Compressor Solutions for the Natural Refrigerant R744 (CO_2) Availability and Development.

BOCK Compressors for CO_2 (R744)

Ullstrøm Fepo AS

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Manager Ullstrøm Fepo AS

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colour the world of tomorrow

Product Range HG CO_2 (transcritical + subcritical)

CO_2

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HGX44e CO_2 - What's new?

1. Improved efficiency (reduced operating costs)
2. Enlarged operating conditions

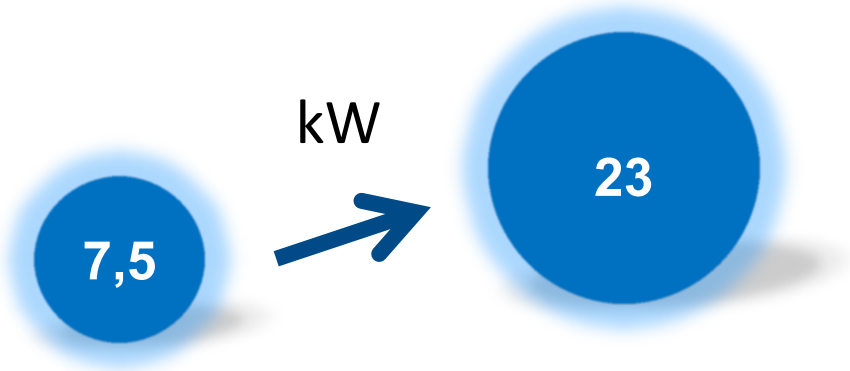
   (further applications, optimized hot gas defrost, wider frequency range)
3. Adapted low pressure design (LP 30 bar)
4. Improved running behaviour (low noise, vibration and pulsations)

Complete compressor adaption to CO_2 requests!

NEW: HGX24 CO_2 LT - Subcritical CO_2 Compressor

Subcritical **CO_2 LT** range, version ML, S
(for LT (low temperature) applications):
Pressure Design: LP/HP: **100/100 bar**

Type HGX24e CO_2 LT	m^3/h (50 Hz)
HGX24e/55-4 ML/S CO_2 LT	4,6
HGX24e/70-4 ML/S CO_2 LT	6,0
HGX24e/90-4 ML/S CO_2 LT	7,6
HGX24e/110-4 ML/S CO_2 LT	9,4
HGX24e/130-4 ML/S CO_2 LT	11,4
HGX24e/145-4 ML/S CO_2 LT	12,7



LT Cooling Capacity

$t_o/t_c/t_{oh}$ = -35°C/-5°C/10K/50 Hz

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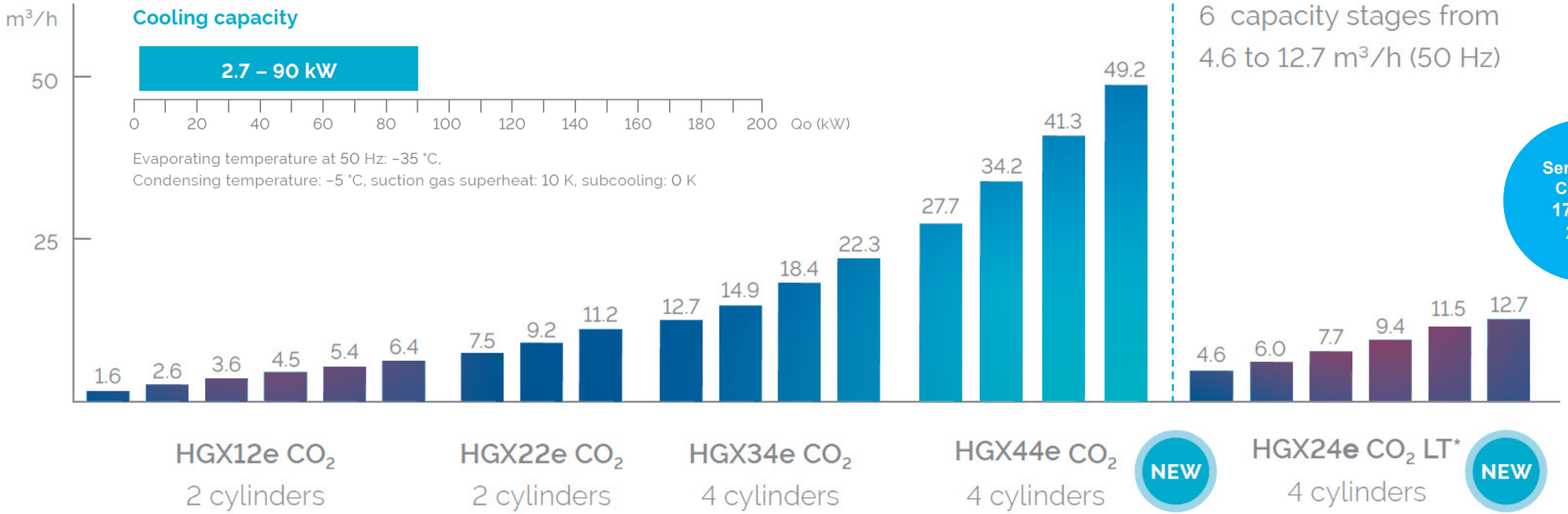
Subcritical CO_2 Compressors-
CO_2 + CO_2 LT Product Program

Subcritical CO_2 compressors (LP 40 bzw. 30 bar)

4 model sizes with 17 capacity stages from 1.6 to 49.2 m³/h (50 Hz)

Subcritical CO_2 compressors (LT range – LP 100 bar)

1 model size with
6 capacity stages from
4.6 to 12.7 m³/h (50 Hz)



Serial start CO_2 LT: 17th Mai 2021

*For higher capacities in low temperature applications with standstill pressures up to LP 100 bar, the HGX34 CO_2 T and HGX46 CO_2 T are available in the ML version with 12 displacement stages.

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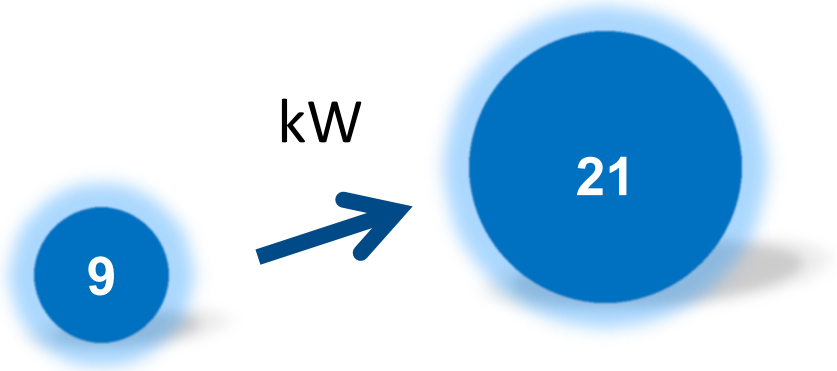
NEW: HGX24 CO_2 T - Transcritical CO_2 Compressor

Type HGX24 CO_2 T	m^3/h (50 Hz)
HGX24/55-4 ML/S/SH CO_2 T	4,6
HGX24/70-4 ML/S/SH CO_2 T	6,0
HGX24/90-4 ML/S/SH CO_2 T	7,7
HGX24/110-4 ML/S/SH CO_2 T	9,4

Transcritical **CO_2 T** range, version ML, S & SH
(for MT/PC/HP/AC[1] applications):
Pressure Design: LP/HP: **100/150 bar**



MT Cooling Capacity

$t_o/t_{gas\_out}/t_{ho}$ = -10°C/35°C(90 bar)/10K/50 Hz

[1] **MT**: **M**edium **T**emperature systems
PC: **P**arallel **C**ompressors
HP: **H**eat **P**ump systems
AC: **A**ir **C**onditioning (chiller) systems

