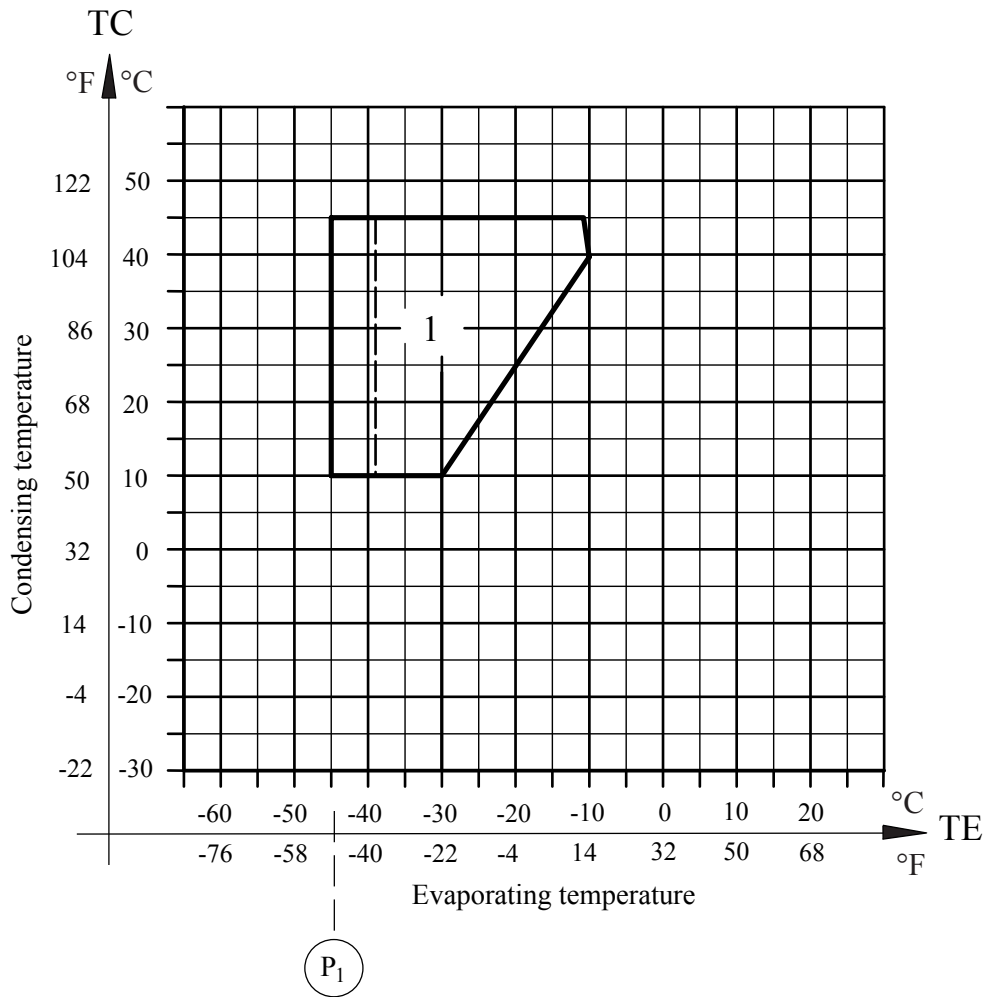
R717 single-stage reciprocating compressor



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

- Δ : Very suitable for new plants
- Θ : If wishing to change from naphtenic mineral oil
- : Non-soluble and non-miscible
- P₁ : Pour point PAO 68
- P₂ : Pour point S 68

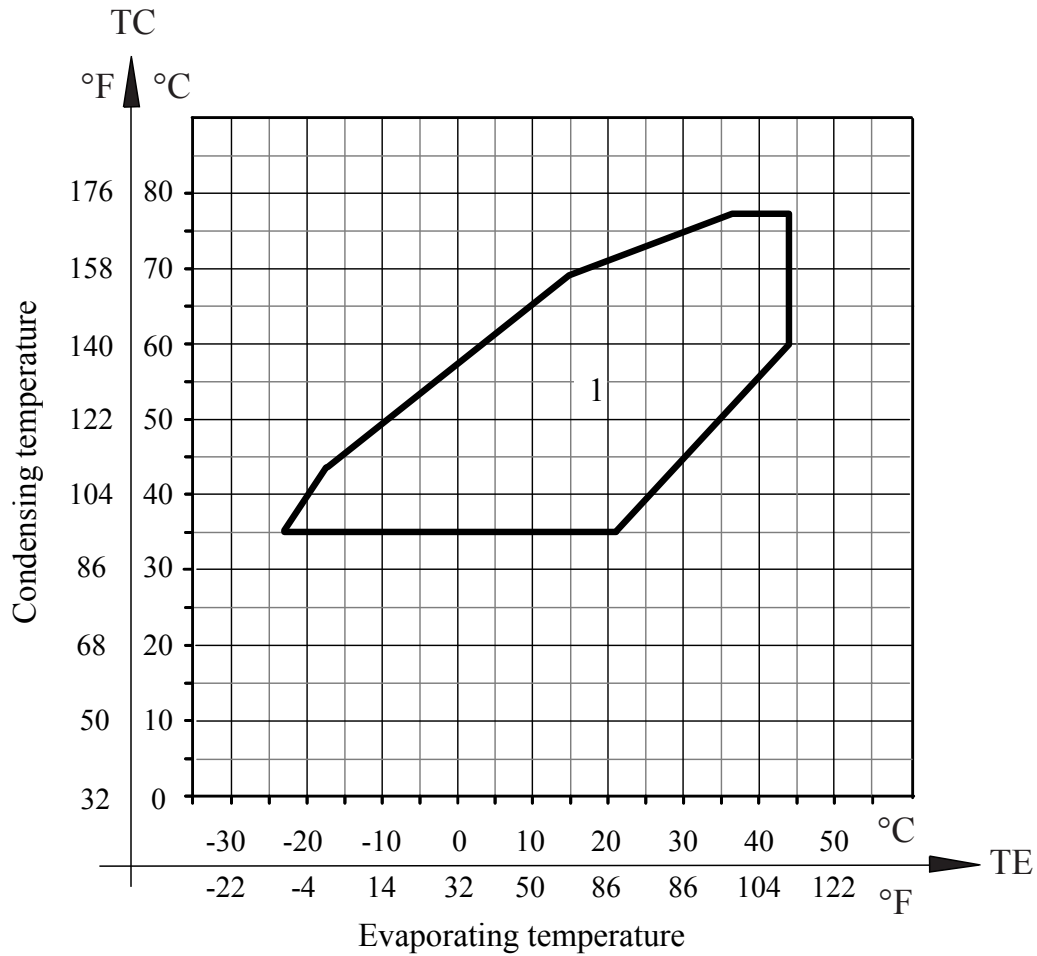
R717 two-stage reciprocating compressor



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

- Δ : Very suitable for new plants
- Θ : If wishing to change from naphthenic mineral oil
- : Non-soluble and non-miscible
- P₁ : Pour point PAO 68

R717 HPO and HPC reciprocating compressor



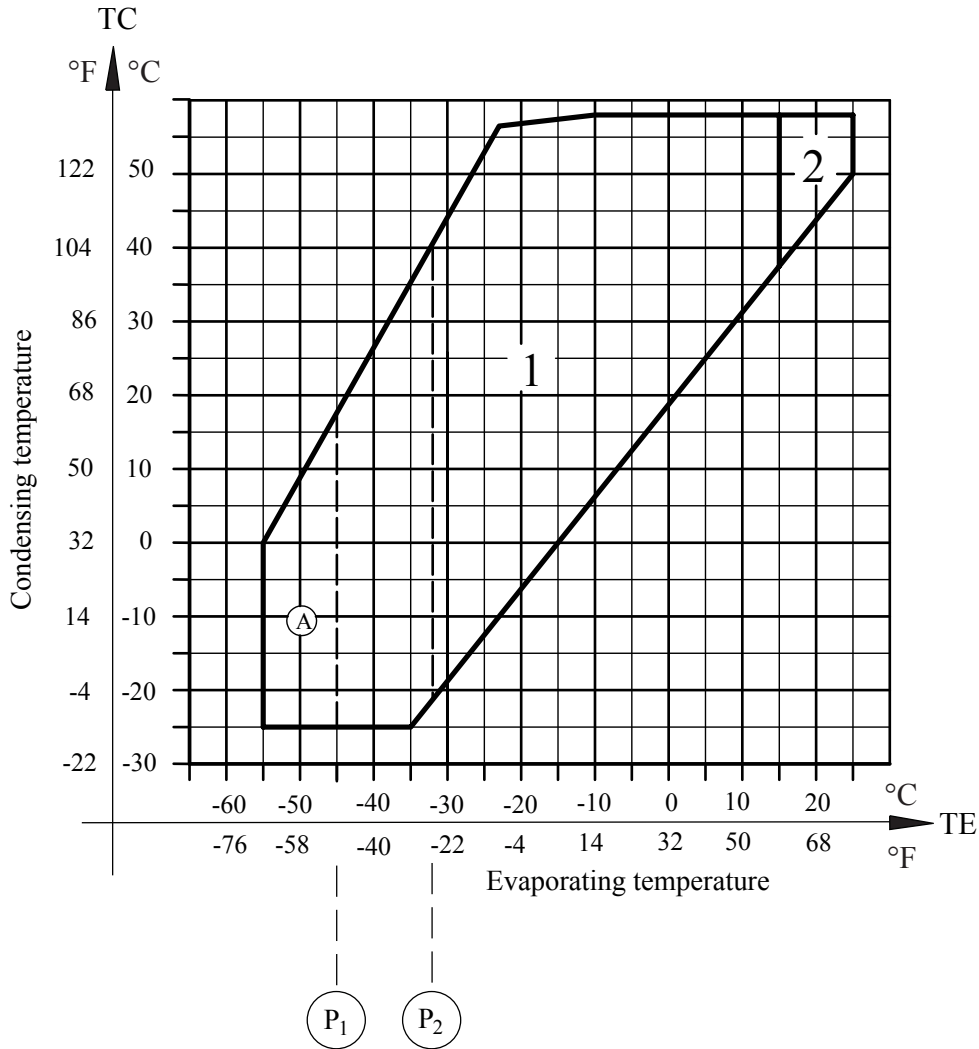
Code no.	Area no. 1
PAO 100	Δ •

Note: PAO 100 oil is the only oil which can be used in HPO and HPC compressors.

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

3.1.2 Refrigerant R22

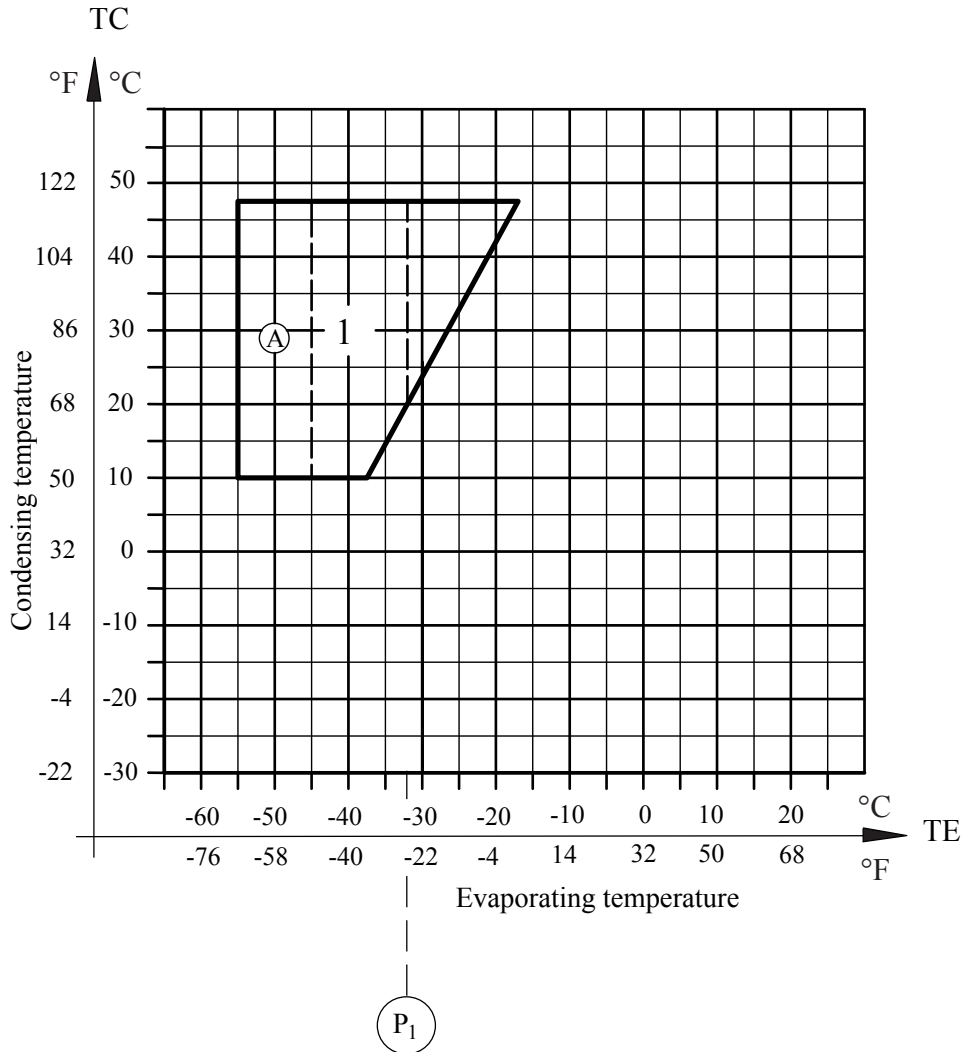
R22 single-stage reciprocating compressors



Code no.	Area no. 1	Area no. 2
A 100	Δ □	
PAO 100		Δ □

- Δ : Very suitable for new plants
- A : Max. oil concentration in liquid phase at TE: 2% W
- : Soluble and miscible
- P₁ : Pour point PAO 100
- P₂ : Pour point A 100

R22 two-stage reciprocating compressors

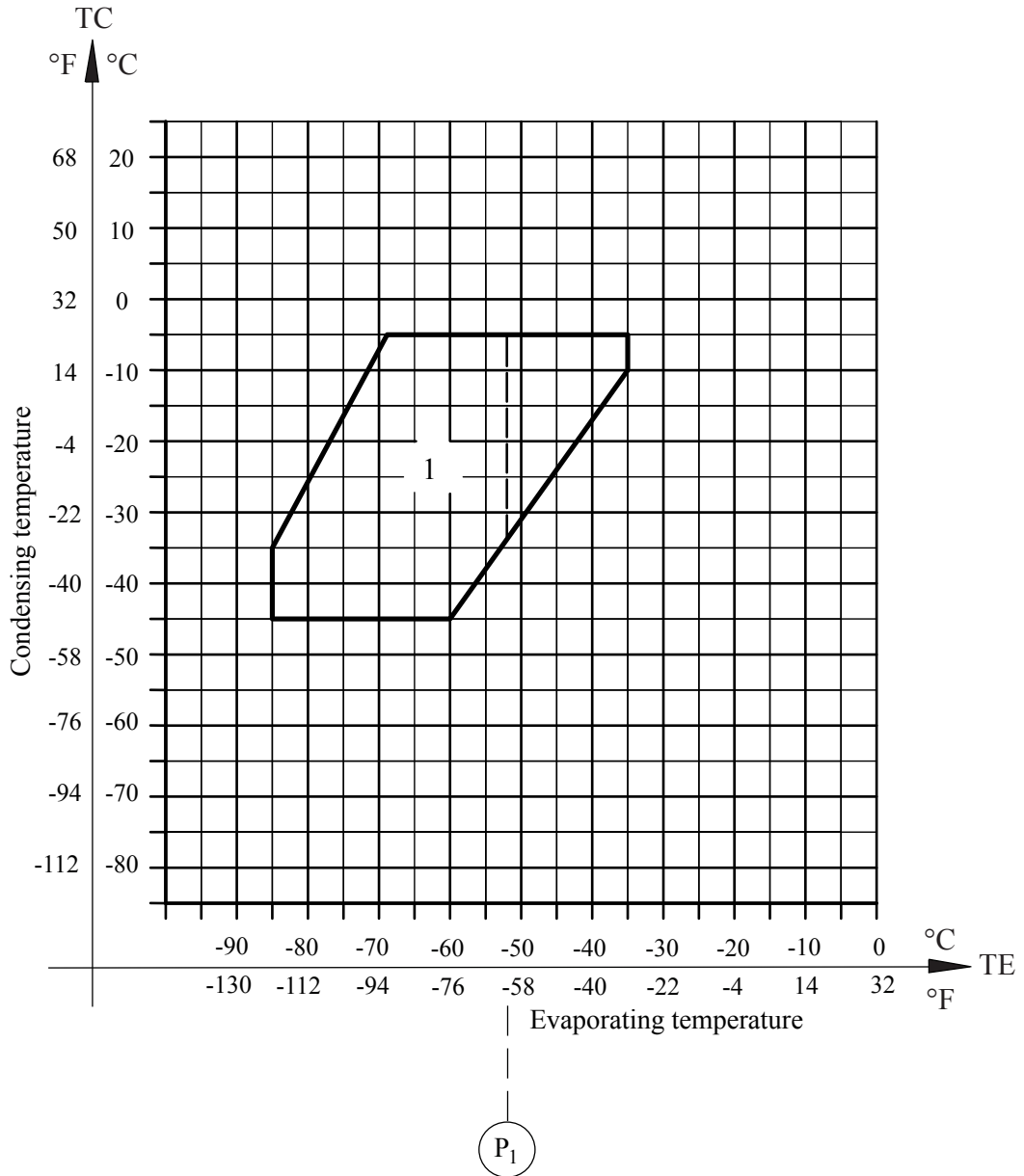


Code no.	Area no. 1
A 100	Δ □

- Δ : Very suitable for new plants
- A : Max. oil concentration in liquid phase at TE: 2% W
- : Soluble and miscible
- P₁ : Pour point A 100

3.1.3 Refrigerant R23

R23 single-stage reciprocating compressors

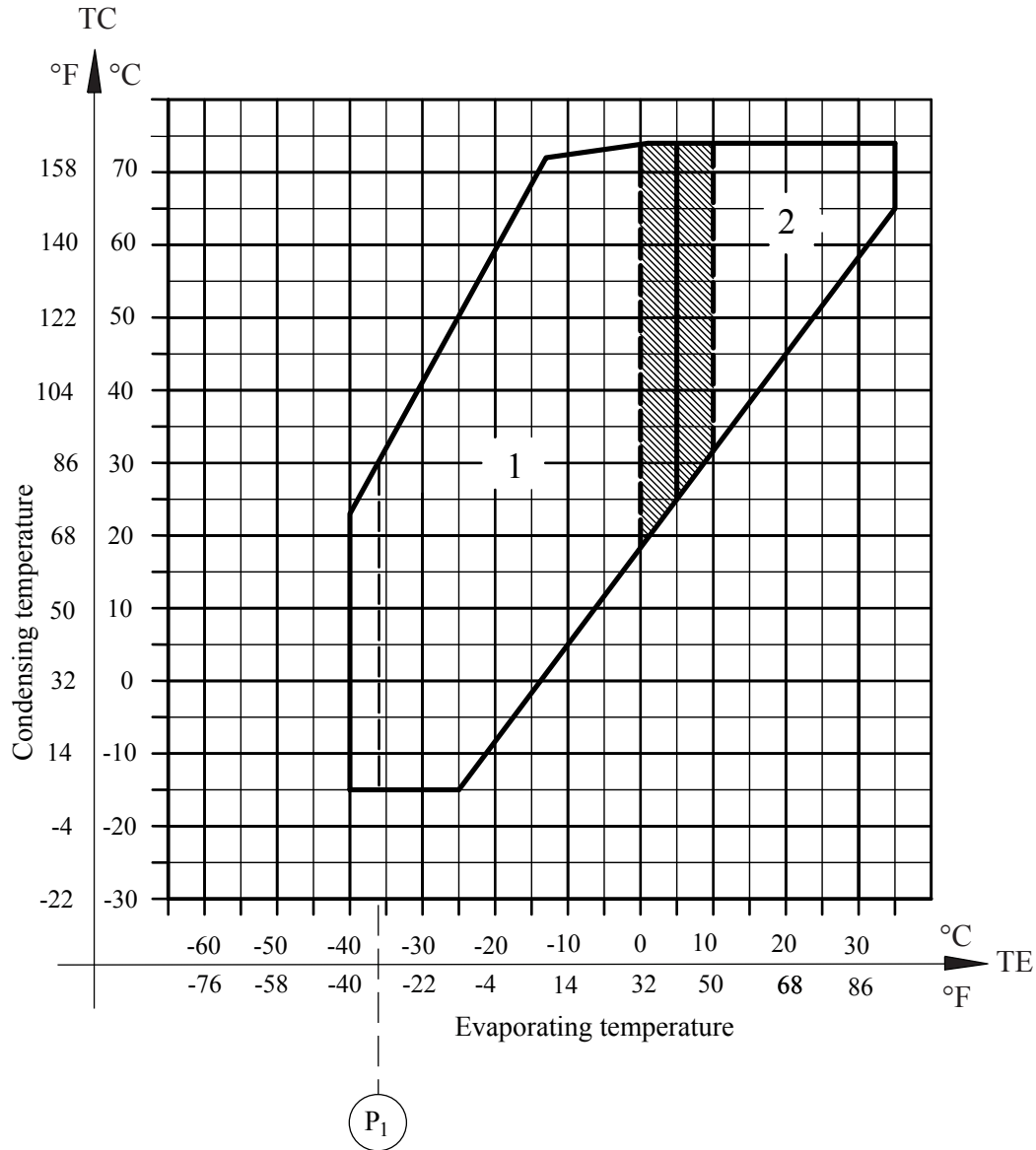


Code no.	Area no. 1
POE LT32	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible
- P₁ : Pour point POE LT32

3.1.4 Refrigerant R134a

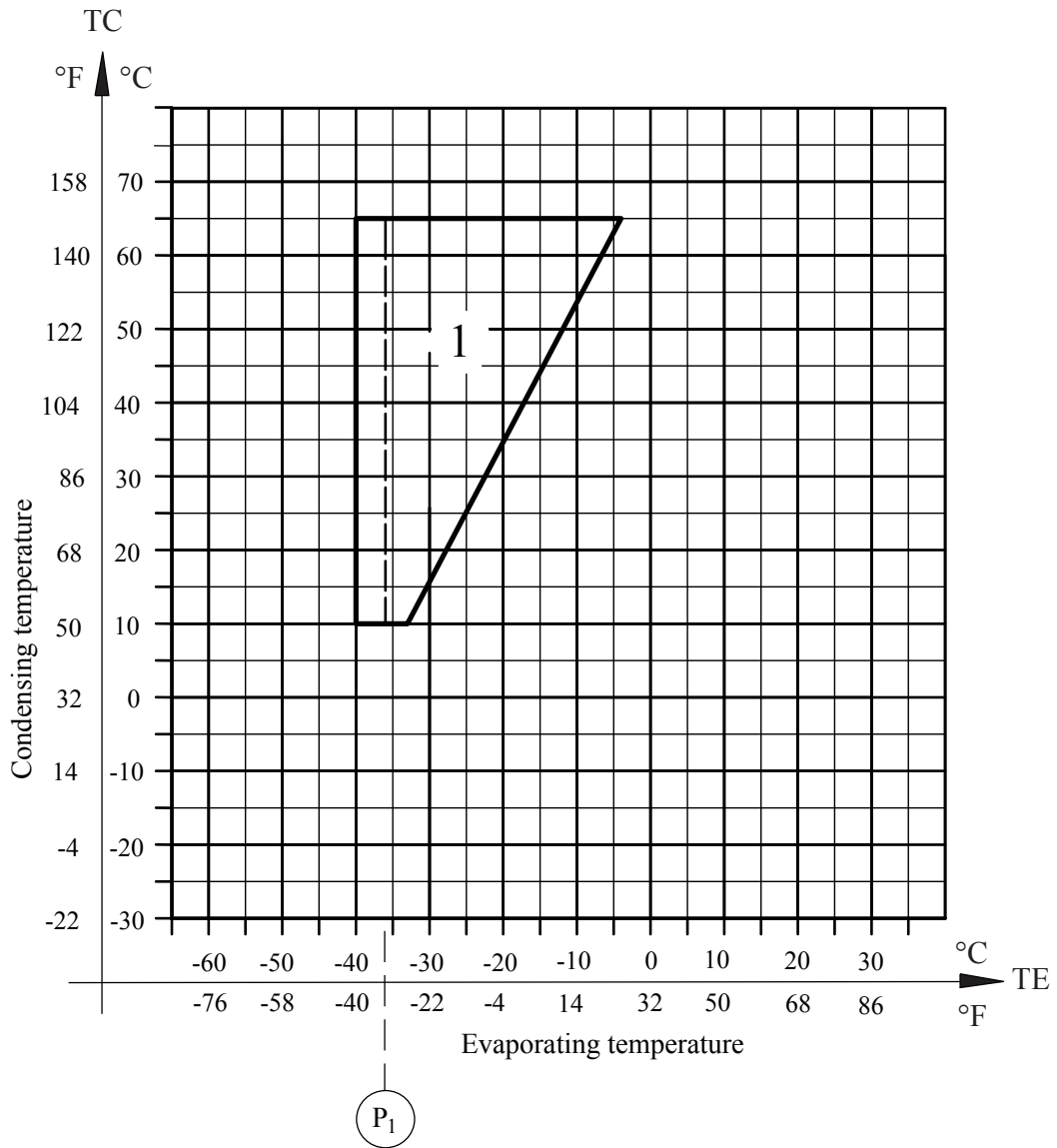
R134a single-stage reciprocating compressors



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
- P₁ : Pour point POE 100

R134a two-stage reciprocating compressors

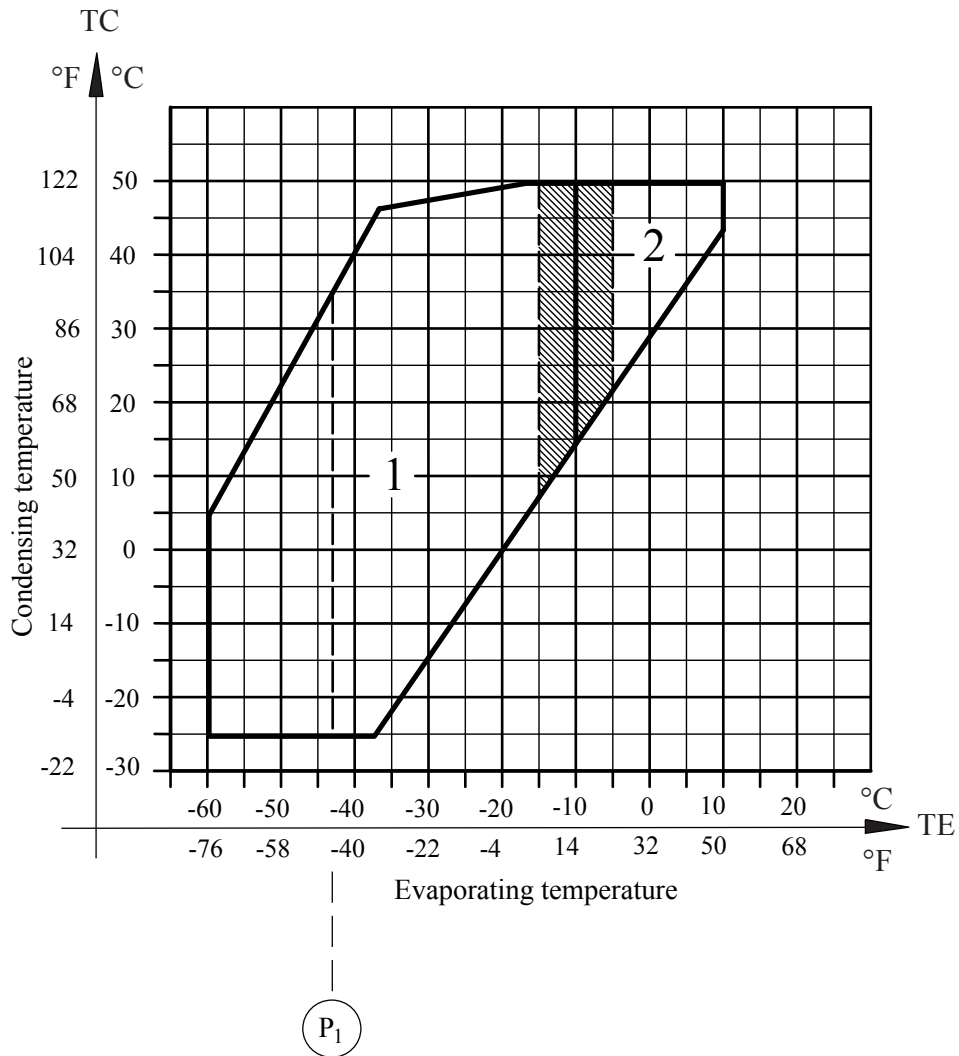


Code no.	Area no. 1
POE 100	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible
- P₁ : Pour point POE 100

3.1.5 Refrigerant R404A

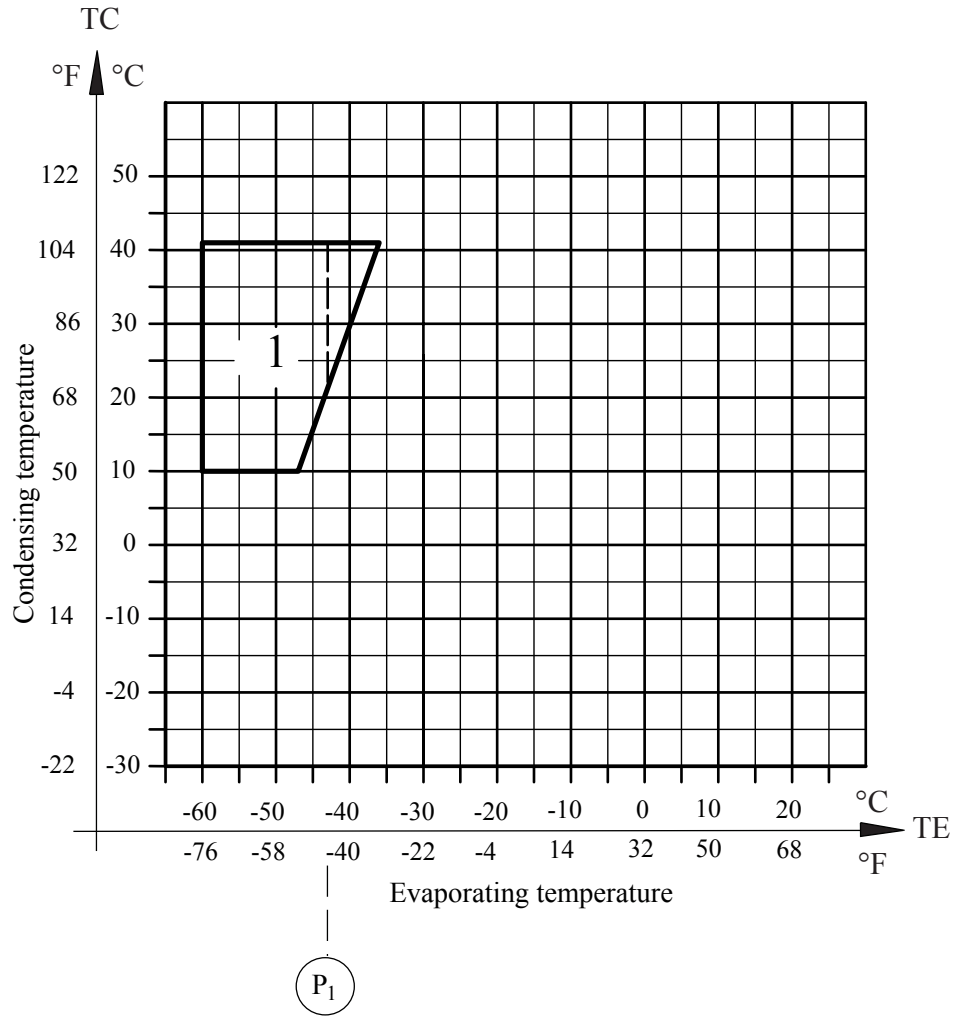
R404A single-stage reciprocating compressors



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
- P₁ : Pour point POE 68

R404A two-stage reciprocating compressors

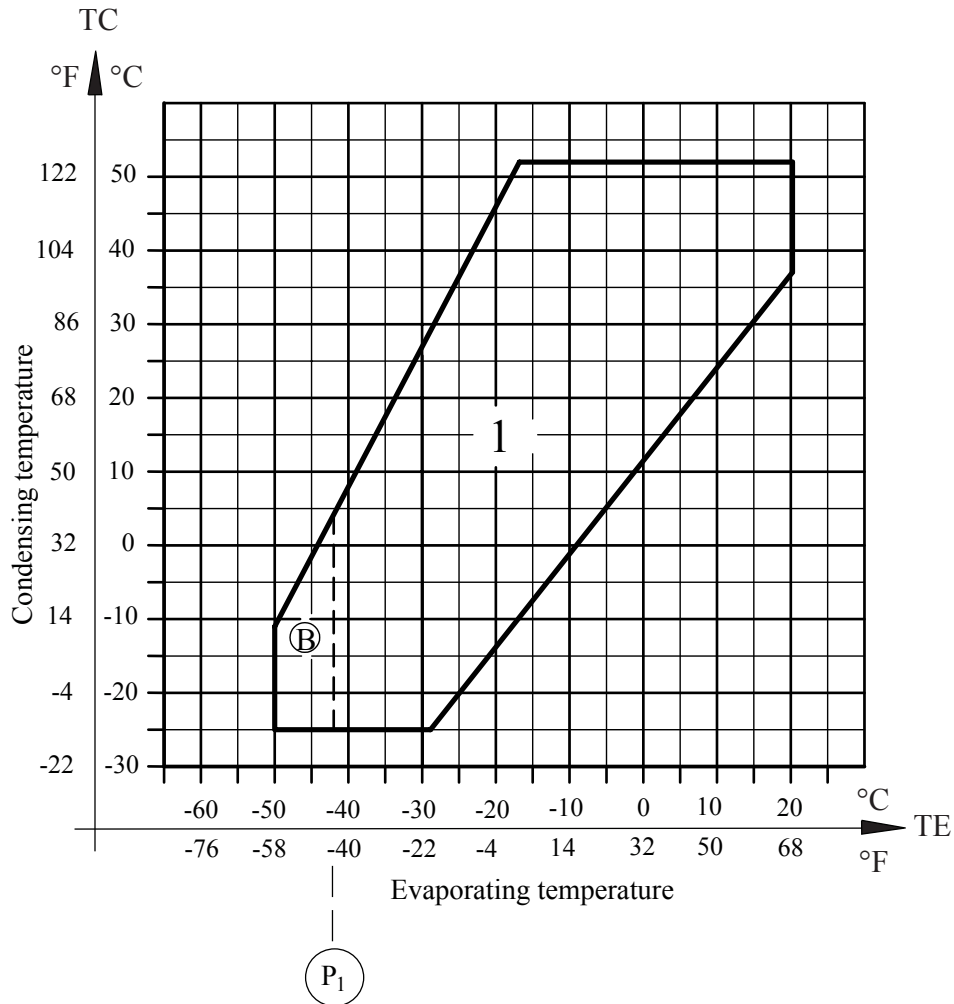


Code no.	Area no. 1
POE 68	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible
- P₁ : Pour point POE 68