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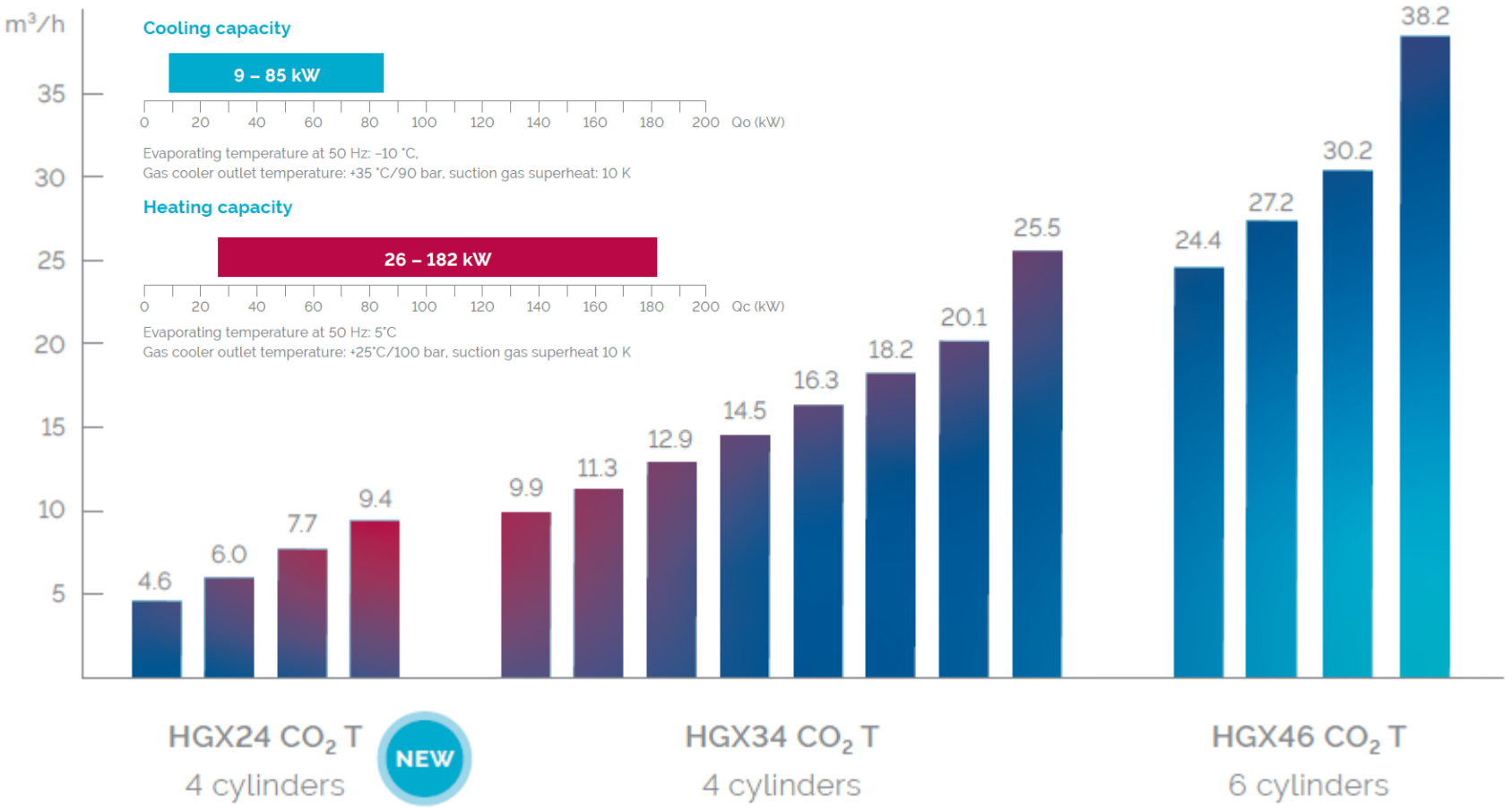
Transcritical CO_2 compressors -
CO_2 T Product Program

Transcritical CO_2 compressors

3 model sizes with 16 capacity stages from 4.6 to 38.2 m³/h (50 Hz)



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CO_2 Compressor Pressure Design

Bock CO_2 compressor ranges:

MT/PC/HP/AC applications (transcritical):

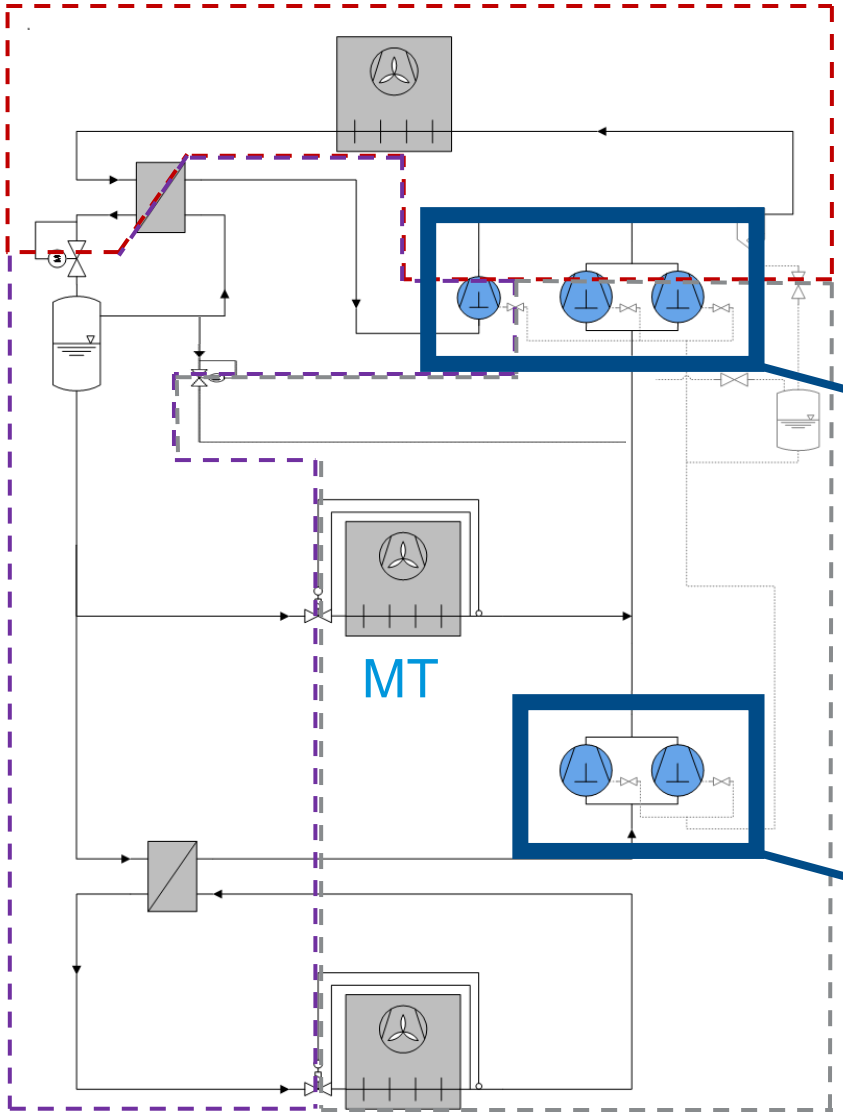
CO_2 T - transcritical compressors: LP/HP -> 100/150 bar

Low Temperature (LT) applications (subcritical):

CO_2 LT + ML CO_2 T – compressors for high stand still pressures (low temperature app.):
LP/HP -> 100/100 bar NEW

CO_2 – subcritical compressors (low temperature app.): LP/HP -> 40(30)/55 bar

CO_2 System Design - Pressure Requests (Stand still)



90 bar

up to 130 bar

LP/HP: 100/150 bar

CO_2 T (transcritical) compressors

LP: 40/(30) bar

CO_2 (subcritical) compressors

up to 40/(30) bar

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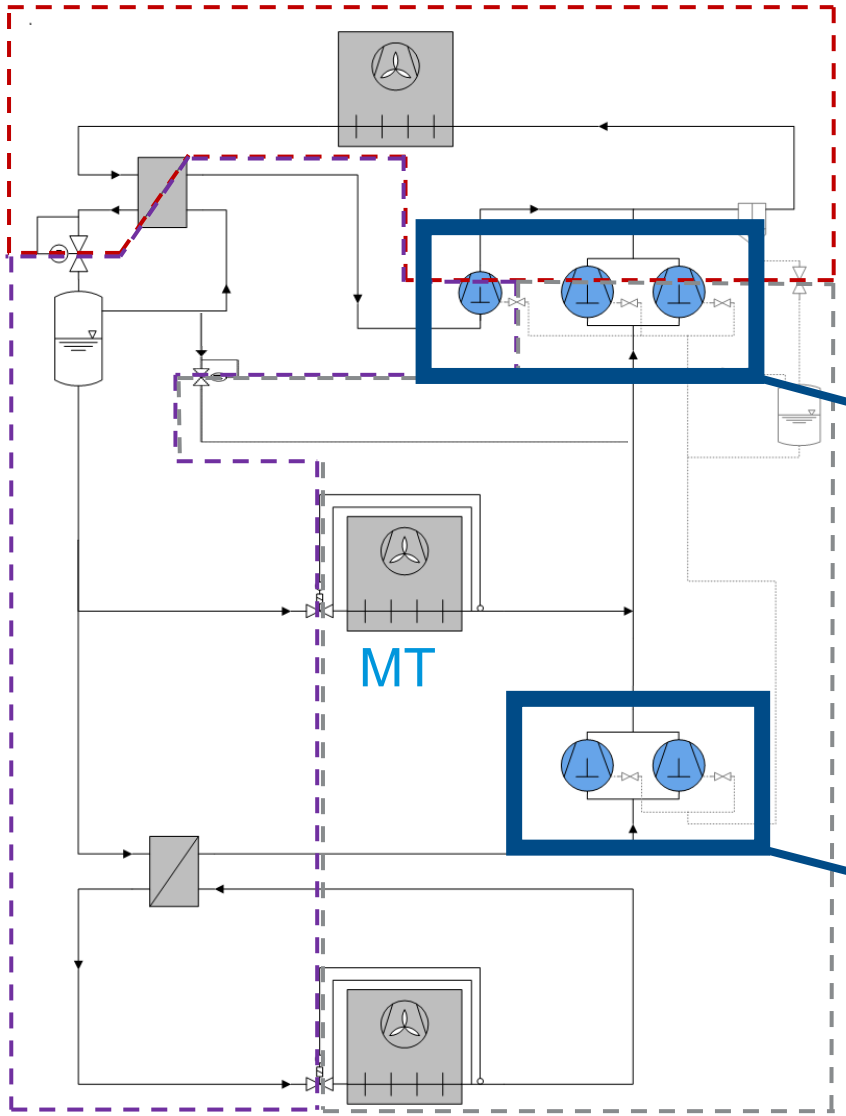
CO_2 System Design - Pressure Requests (Stand still)



up to 130 bar

90 bar

LP/HP: 100/150 bar

CO_2 T (transcritical) compressors

LP/HP: 100/100 bar

CO_2 LT (low temperature) compressors

up to 100 bar

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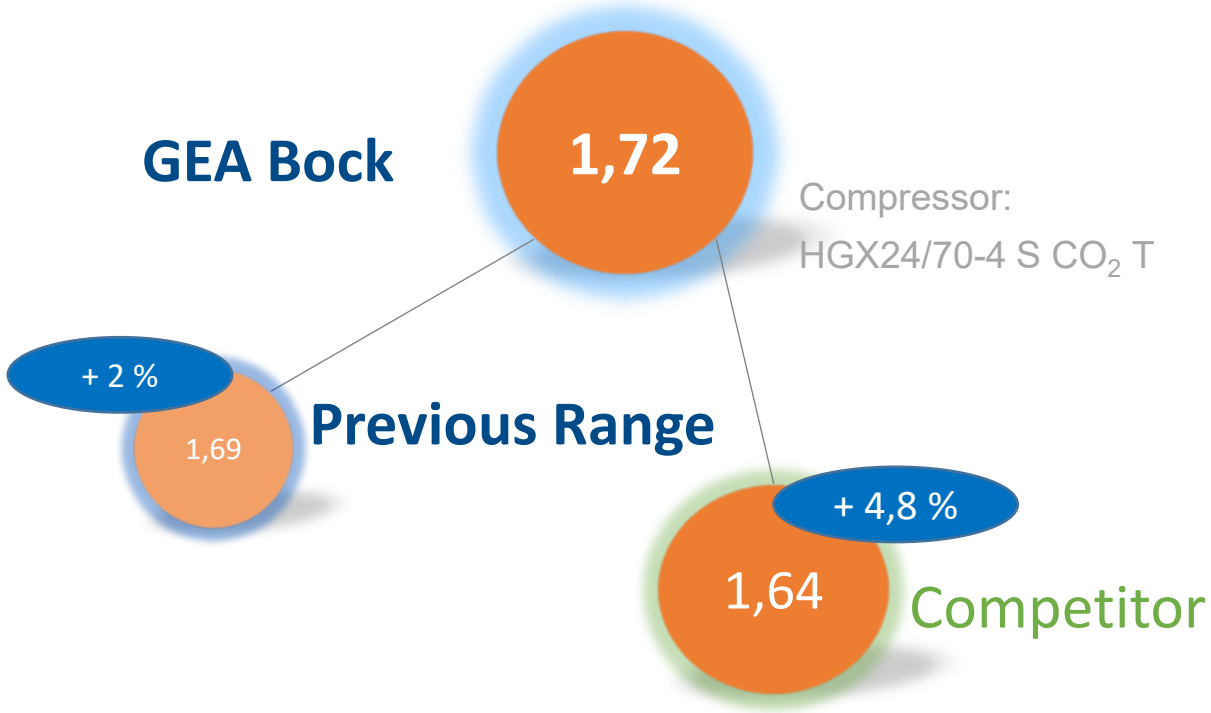
Bock Development Focus on NEW Compressors

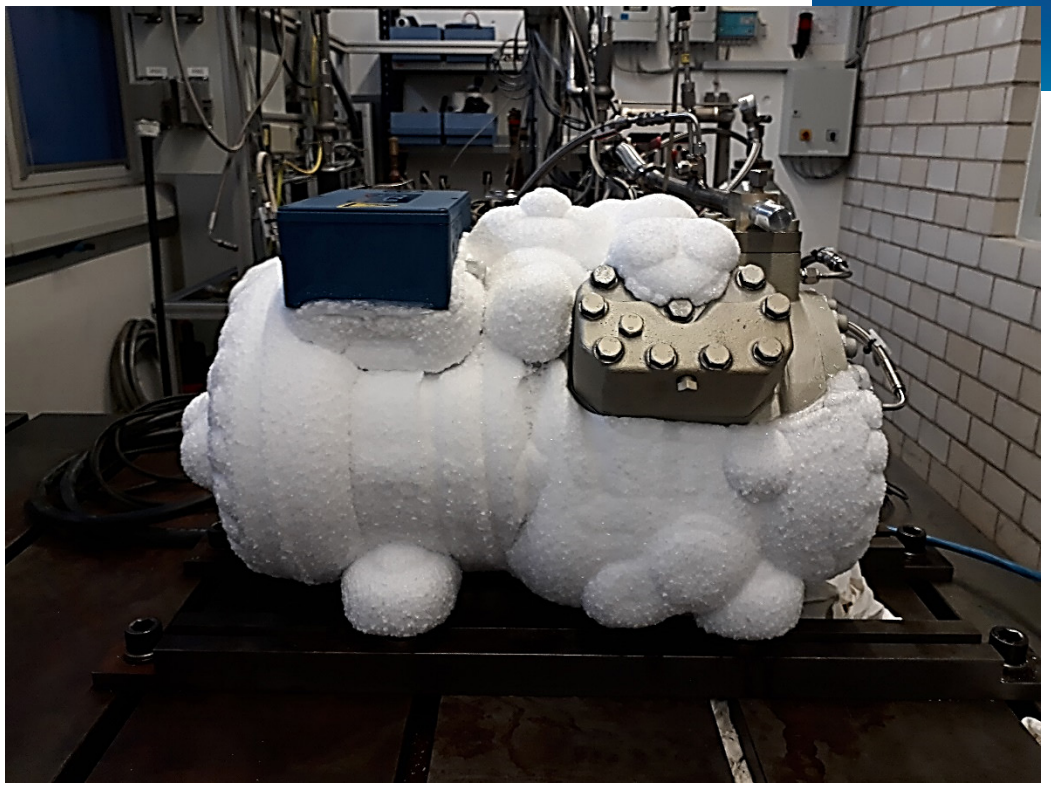
Efficiency

MT Efficiency (EER)



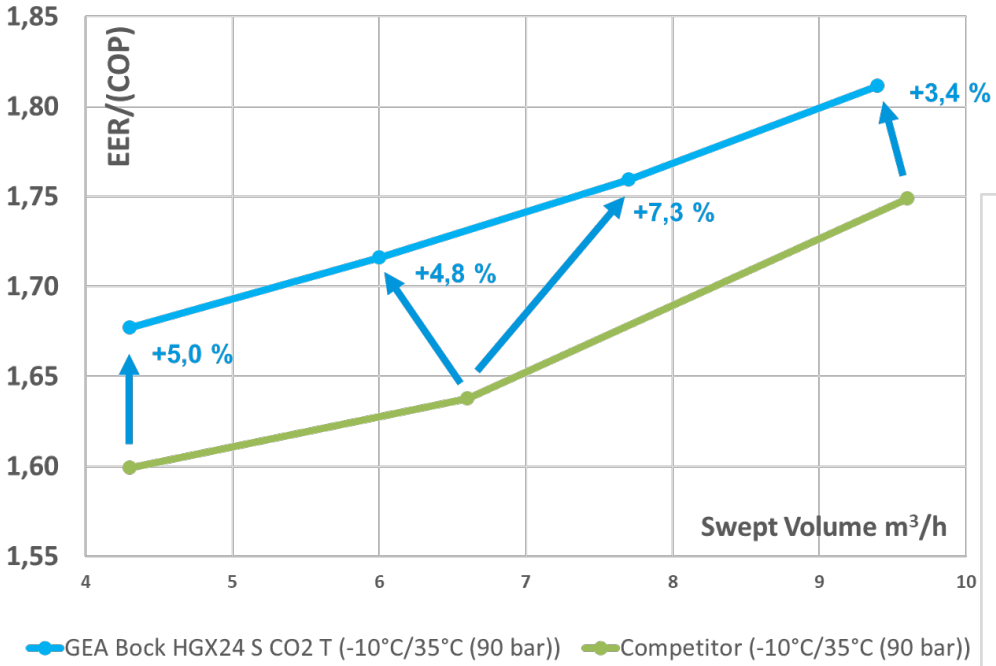
$t_o/t_{ga}(p_{v2})/t_{oh}$ = -10°C/35°C(90bar)/10K/50 Hz