3.1.6 Refrigerant R407C

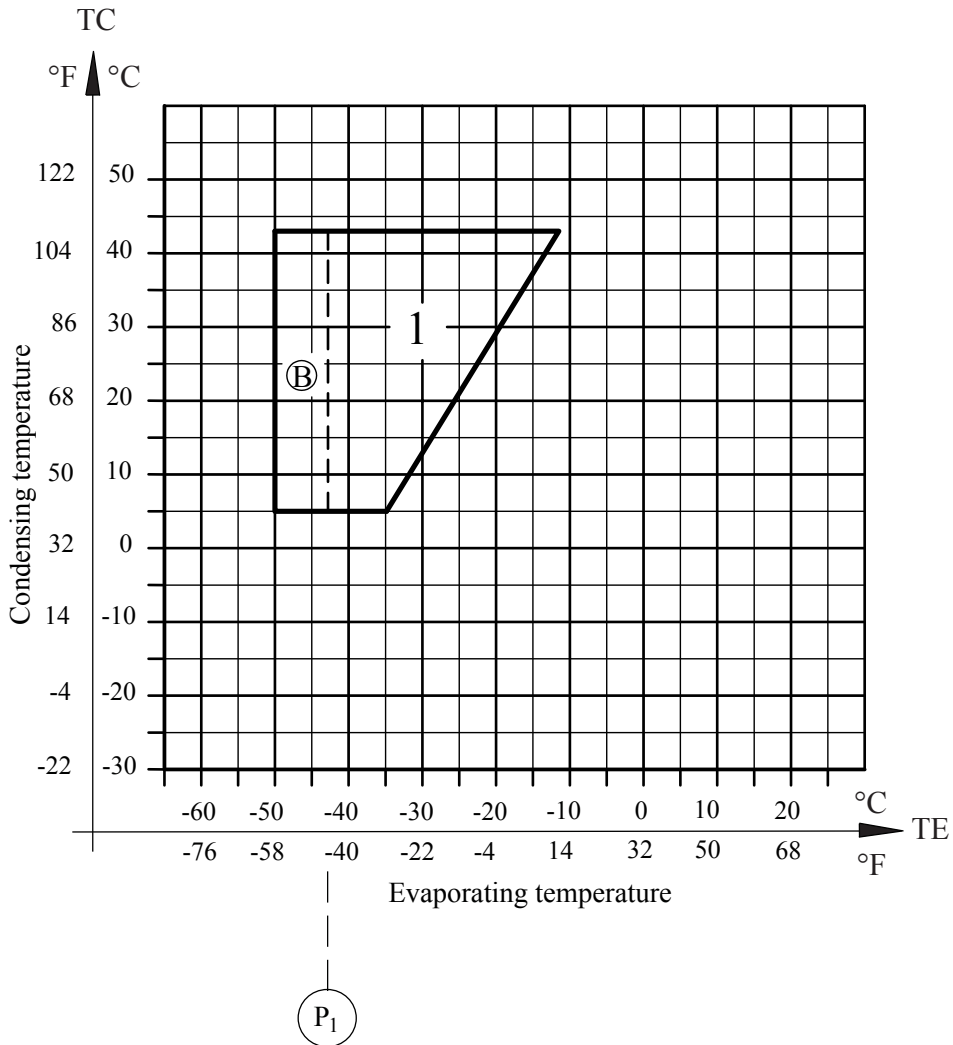
R407C single-stage reciprocating compressor



Code no.	Area no. 1
POE 68	Δ □

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- : Soluble and miscible
- P₁ : Pour point POE 68

R407C two-stage reciprocating compressors

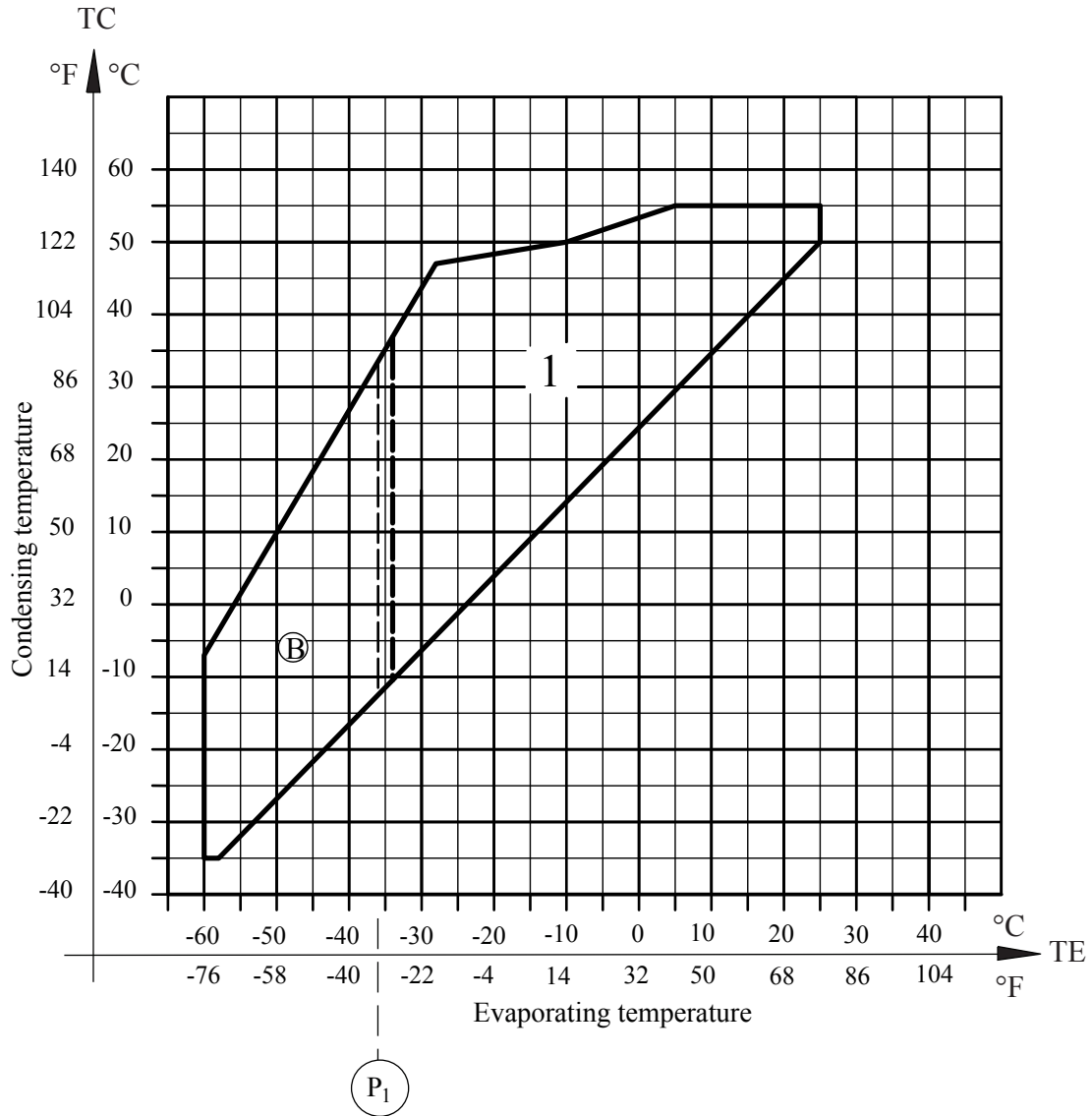


Code no.	Area no. 1
POE 68	Δ □

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- : Soluble and miscible
- P₁ : Pour point POE 68

3.1.7 Refrigerant R410A

R410A HPO and HPC reciprocating compressors

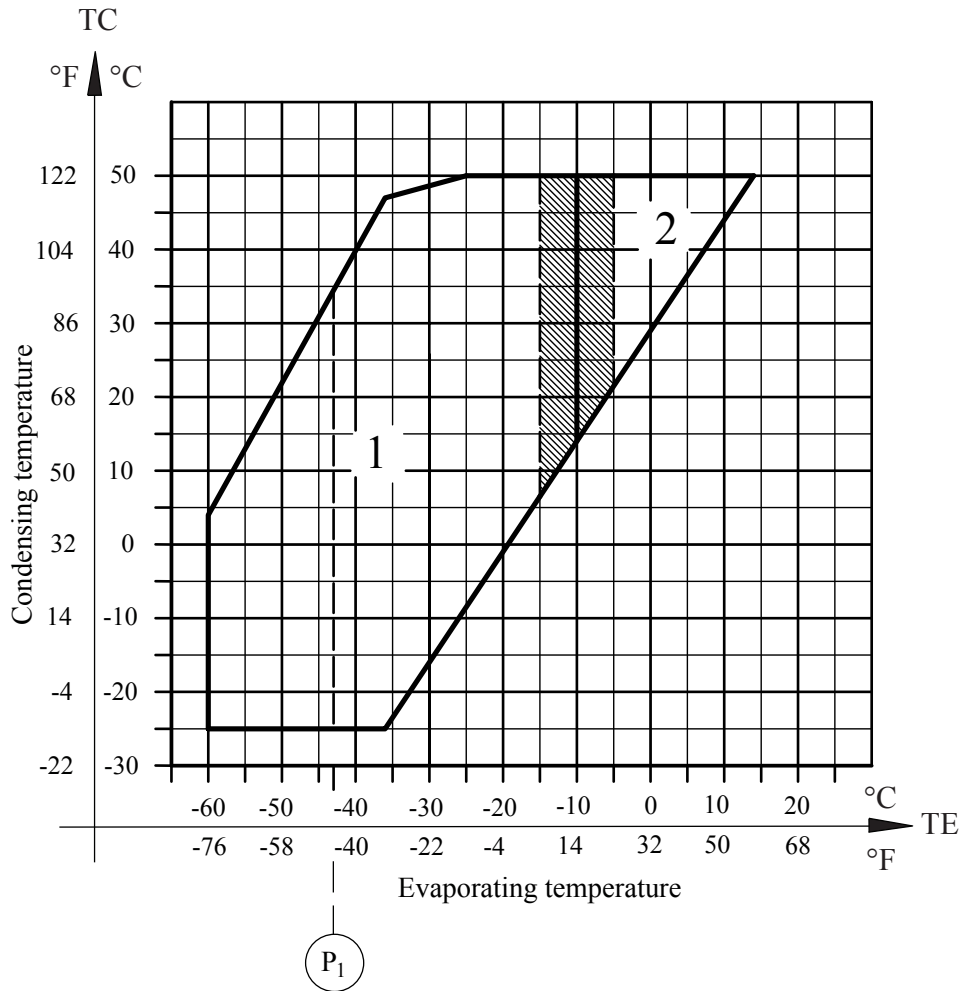


Code no.	Area no. 1
POE 100	Δ □

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- : Soluble and miscible
- P₁ : Pour point POE 100

3.1.8 Refrigerant R507

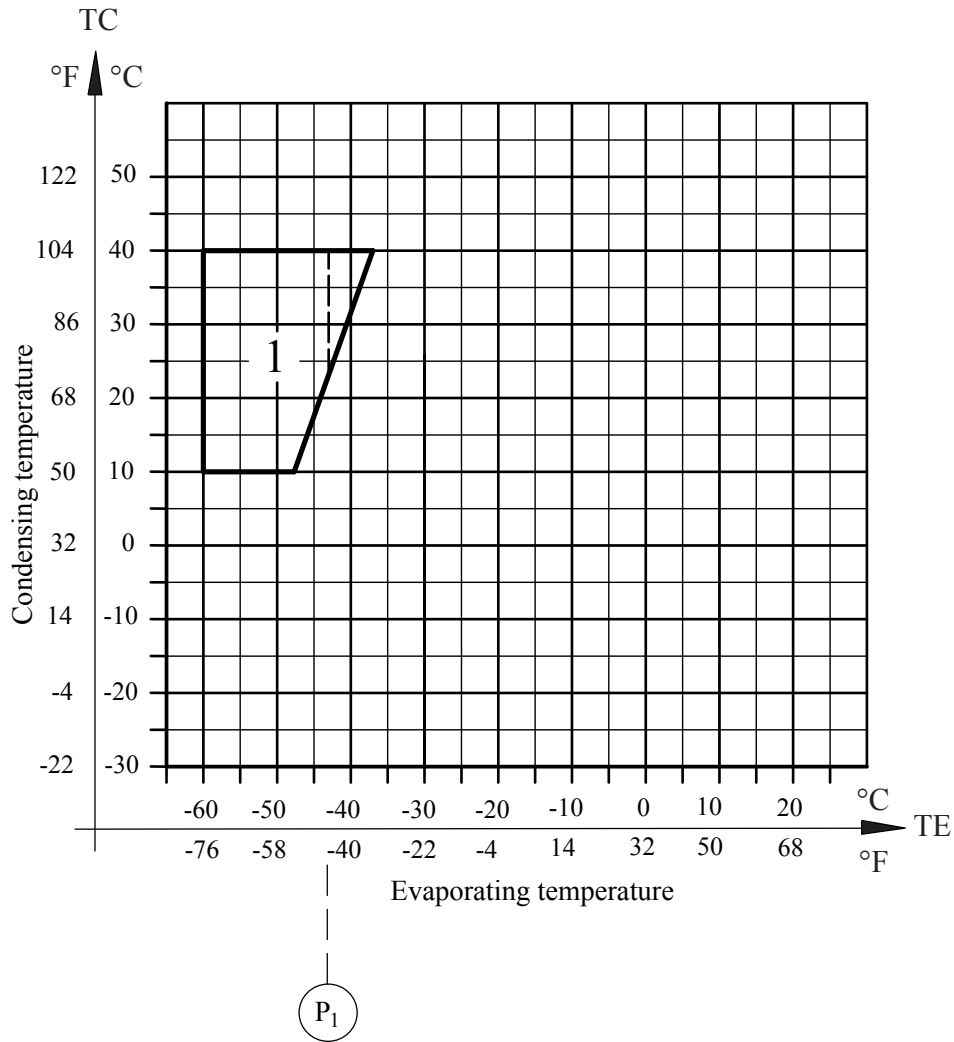
R507 single-stage reciprocating compressors



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
- P₁ : Pour point POE 68

R507 two-stage reciprocating compressors



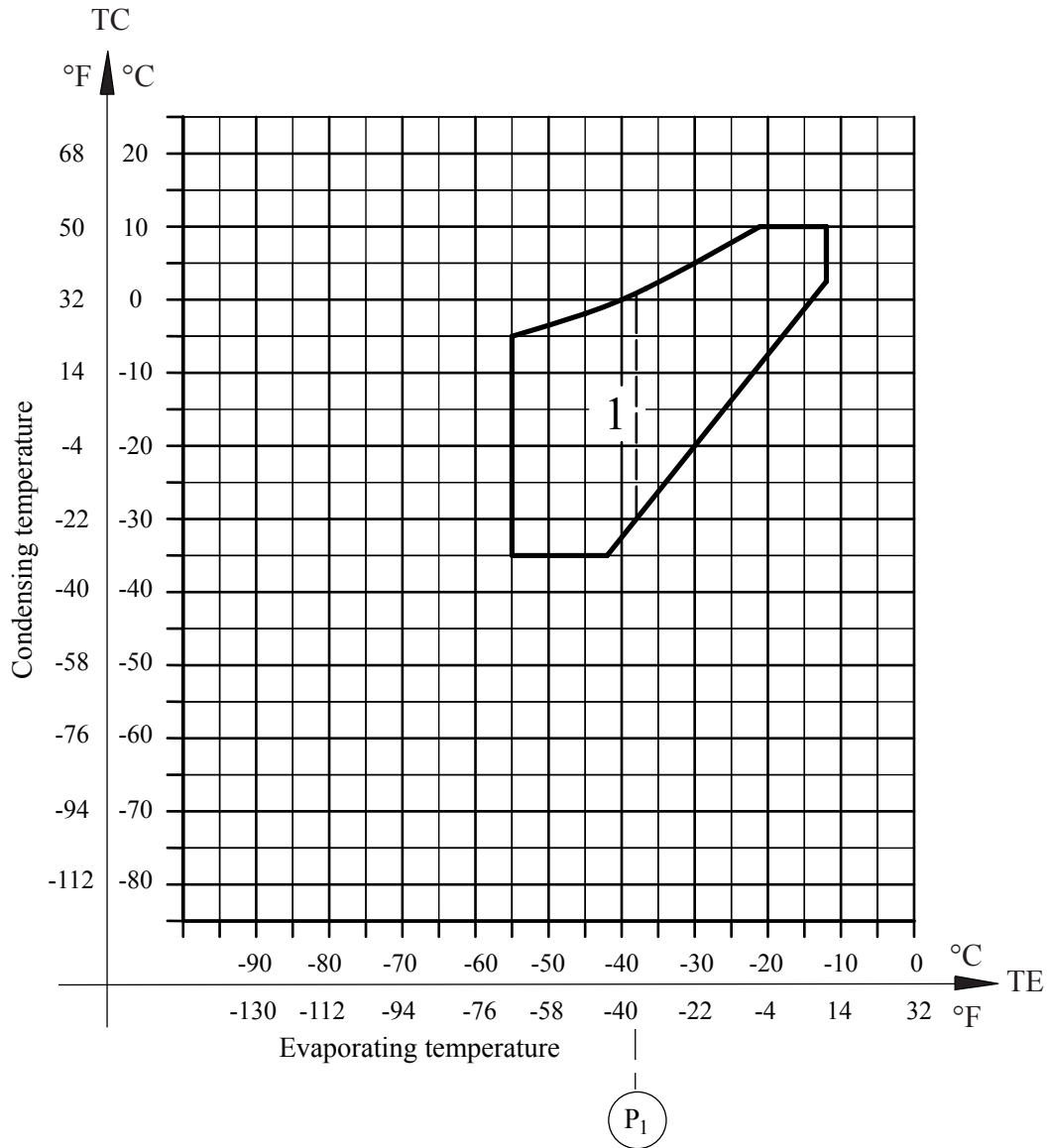
Code no.	Area no. 1
POE 68	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible
- P₁ : Pour point POE 68