Reliability



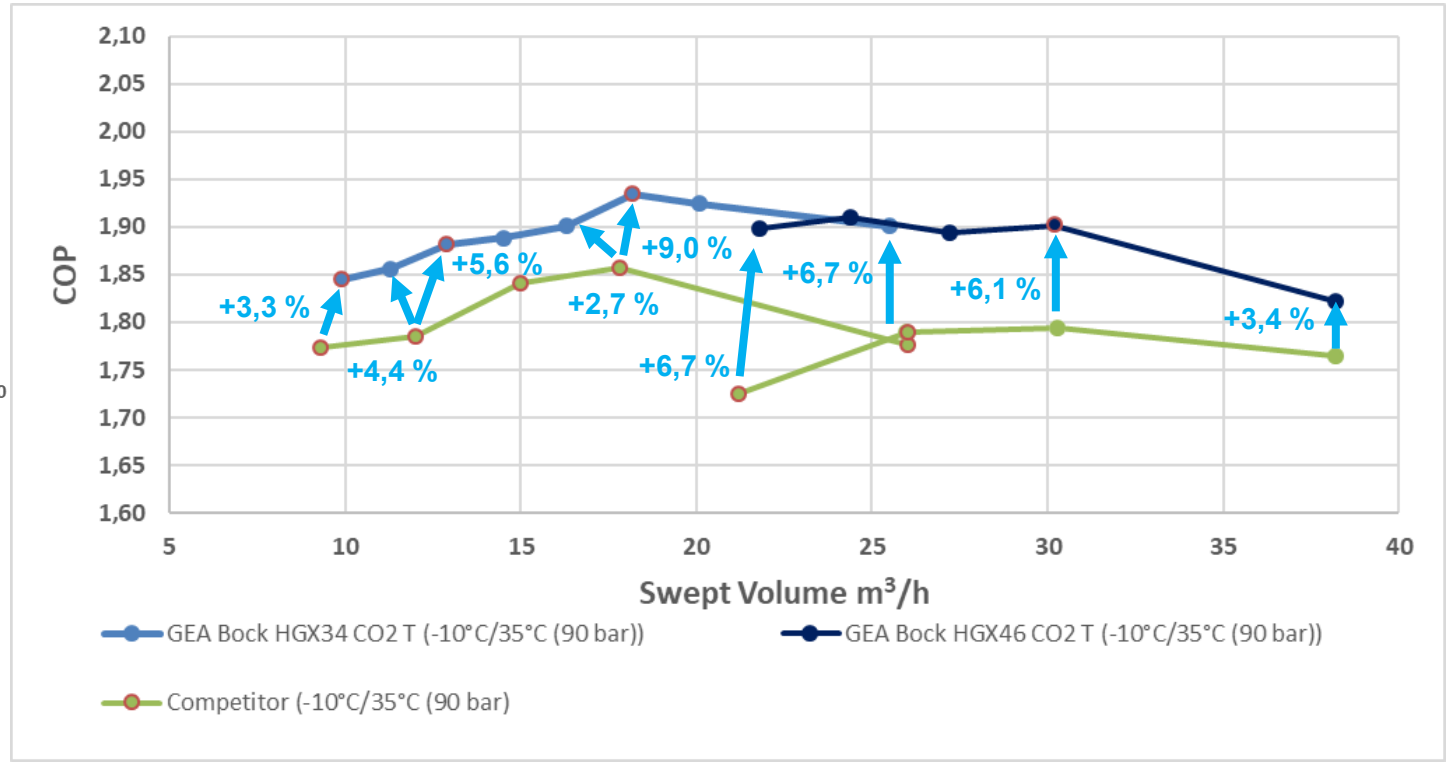
Validation & stress test in the Bock lab

Efficiency - Benchmark



Operating condition: summer

-10°C/**35°C** (90 bar)



CERTIFIED PRODUCT ASERCOM

comparision with standard motors

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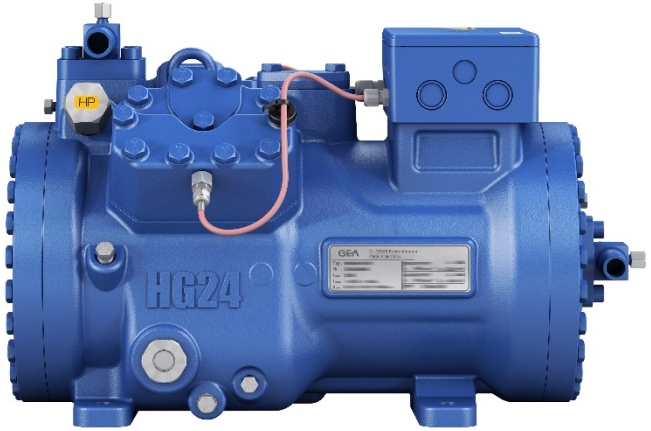
BOCK Benchmark in Efficiency

Why!

1. °Clever compressor thermo management
   - Consequent separation of hot discharge gas from cold suction gas
2. Low internal pressure and return flow losses
3. Low compressor oil carry over
4. Individual optimized components
   - Electrical motors
   - Driving gear
   - Valve plates
   - Shut off valves and filters
   - …

Reliability with CO_2

Long-life compressor design



High refrigerant (CO_2) soluble in oil

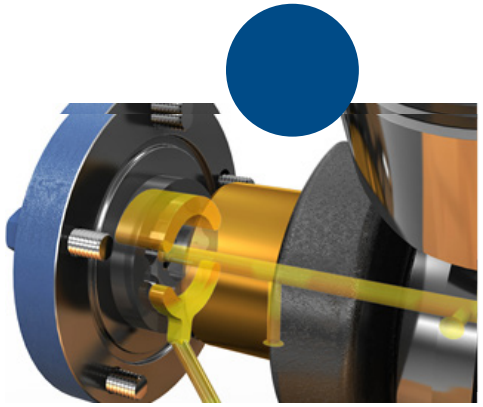
→ reduced oil viscosity

→ challenging compressor lubrication (extreme conditions)

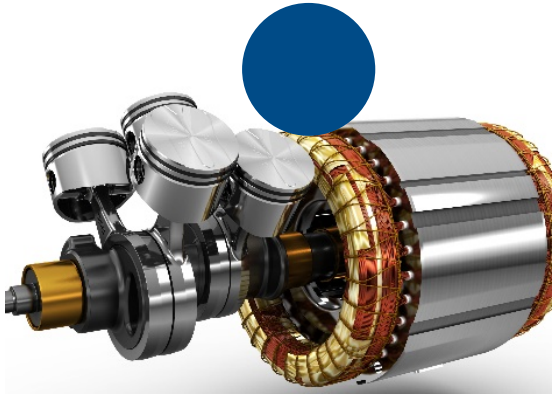
CO_2 has high cleaning effect

→ “Wash out” bearings (e.g. liquid operating in compressor)

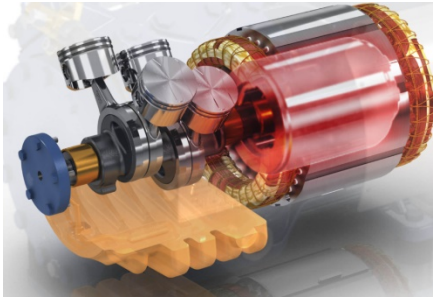
→ take everything along (e.g. dirt, particles…)

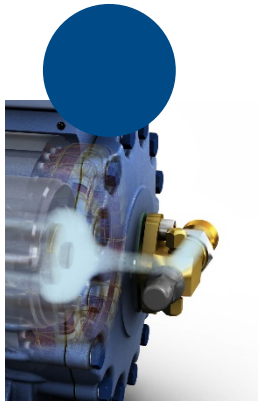


1. Oil management & CO_2 oil



2. Durable driving gear





3. Compressor protection measures

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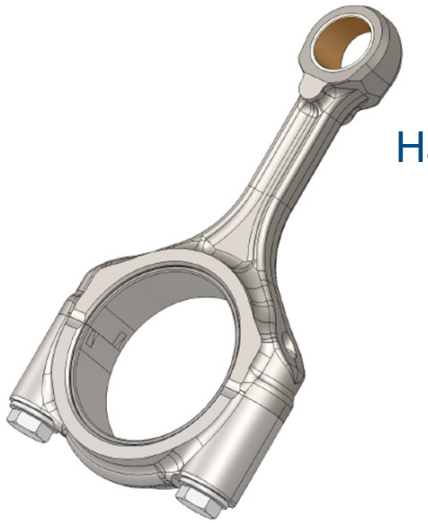
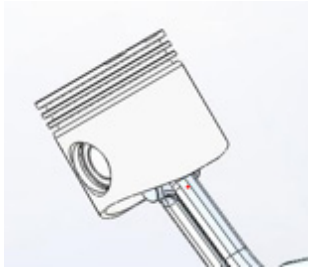
CO_2 T Compressors - Reliability / Sustainability