3.1.9 Refrigerant R744

R744 HPO and HPC reciprocating compressors

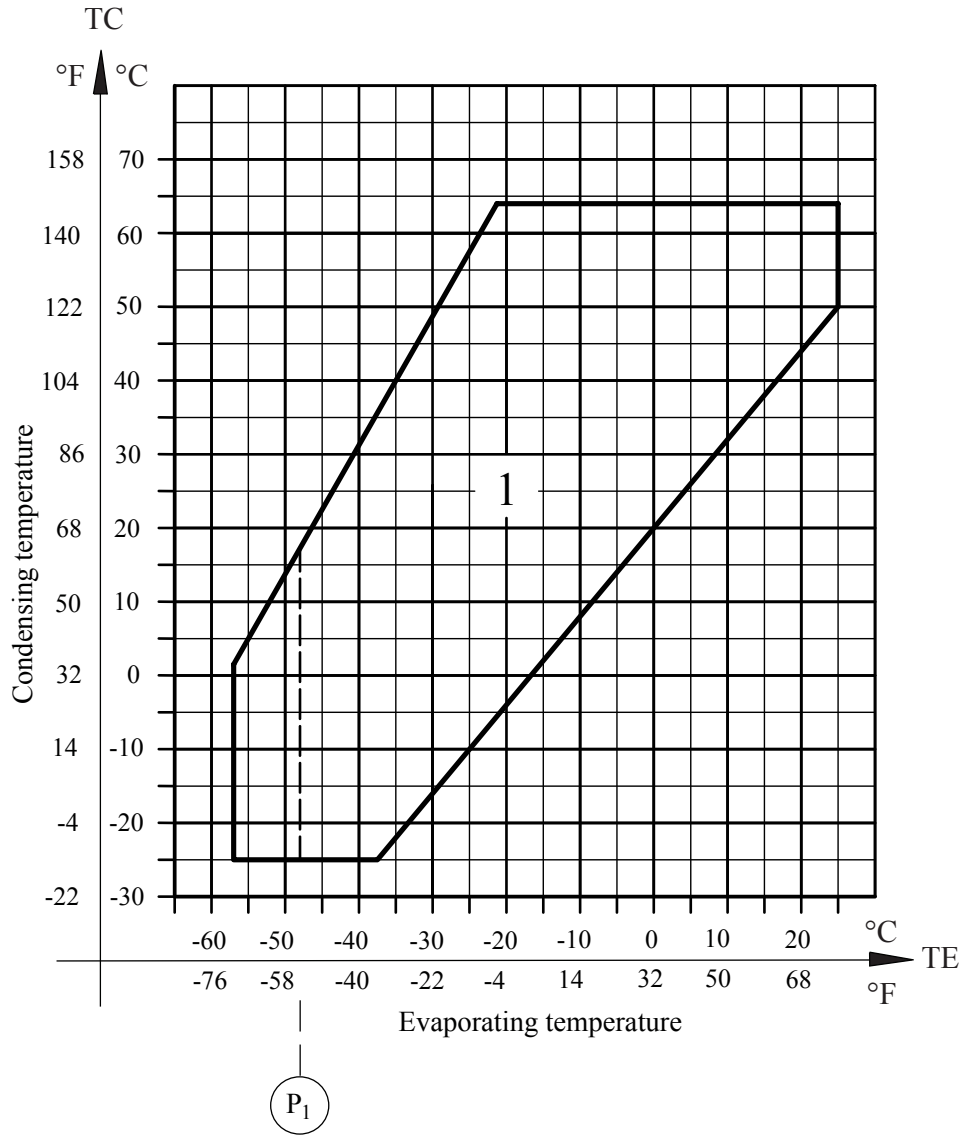


Code no.	Area no. 1
POE C85E	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible
- P₁ : Pour point POE C85E

3.1.10 Refrigerant R290

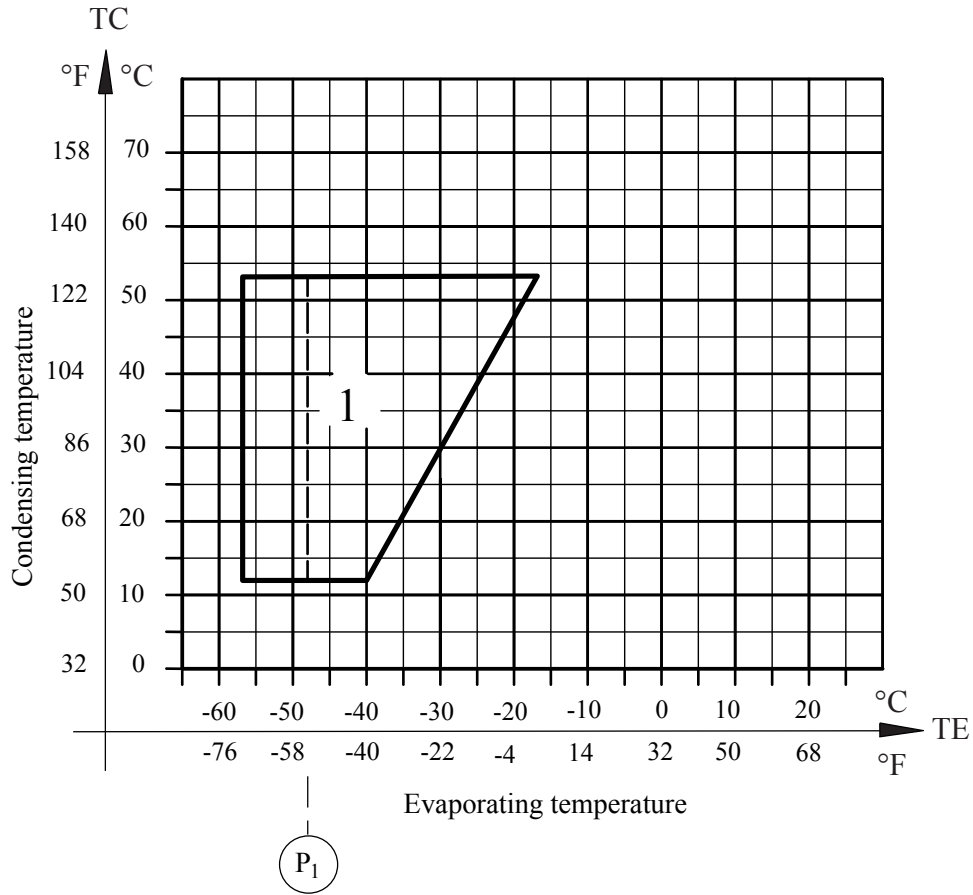
R290 single-stage reciprocating compressors



Code no.	Area no. 1
PAG	Δ □
1515-100	

- Δ : Very suitable for new plants
- : Soluble and miscible
- P₁ : Pour point PAG 1515-100

R290 two-stage reciprocating compressors

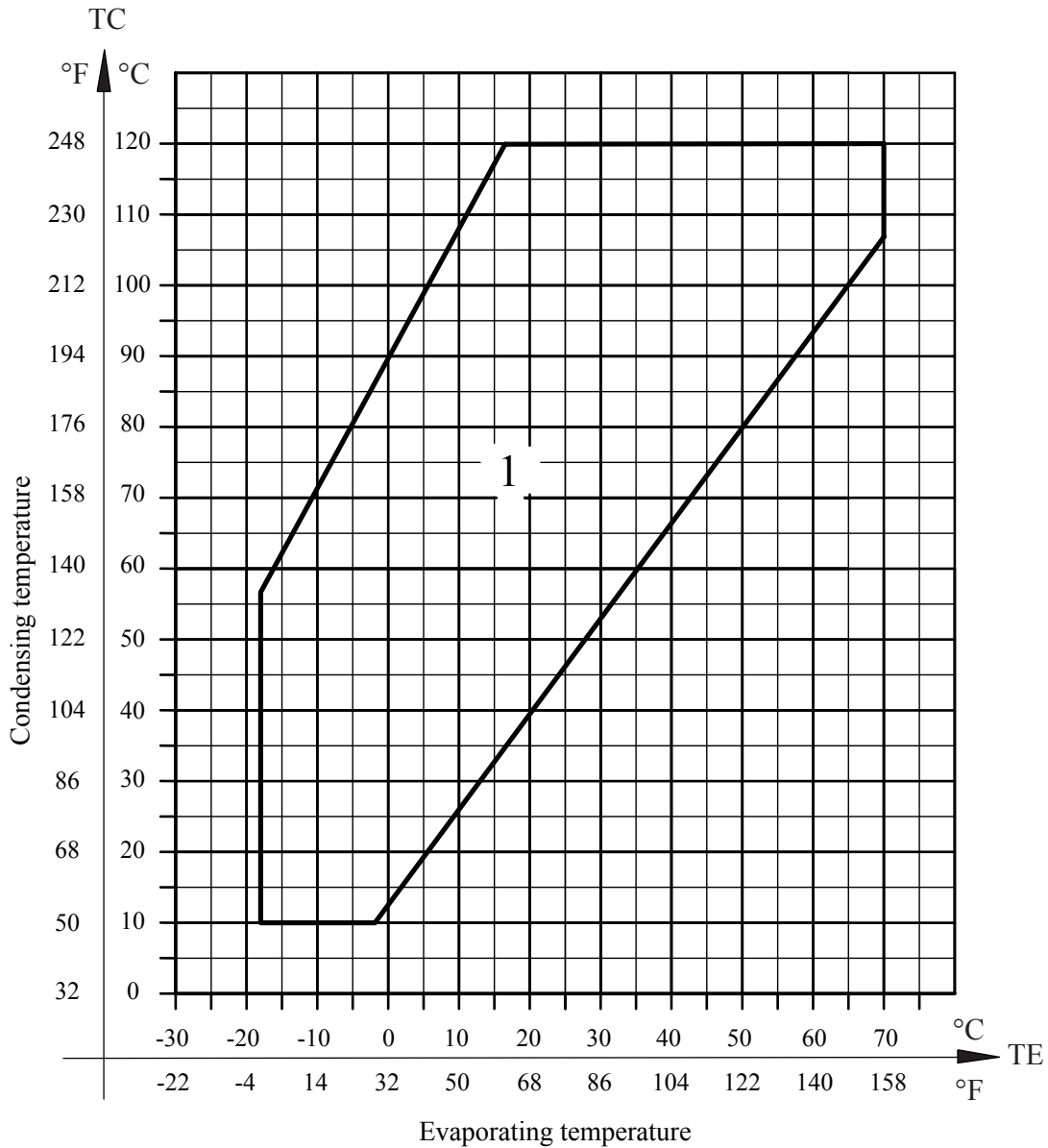


Code no.	Area no. 1
PAG 1515-100	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible
- P₁ : Pour point PAG 1515-100

3.1.11 Refrigerant R600

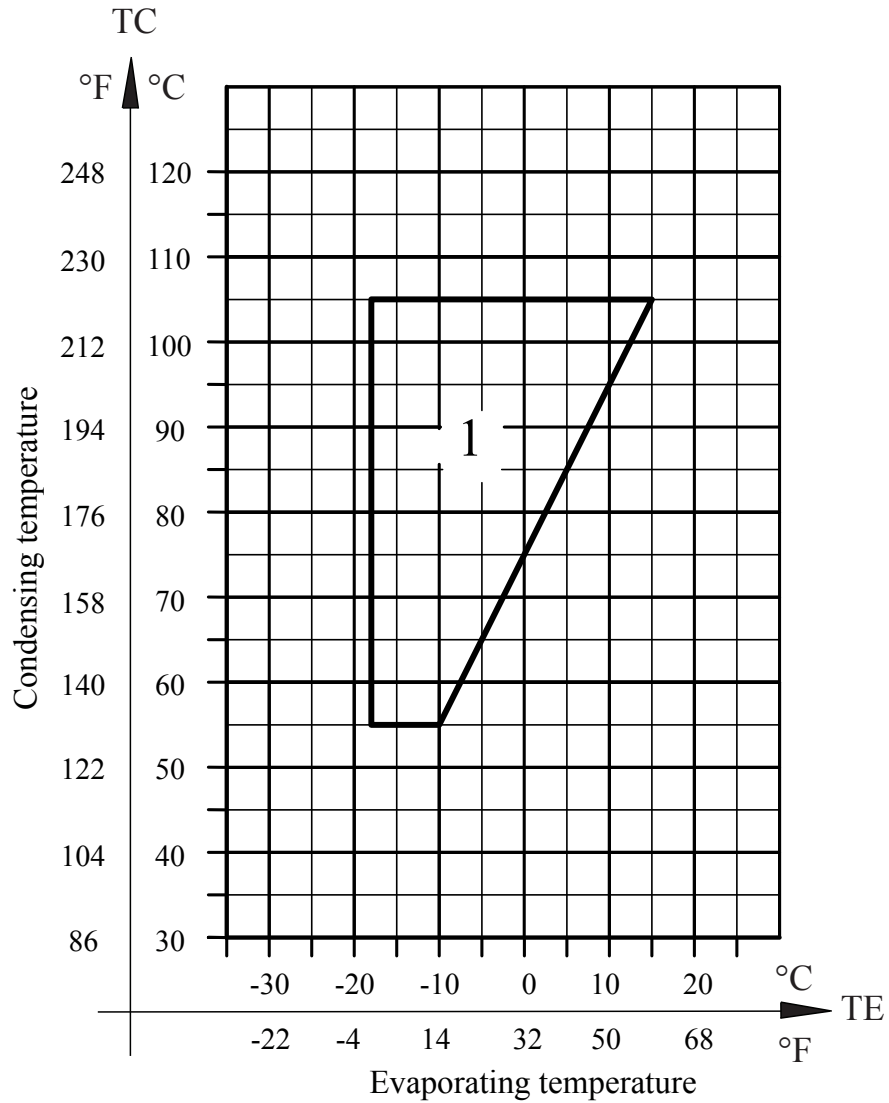
R600 single-stage reciprocating compressors



Code no.	Area no. 1
PAG 1515-100	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible

R600 two-stage reciprocating compressors

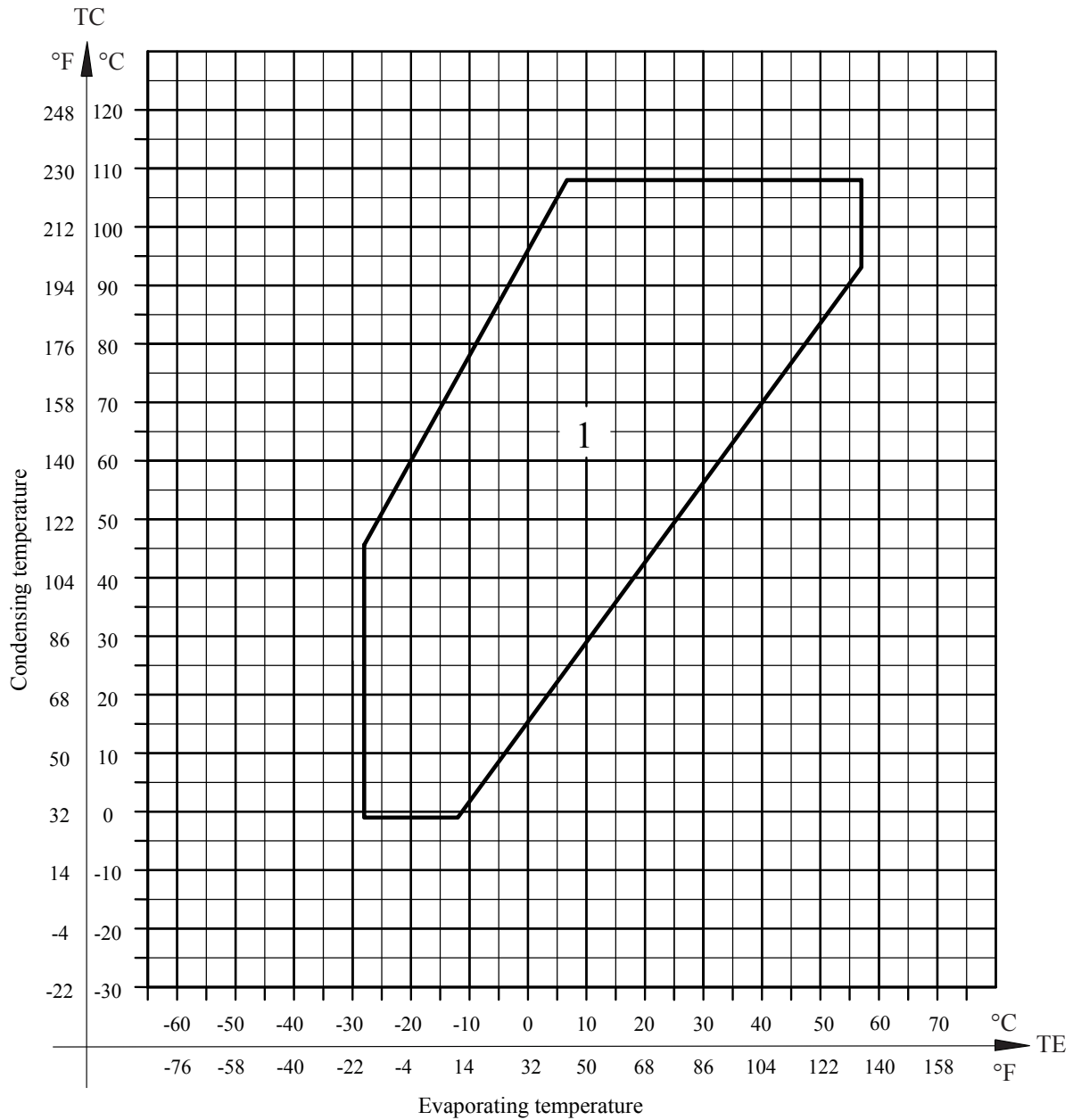


Code no.	Area no. 1
PAG 1515-100	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible

3.1.12 Refrigerant R600a

R600a single stage reciprocating compressor

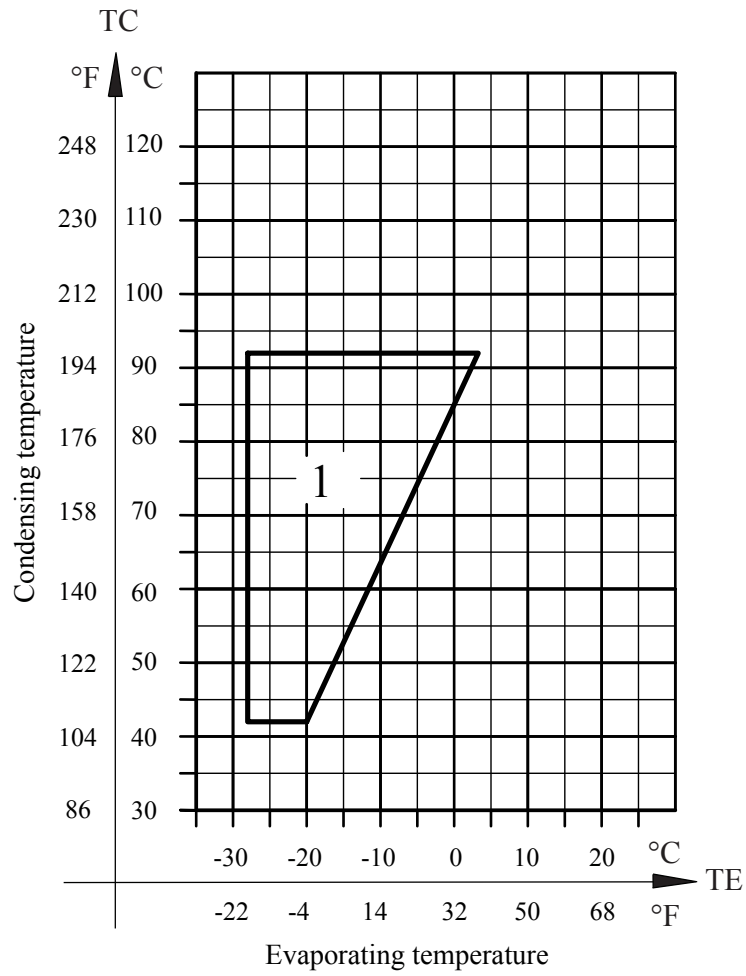


Code no.	Area no. 1
PAG	Δ □
1515-100	

- Δ : Very suitable for new plants
- : Soluble and miscible



R600a two-stage reciprocating compressor

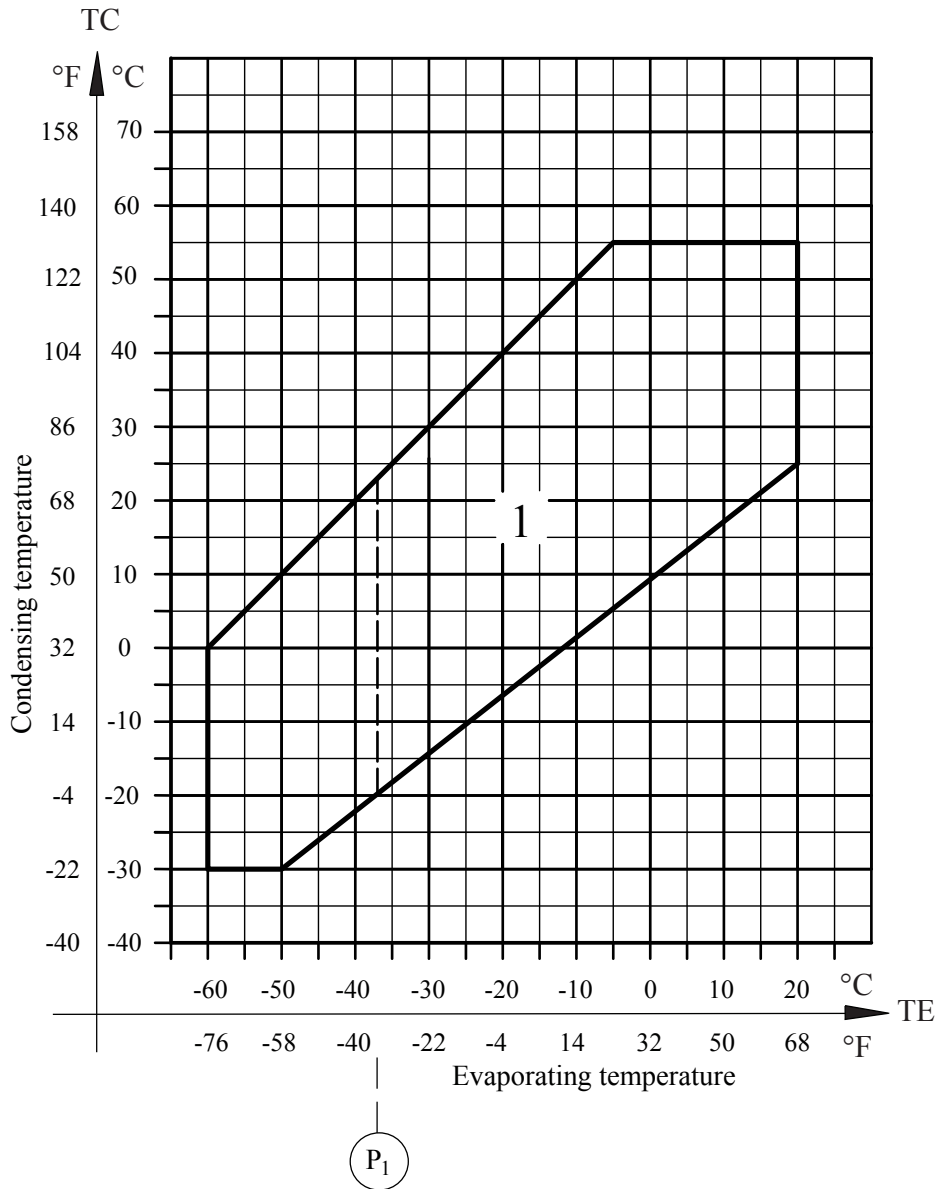


Code no.	Area no. 1
PAG 1515-100	Δ □

- Δ : Very suitable for new plants
- : Soluble and miscible

3.1.13 Refrigerant R1270

R1270 single stage reciprocating compressor



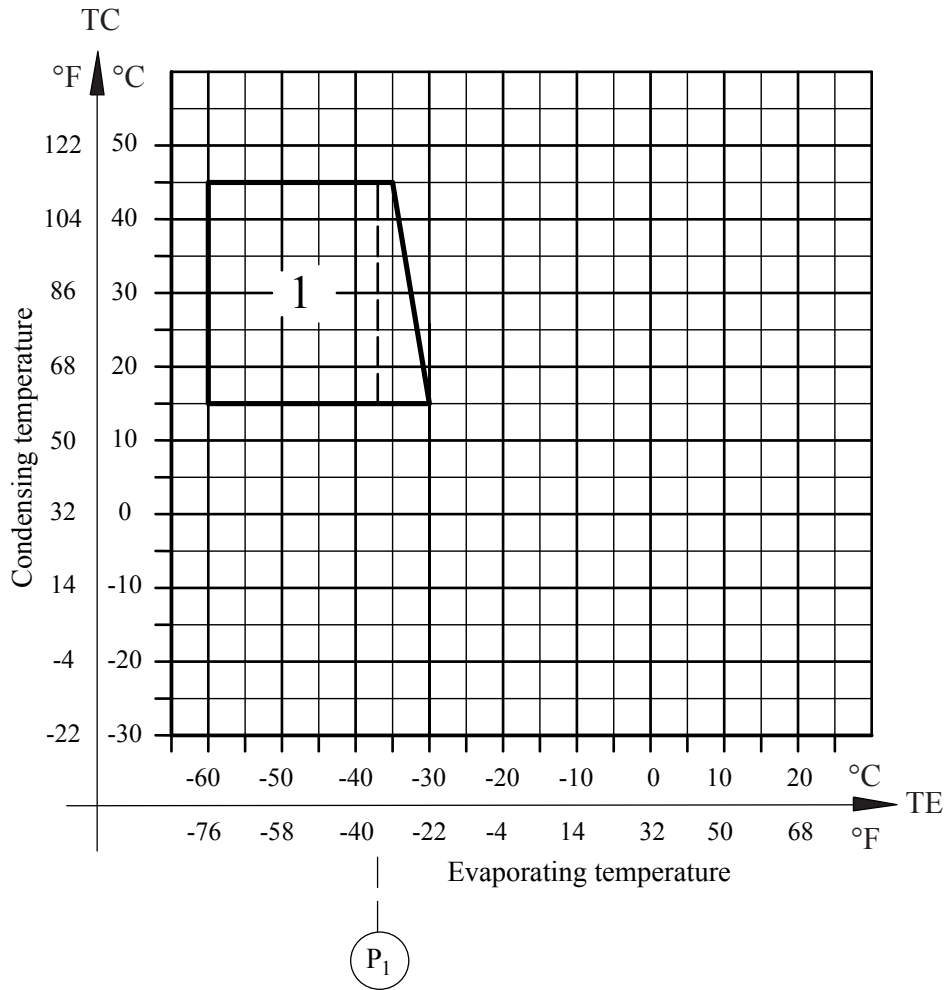
Code no.	Area no. 1
PAG 1507-100	Δ ●

- Δ : Very suitable for new plants
- : Non-soluble and non-miscible
- P₁ : Pour point PAG 1507-100

Note: Elastomer. Viton is recommended.



R1270 two-stage reciprocating compressor



Code no.	Area no. 1
PAG 1507-100	Δ •

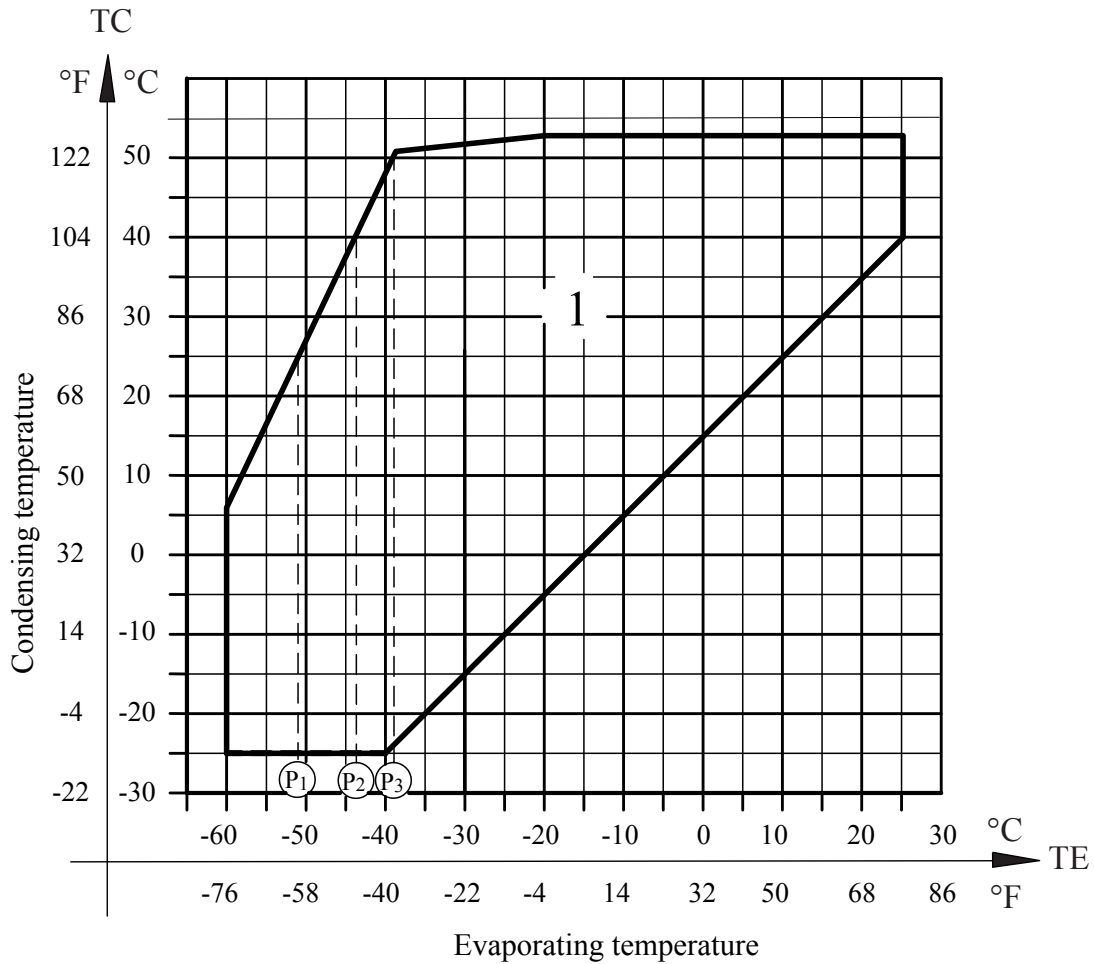
- Δ : Very suitable for new plants
- : Non-soluble and non-miscible
- P₁ : Pour point PAG 1507-100

Note: Elastomer. Viton is recommended.

4. Diagrams for screw compressors

4.1.1 Refrigerant R717

R717 screw compressor

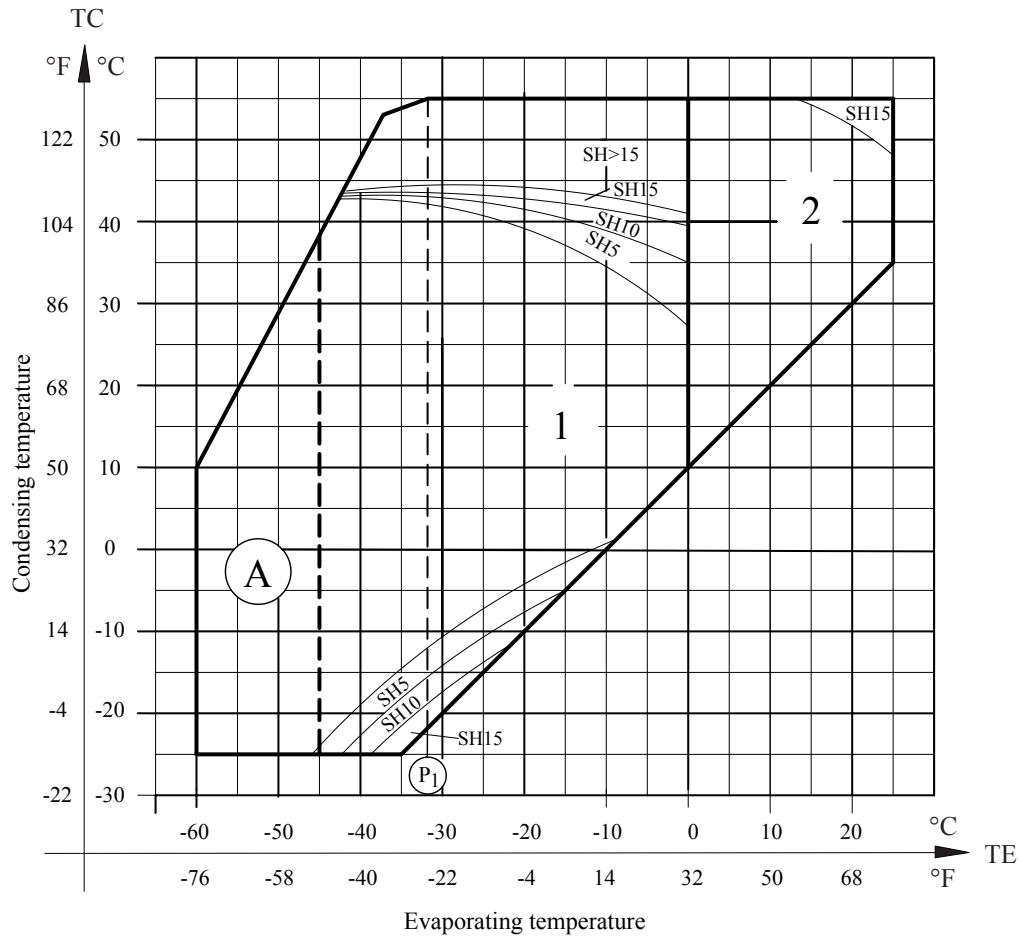


Code no.	Area no. 1
PAO 68	Δ ●
AP 68	Δ Θ ●
S 68	Δ Θ ●

- Δ : Very suitable for new plants
- Θ : If wishing to change from naphtenic mineral oil
- : Non soluble and non miscible
- P₁ : Pour point AP 68
- P₂ : Pour point PAO 68
- P₃ : Pour point S 68

4.1.2 Refrigerant R22

R22 screw compressors with journal bearings or roller bearings

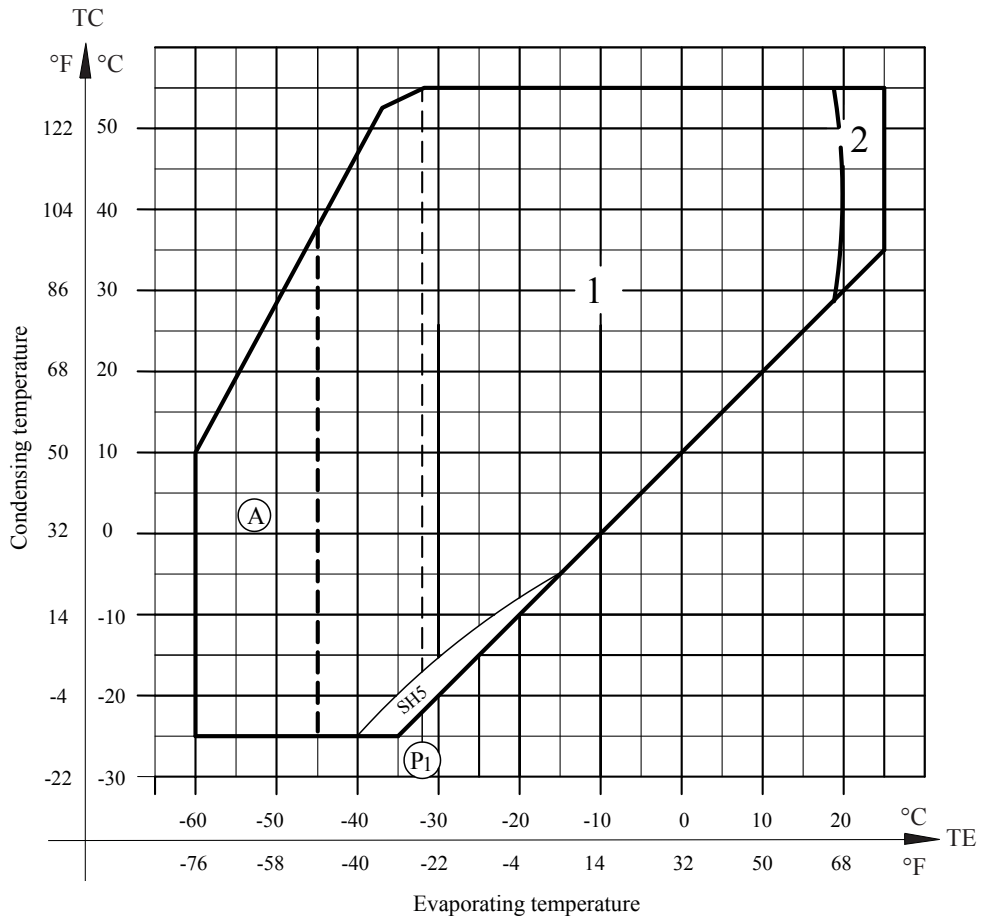


Code no.	Area no. 1	Area no. 2
A 100	$\Delta \square$	
PAO 100		$\Delta \square$

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- A : Max. oil concentration in refrigerant liquid phase at: T_E : 2% W
- * : Dry expansion system only. Flooded system to be considered individually: contact Johnson Controls Denmark
- SH : Suction gas superheat, K (Kelvin)
- \square : Soluble and miscible
- P_1 : Pour point A 100

R22 screw compressors with roller bearings only



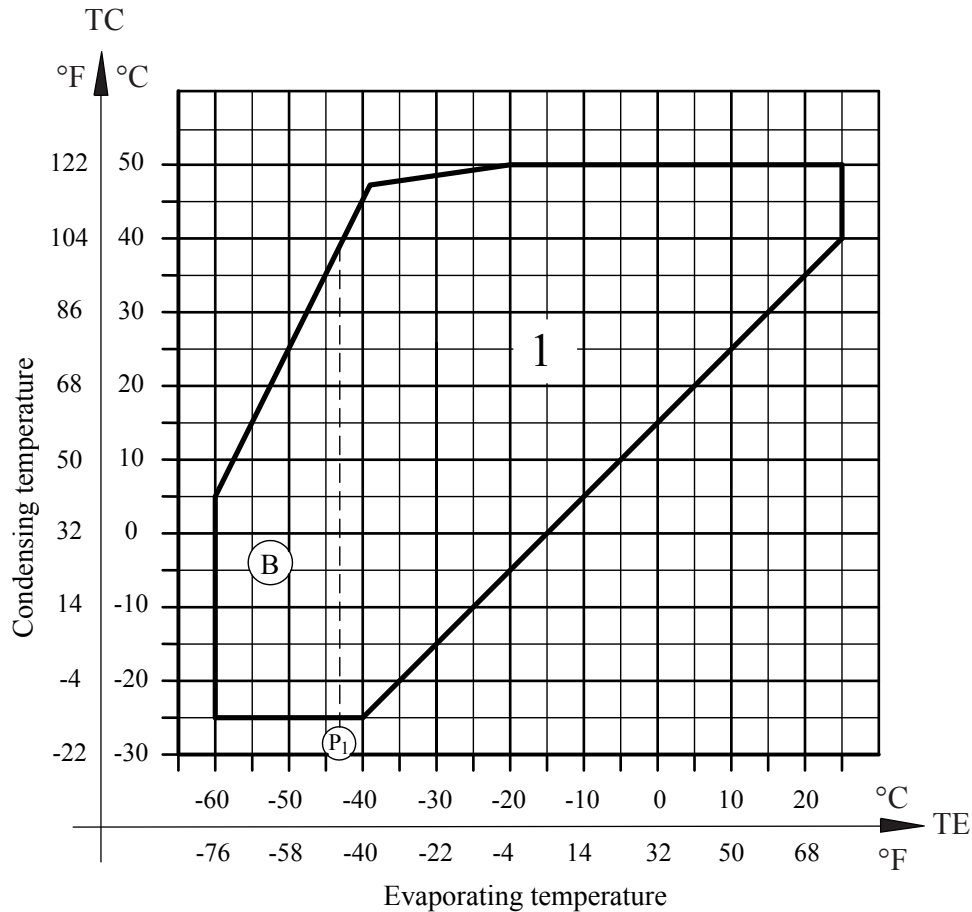
Code no.	Area no. 1	Area no. 2
A 100	Δ □	
PAO 100		Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- A : Max. oil concentration in refrigerant liquid phase at: T_E: 2% W
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point A 100

4.1.3 Refrigerant R407C

R407C screw compressors with roller bearings only

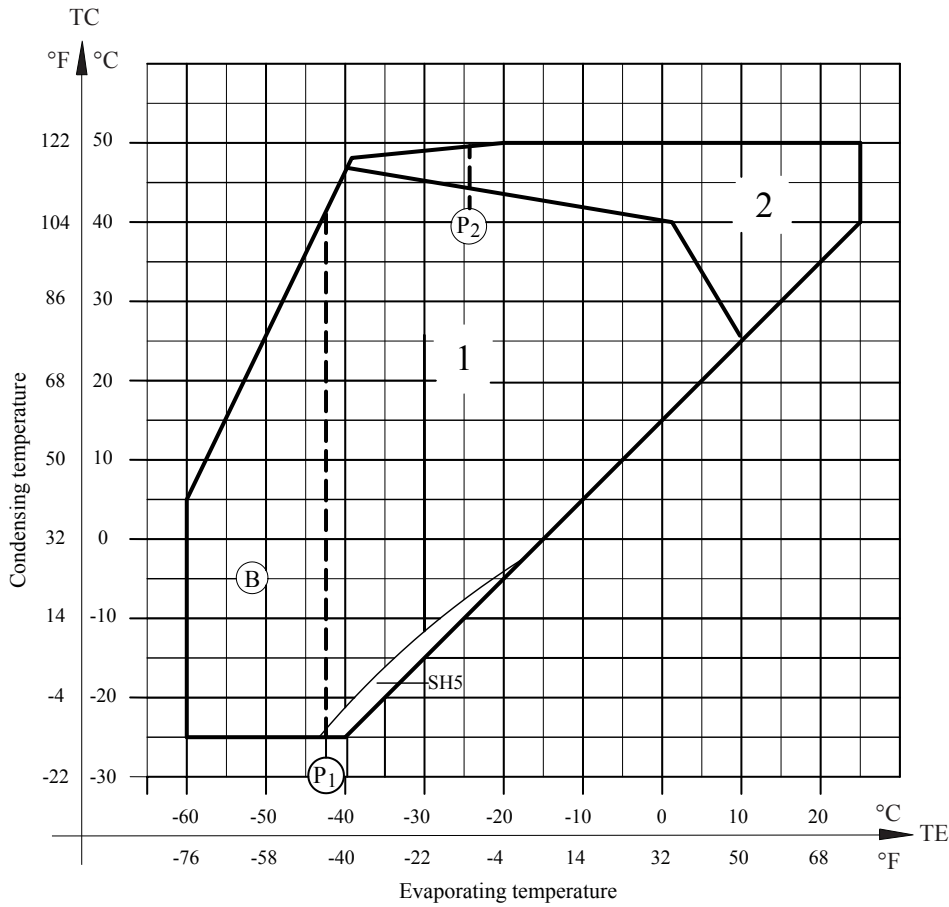


Code no.	Area no. 1
POE 68	Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 68

R407C screw compressors with journal bearings or roller bearings



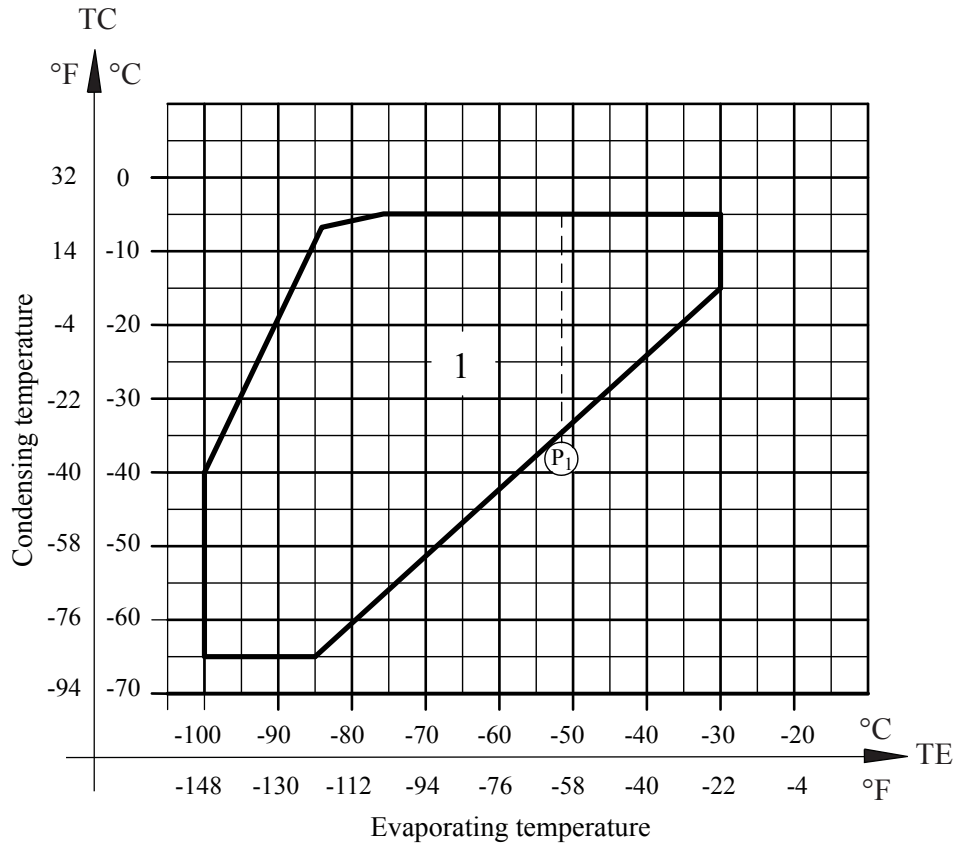
Code no.	Area no. 1	Area no. 2
POE 68	Δ □	
POE 220		Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 68
- P₂ : Pour point POE 220

4.1.4 Refrigerant R23

R23 screw compressors with journal bearings or roller bearings



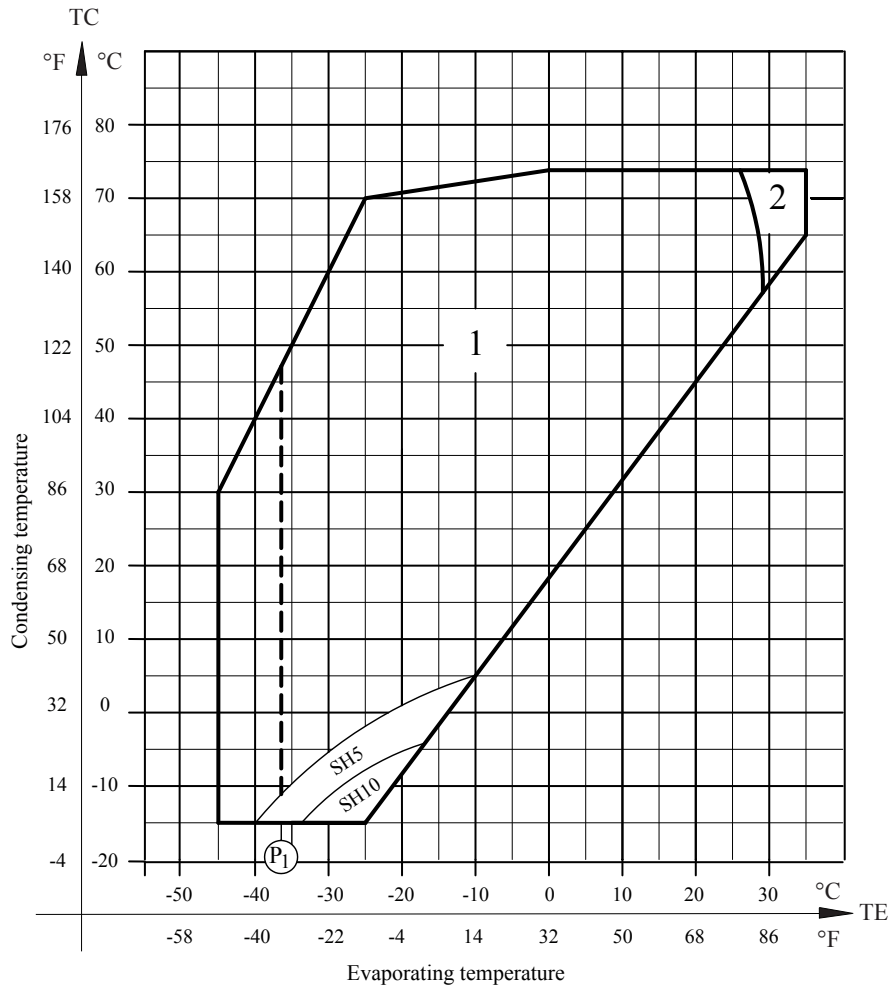
Code no.	Area no. 1
POE LT32	Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- : Soluble and miscible
- P₁ : Pour point POE LT32

4.1.5 Refrigerant R134a

R134a screw compressors with roller bearings only



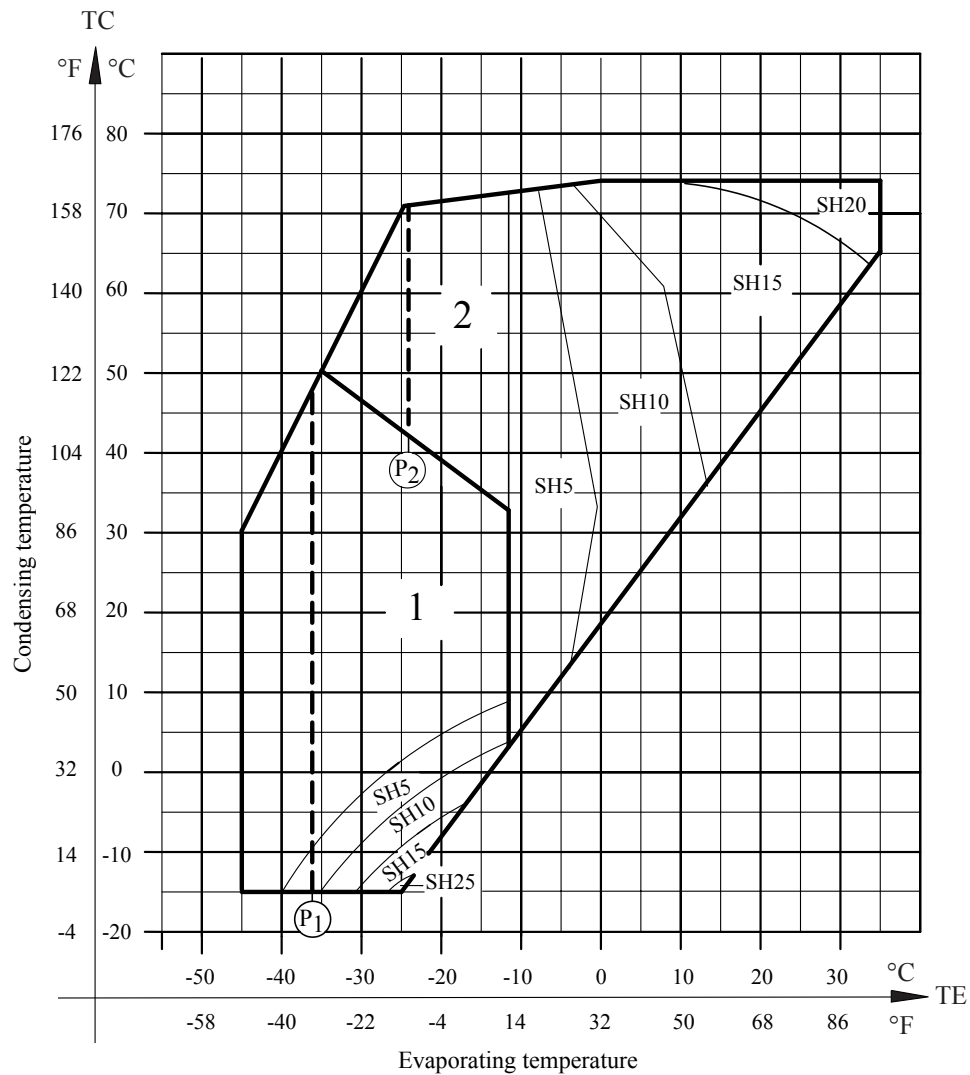
Code no.	Area no. 1	Area no. 2
POE 100	Δ □	
POE 220		Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 100