Steal piston conrod with unique design

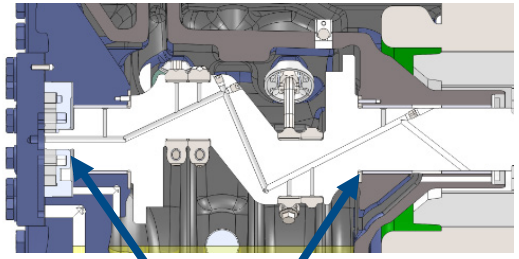
Conrod with shells & bushes



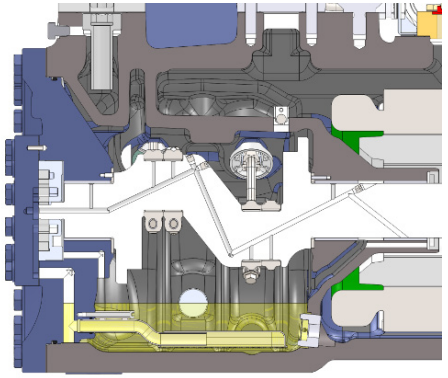
Hardened piston

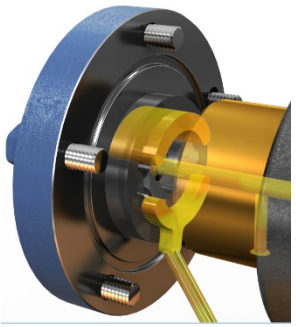


Honed cylinder liners



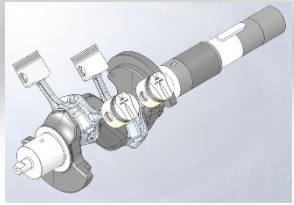
Thrust washers (2x)





Three piston rings with high performance design
(for high efficiency, high durability and low oil carry over)

Tempered crank shaft



Unexcelled oil management system with independent of direction of rotation oil pump (hardened design)

Solid design of the crank shaft
Differential pressures up to 105 bar

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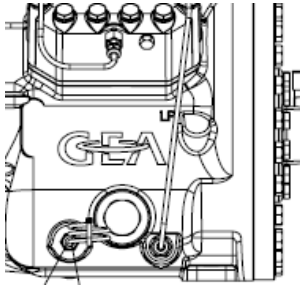
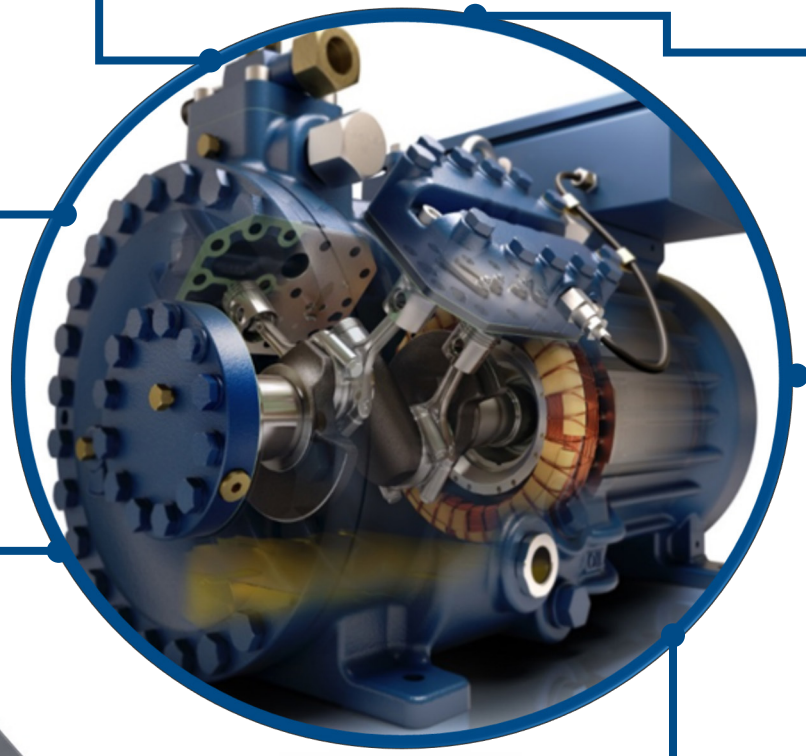
CO_2 T Compressors - Reliability / Sustainability

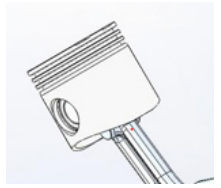
Generous designed oil sump heater

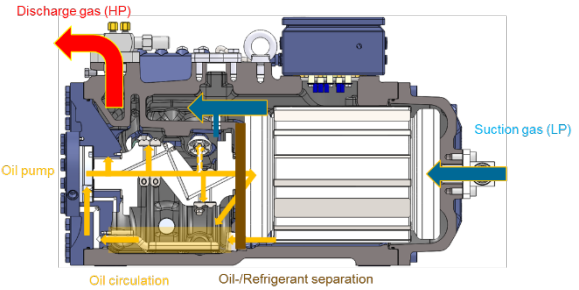


Oil temperature sensor (option)

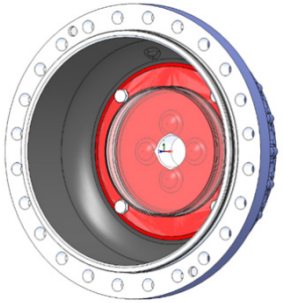


Lowest oil carry over design

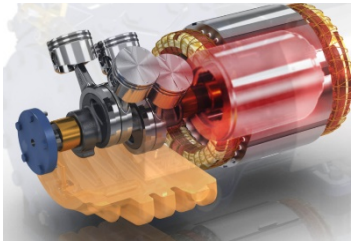


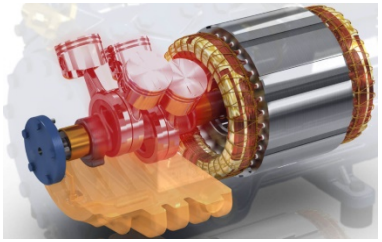


Dirt protection
(high filter effect on suction side, anti-dirt pocket on valve plate)*



Motor winding protection and thermal protection thermostat (option) with PTC sensors