R134a screw compressors with journal bearings or roller bearings



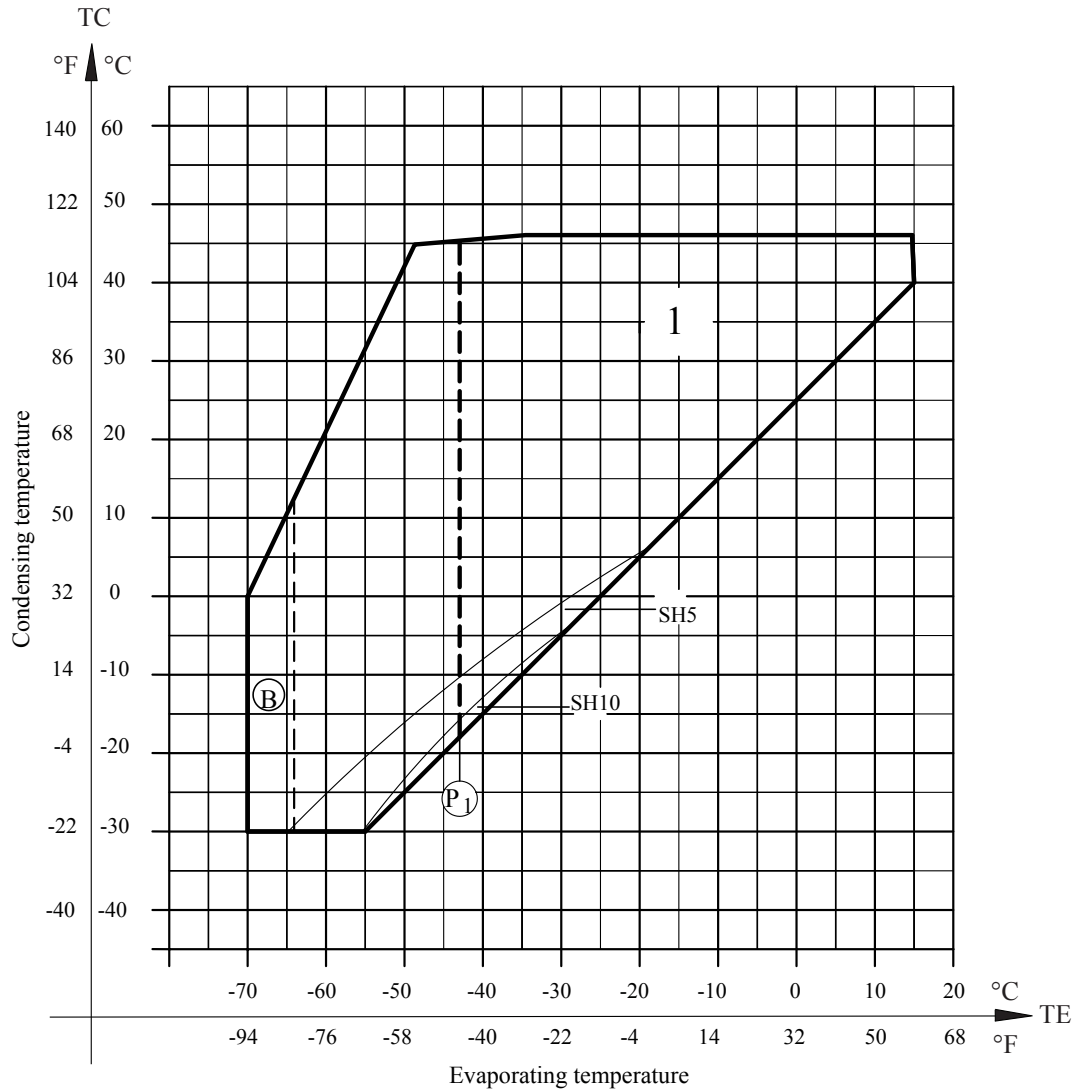
Code no.	Area no. 1	Area no. 2
POE 100	Δ □	
POE 220		Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 100
- P₂ : Pour point POE 220

4.1.6 Refrigerant R404A

R404A screw compressors with roller bearings only

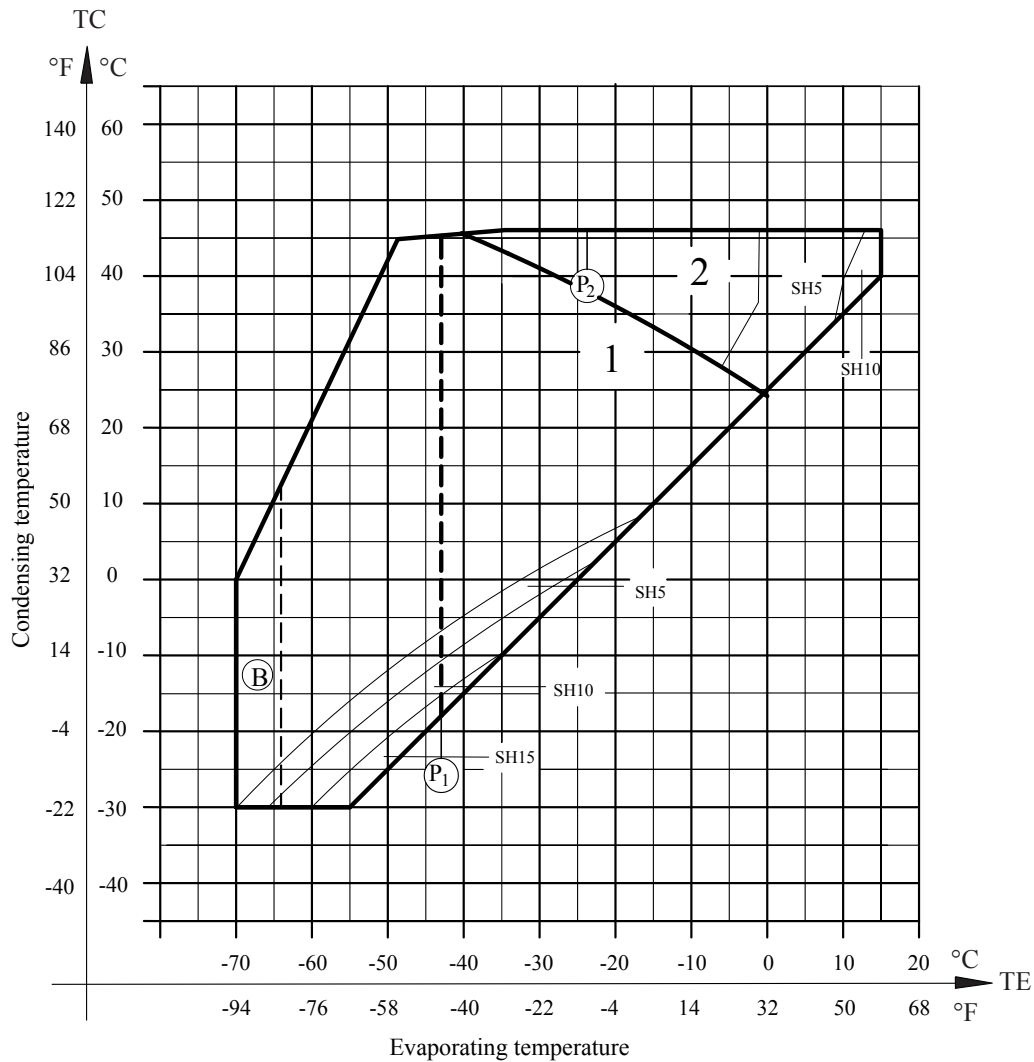


Code no.	Area no. 1
POE 68	Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 68

R404A screw compressors with journal bearings or roller bearings



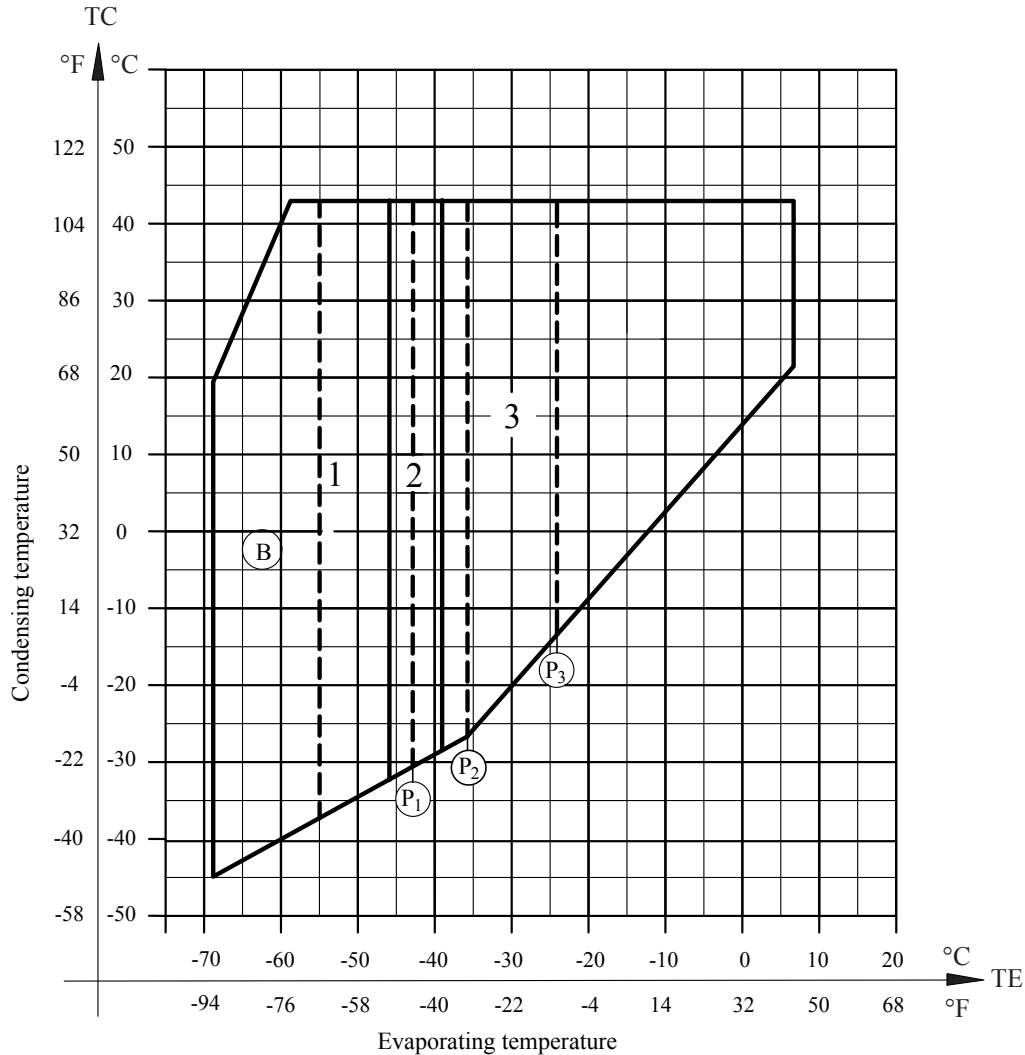
Code no.	Area no. 1	Area no. 2
POE 68	Δ □	
POE 220		Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 68
- P₁ : Pour point POE 220

4.1.7 Refrigerant R410A

R410A screw compressors with journal bearings or roller bearings



Code no.	Area no. 1	Area no. 2	Area no. 3
POE 68	Δ □		
POE 100		Δ □	
POE220			Δ □

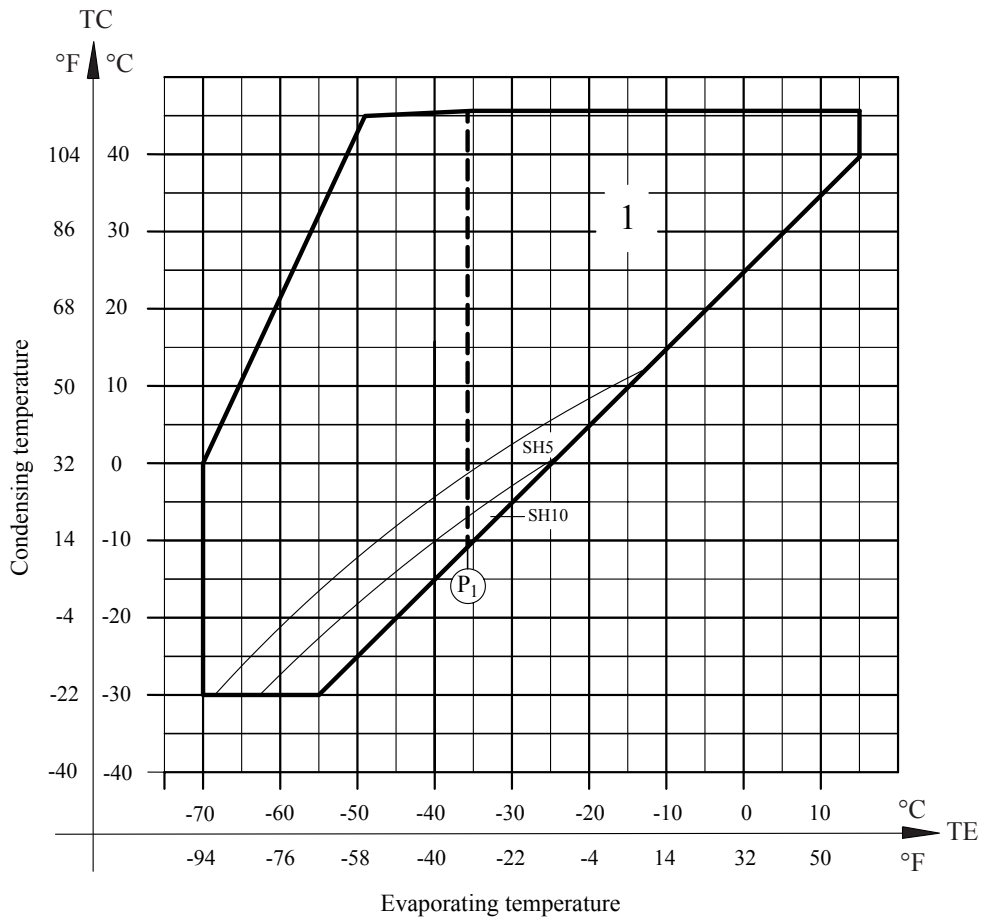
When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- B : Max. oil concentration in refrigerant liquid phase: contact Johnson Controls Denmark
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 68
- P₂ : Pour point POE 100
- P₃ : Pour point POE 220



4.1.8 Refrigerant R507

R507 screw compressors with roller bearings only

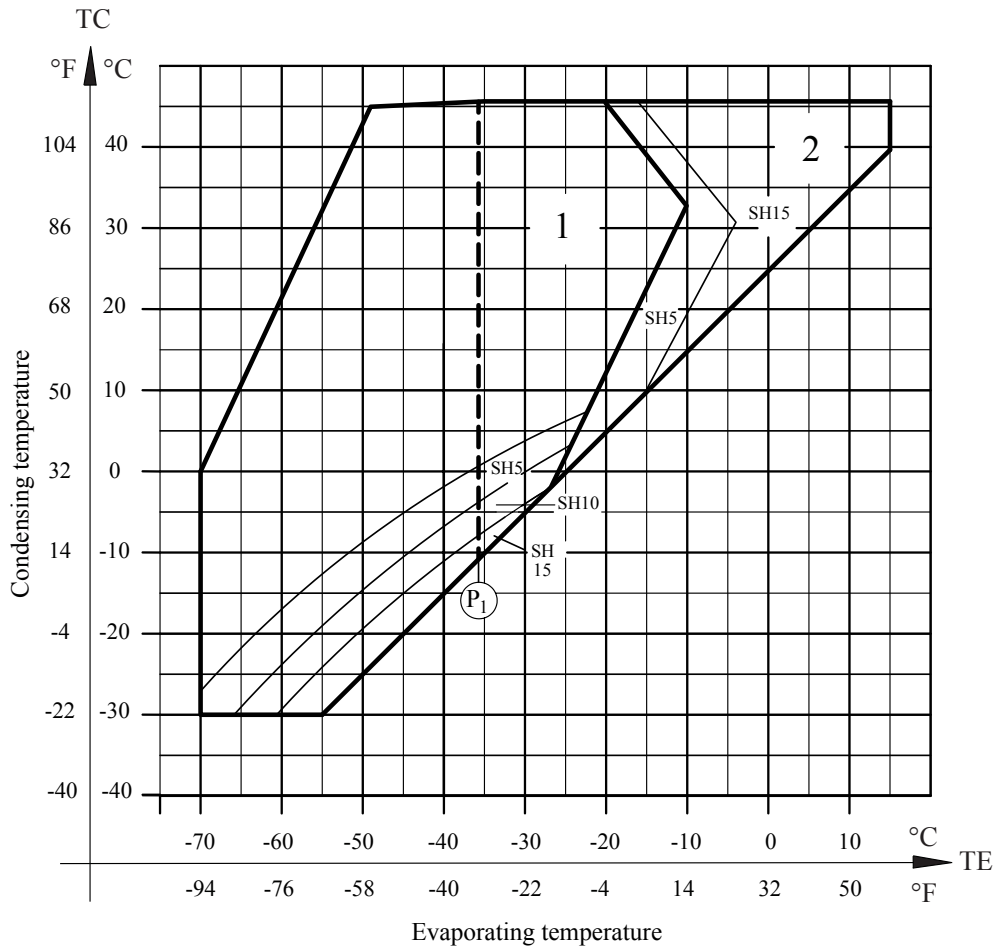


Code no.	Area no. 1
POE 100	Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 100

R507 screw compressors with journal bearings or roller bearings



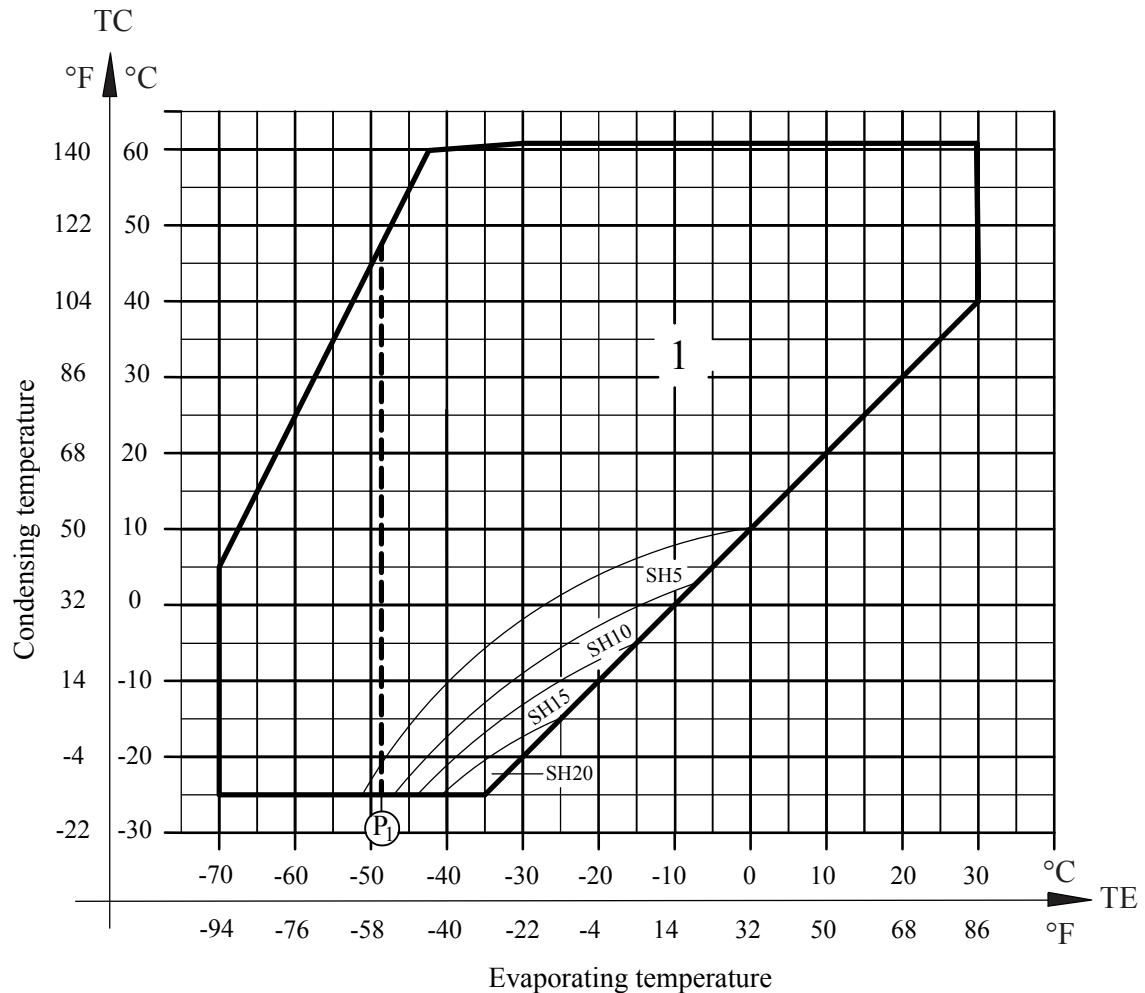
Code no.	Area no. 1	Area no. 2
POE 100	Δ □	
POE 220		Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point POE 100

4.1.9 Refrigerant R290

R290 screw compressors with journal bearings or roller bearings



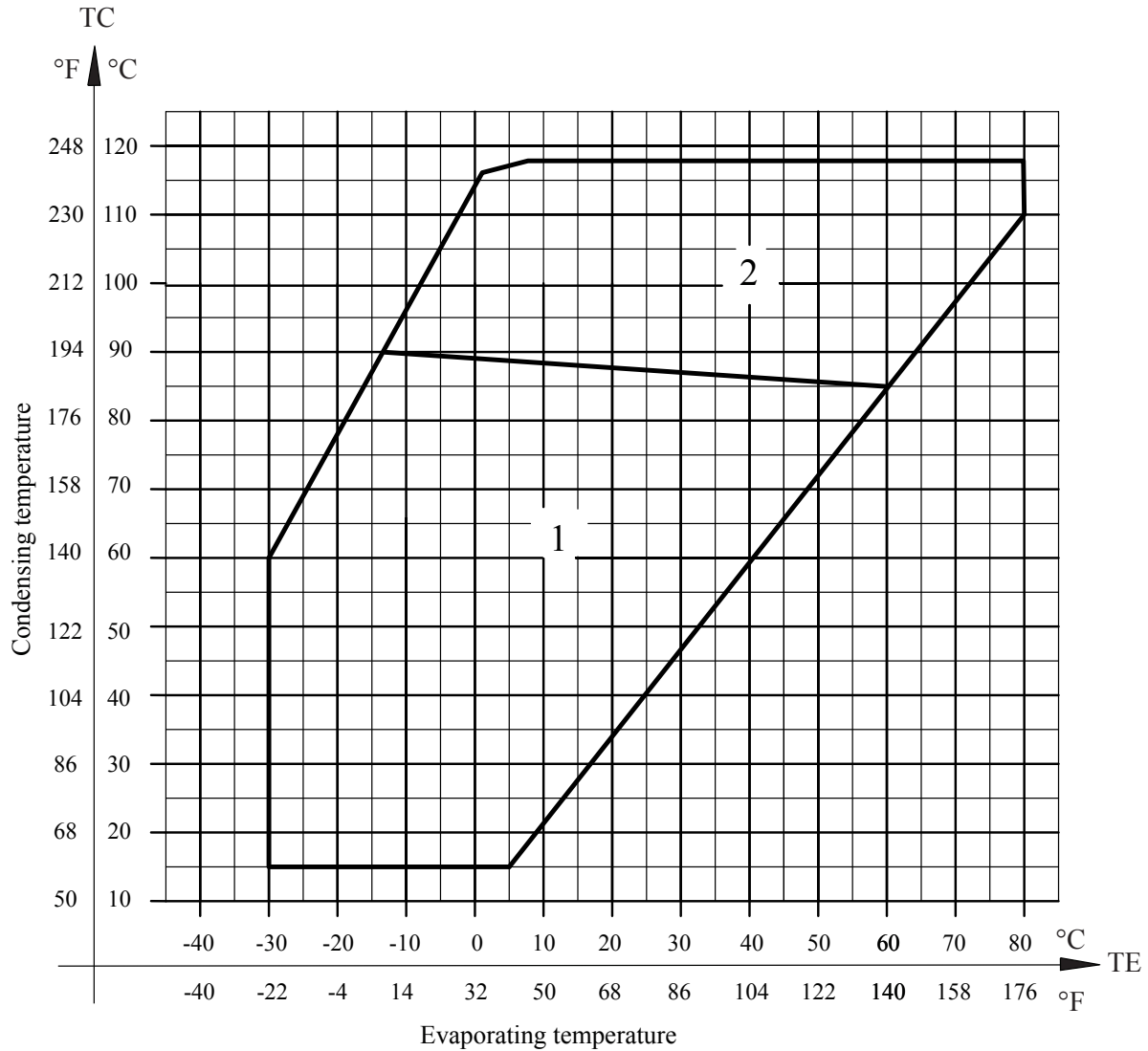
Code no.	Area no. 1
PAG 1515-100	Δ □

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

- Δ : Very suitable for new plants
- SH : Suction gas superheat, K (Kelvin)
- : Soluble and miscible
- P₁ : Pour point PAG 1515-100

4.1.10 Refrigerant R600

R600 screw compressors with journal bearings or roller bearings



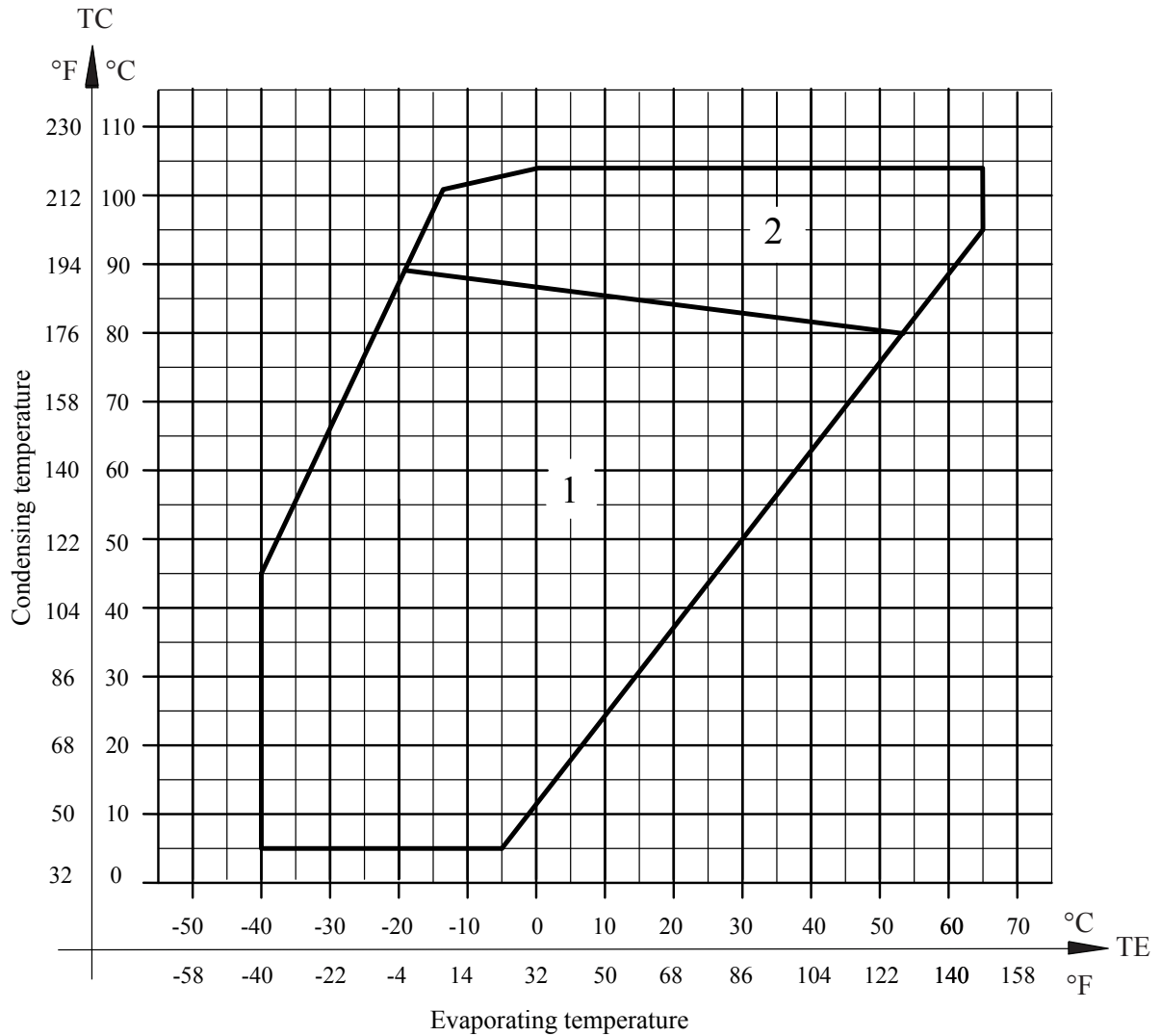
Code no.	Area no. 1	Area no. 2
PAG 1515-100	Δ □	
PAG 1515-150		Δ □

Δ : Very suitable for new plants

□ : Soluble and miscible

4.1.11 Refrigerant R600a

R600a screw compressors with journal bearings or roller bearings

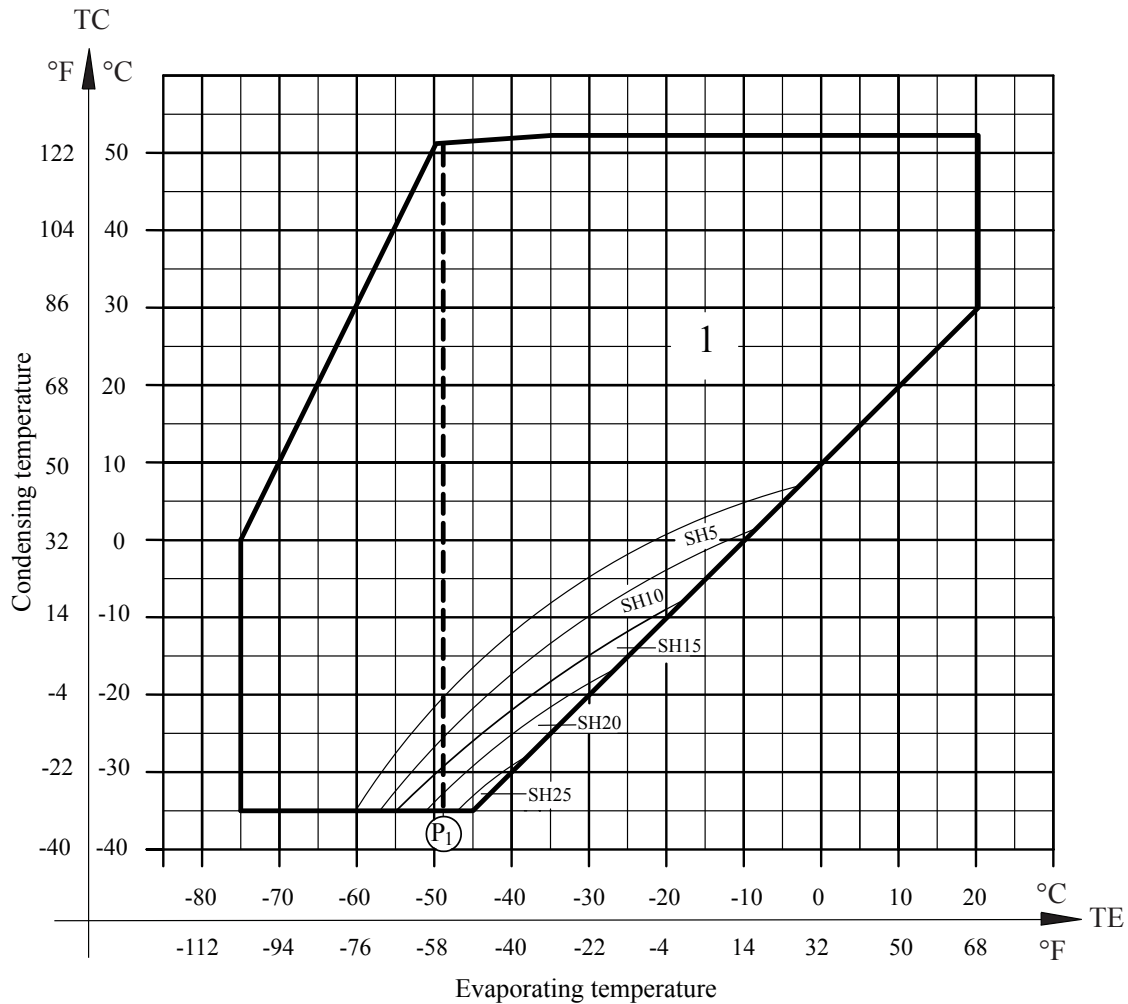


Code no.	Area no. 1	Area no. 2
PAG 1515-100	Δ □	
PAG 1515-150		Δ □

- Δ : Very suitable for new plants
 □ : Soluble and miscible

4.1.12 Refrigerant R1270

R1270 screw compressors with journal bearings or roller bearings



Code no.	Area no. 1
PAG	Δ ●
1507-100	

When using the calculation programme COMP1 it is possible to optimize overlap between oils and the requirement for suction superheat values (SH) as stated in the diagram.

Note: Elastomer. Viton is recommended.

- Δ : Very suitable for new plants
- SH : Suction gas superheat, K (Kelvin)
- : Non-soluble and non-miscible
- P₁ : Pour point PAG 1507-100