Special oils for CO_2
POE & PAG based oil available

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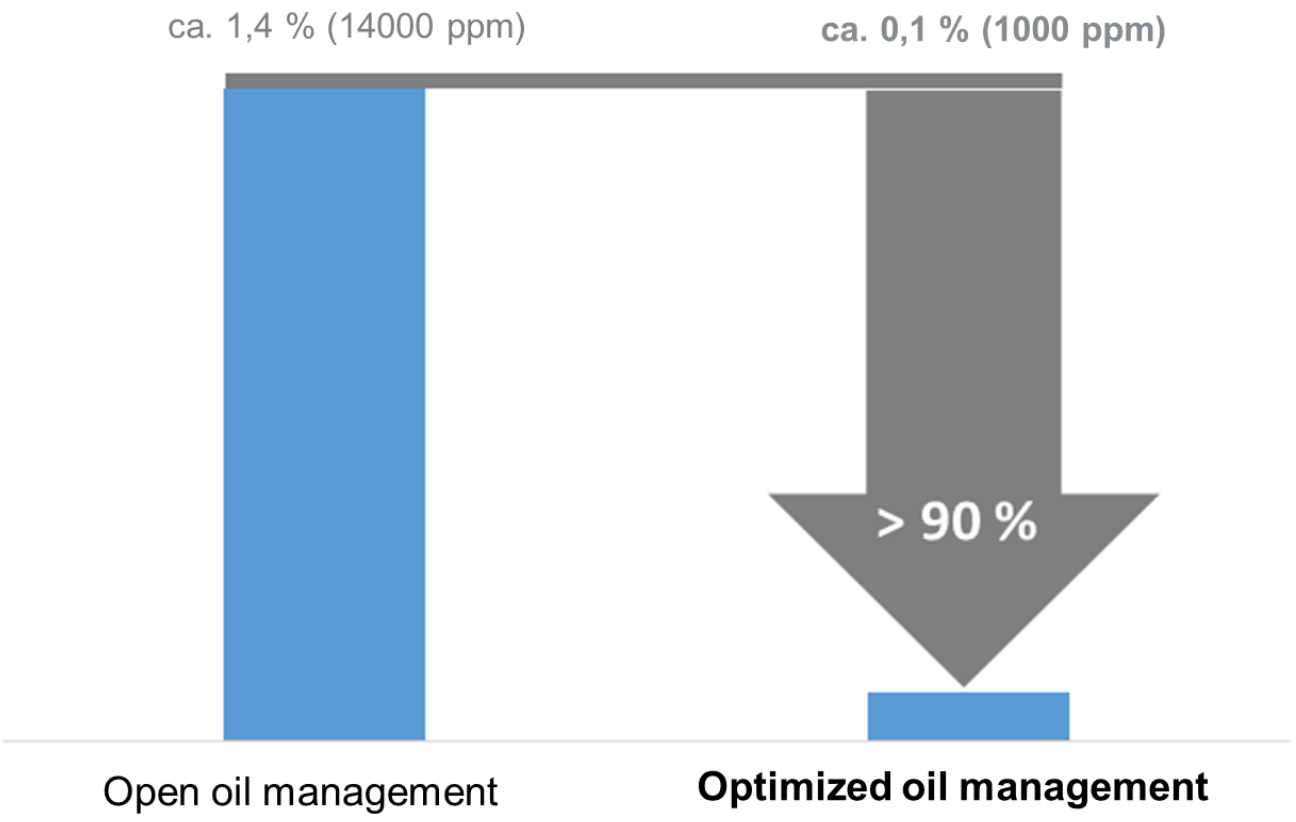
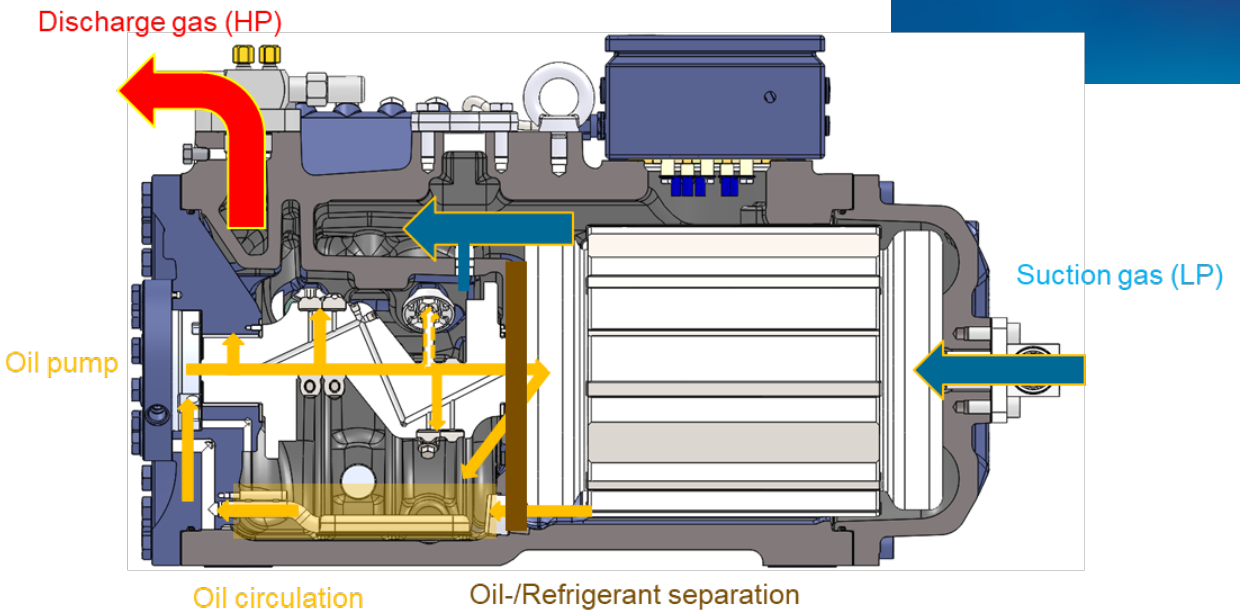
* Attention:
For systems with long pipes and higher degree of contamination, a additional filter on the suction side is highly recommended.

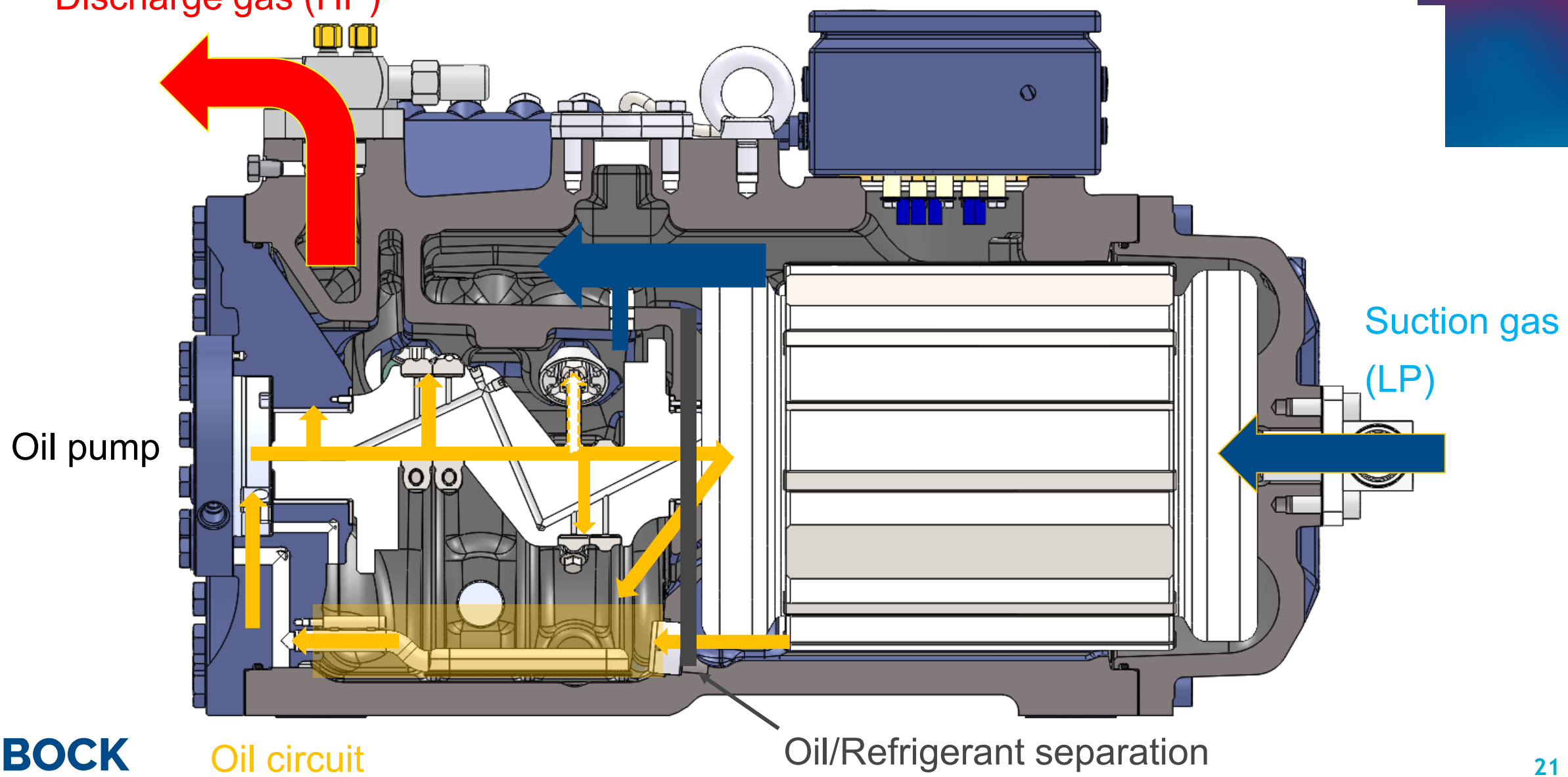
Compressor – Oil management



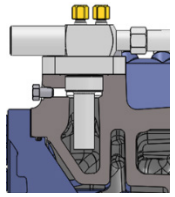


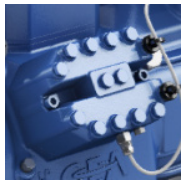
Oil throw reducing at to = 3°C (37,7 bar (abs.)) @ 50 Hz
Higher suction pressure rises oil carry over (value for all compressors)

Compressor Requirements - Oil Management



CO_2 T Compressors - Operating & Applications



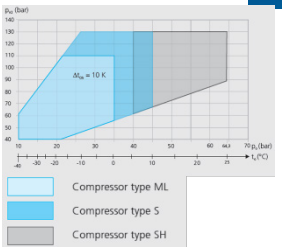


Low pulsation

- High discharge volume
- Pulsation damper

Operating conditions for all applications

- LT applications (extension on request)
- MT applications
- HP/AC applications



Excellent running behavior with low vibration

(entire frequency range 20-70 Hz)

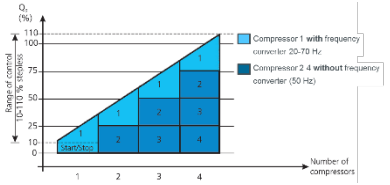
- Good mass balance
- Beneficial comp. design

Low noise level

Verdichtertyp compressor type	Normalkühlung subkritisch normal cooling subcritical -10 °C / 15 °C / 10 K		Normalkühlung transkritisch normal cooling transcritical -10 °C / 90 bar / 10 K		Klimaanwendung transkritisch air conditioning transcritical +5 °C / 100 bar / 10 K	
	L_{WA} 1)	L_{pA} 2)	L_{WA} 1)	L_{pA} 2)	L_{WA} 1)	L_{pA} 2)
HG34/110-4 ML CO2 T	73	60	73	60		
HG34/110-4 S CO2 T	73	60	73	60	73	59
HG34/110-4 SH CO2 T					73	59
HG34/130-4 ML CO2 T	74	61	74	61		

Excellent variable speed drive (VSD) with all CO_2 compressors

- CO_2 T trans. (4/4 & 6 cyl.): 30/20-70 Hz
- CO_2 sub. (2/4 cylinder): 25/30-70 Hz

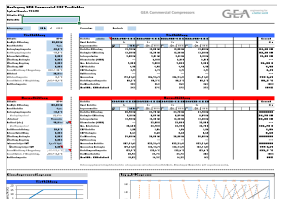


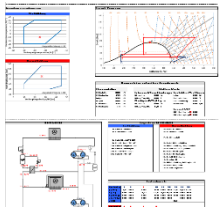
Compact dimensions

Documentation und Support

- Convenient handling compressor selection software ("VAP", CO_2 Booster calculation tool "CO_2 T(ool)"
- Important information material always available
- On demand: Application Engineers specialists

Flexible connection possibilities





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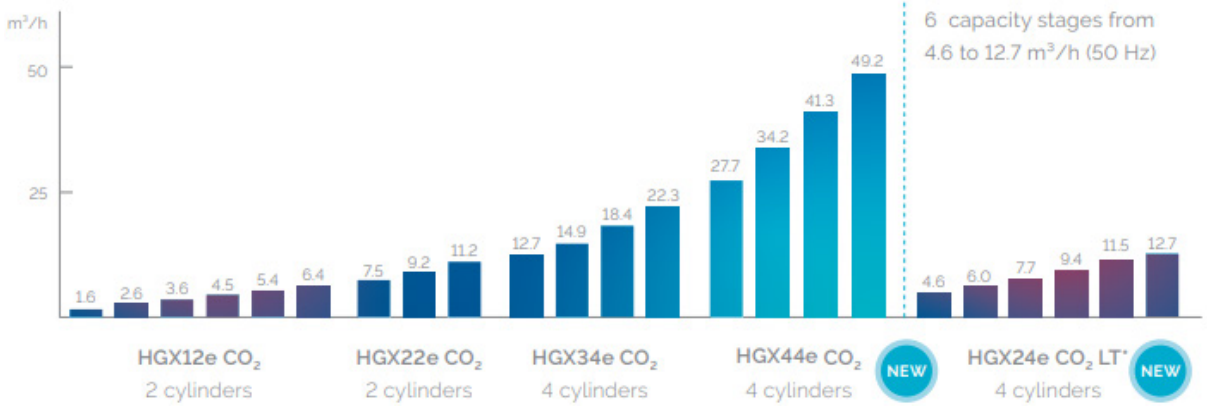
CO_2 Compressors - Product Program

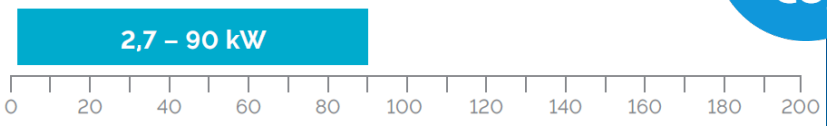
LT Applications (subcritical)

Subcritical CO_2 compressors (LP 40 bzw. 30 bar)
4 model sizes with 17 capacity stages from 1.6 to 49.2 m³/h (50 Hz)

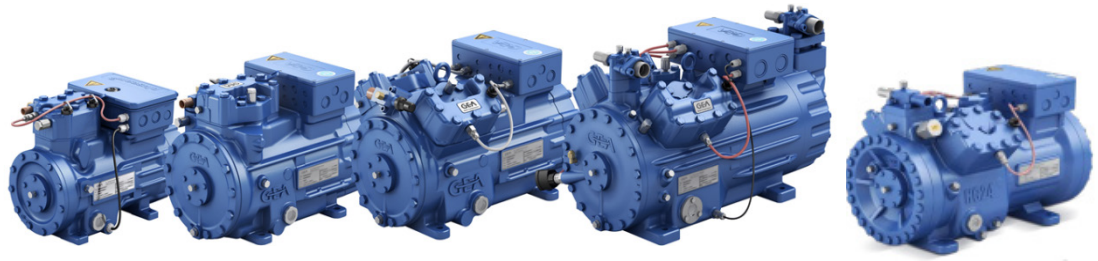
Subcritical CO_2 compressors (LT range – LP 100 bar)
1 model size with
6 capacity stages from
4.6 to 12.7 m³/h (50 Hz)



Cooling Capacity

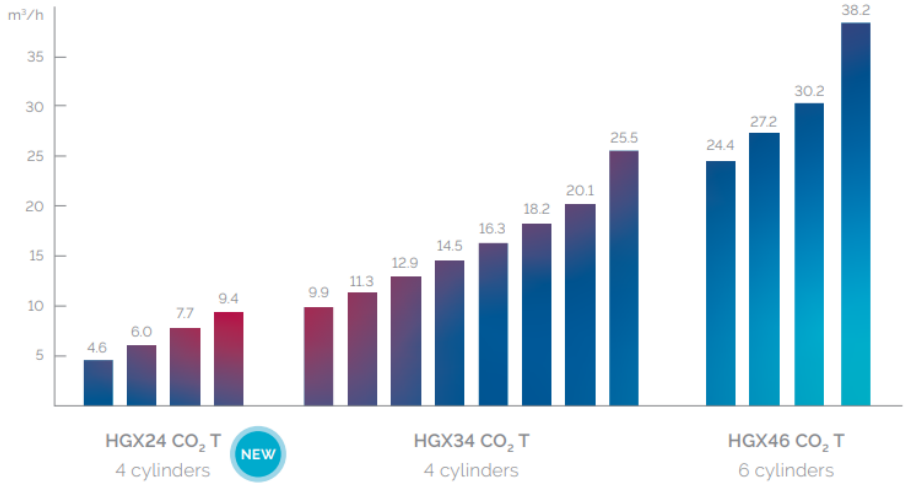


At 50 Hz [1450 rpm], evaporating temperature: –35 °C, condensing temperature: –5 °C, superheat: 10 K, subcooling: 0 K

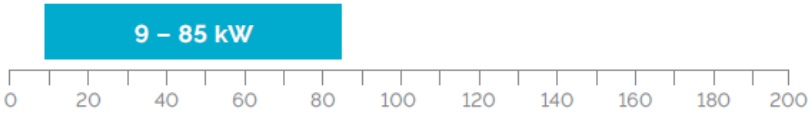


LT, MT, AC & HP Applications (transcritical)

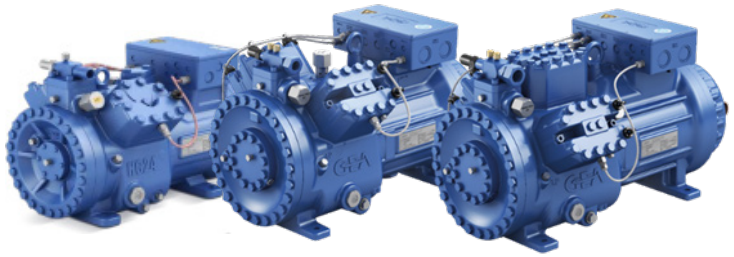
Transcritical CO_2 compressors
3 model sizes with 16 capacity stages from 4.6 to 38.2 m³/h (50 Hz)



Cooling Capacity



At 50 Hz [1450 rpm], evaporating temperature: –10 °C, gas cooler outlet temperature: +35 °C/90 bar, superheat: 10 K



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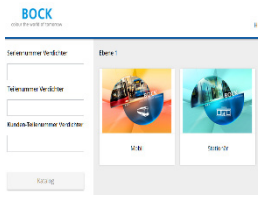
CO_2 Compressor and System Calculation and Selection

Bock VAP / **BockShop** software
for single compressor selection!

VAP Stationary Applications

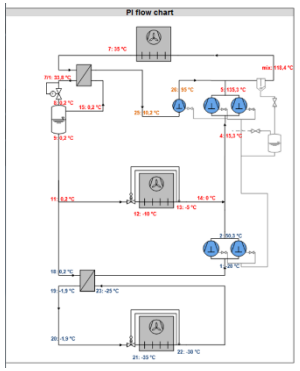
VAP Mobile Applications

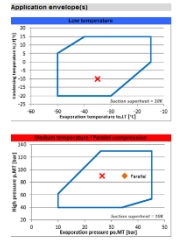
BockShop –
Online Spar Part Catalogue

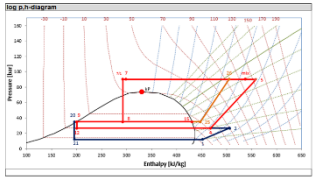


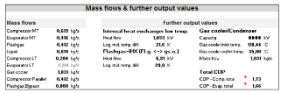
Source for all specific technical information,
performance data and documentations
for Bock compressors!
www.ullstromfepo.no(nedlastinger)

Bock CO_2 T(ool) software for CO_2
system and compressor selection!

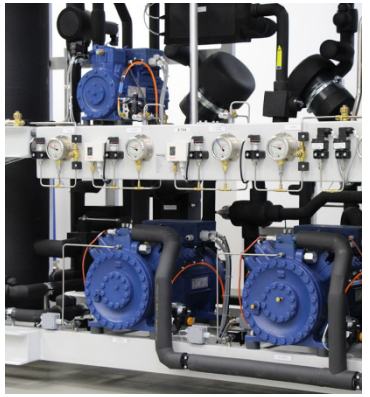








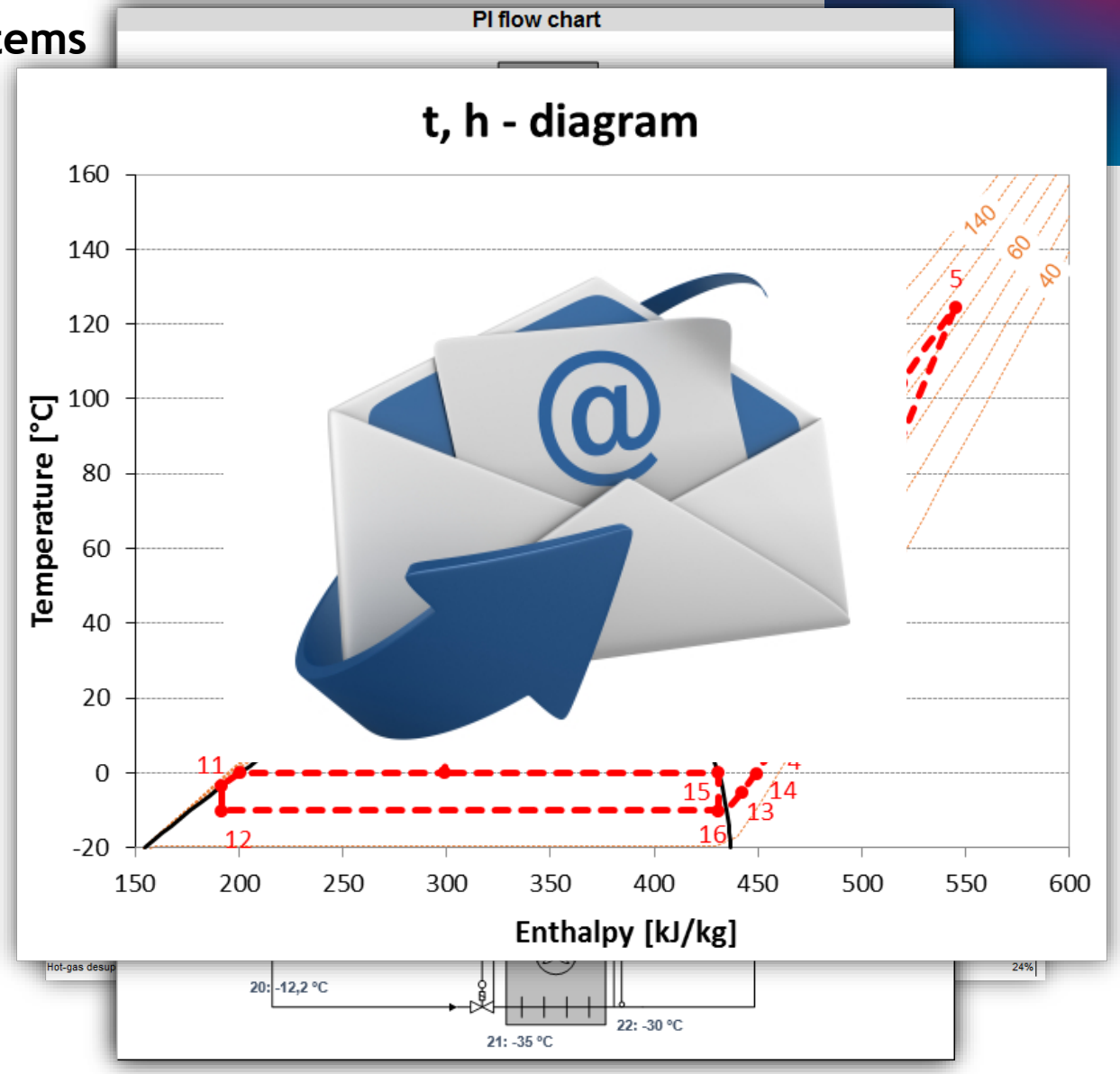
Source for CO_2 system and compressor
calculation and selection!



BOCK

GEA CO_2 T(ool) // CO_2 Booster Selection Program

- Selection of GEA Bock CO_2-compressors for **CO_2 Systems**
- **Available** system designs
  - Booster LT+MT (+ parallel compressor)
  - Booster only LT
  - Only MT
  - Heat recovery
- Software tool based on ***Microsoft Excel***
- Software available ***on request***
- www.ullstromfepo.no



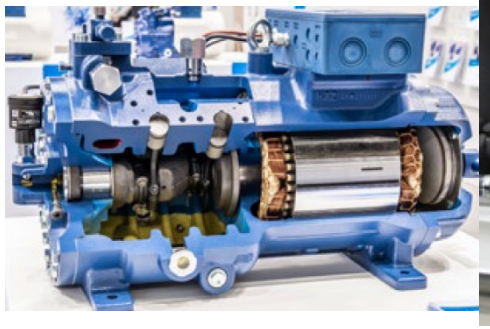
BOCK

Training at GEA Bock

GEA Bock training program:

- Electric Training + Workshop
- CO_2 Training + Workshop
- Specific customer trainings

Trainer: Frank Alisch (l.)



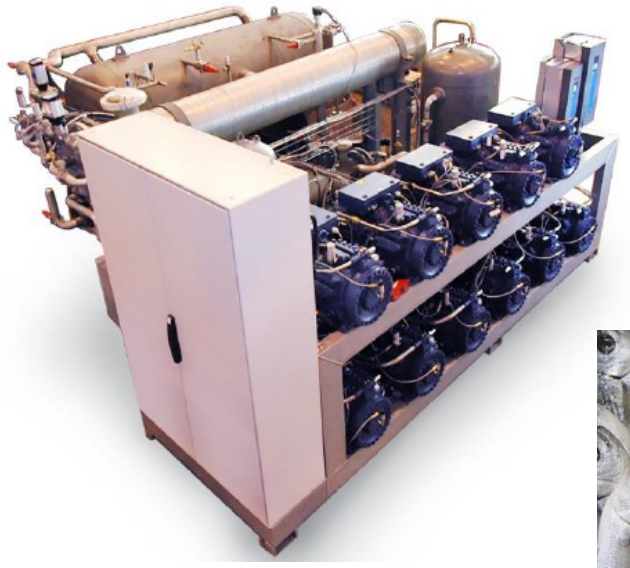
1. **Online Trainings** NEW
2. **Flammable refrigerants (A2L/A3)**

BOCK

BOCK colour the world of tomorrow

Bock GmbH . Benzstraße 7 . 72636 Frickenhausen . Germany . Tel +49 7022 9454-0 . Fax +49 7022 9454-137 . info@bock.de . bock.de

Food Production - Fishing (Freezer)



Information regarding CO_2 Booster

LT ref. capacity: 240 kW (-50° C)

1-stage: 5 x HGX46 CO_2 T (transcritical compressors)

2-stage: 6 x HGX46 CO_2 T (transcritical compressors)

Rack system: Kuldeteknisk AS

End-user: Nordic wildfish AS (Boat: Roaldnes)

Application: Fisher boat with CO_2 freezer

36 t fish per day (@ 25°C water temperature)

Higher freezing capacity of around 25 %

with higher freezer speed with CO_2 compared to R22

→ higher product quality

+ 20 % less volume of the refrigeration system

BOCK

Food Production - Fishing (Freezer)

Information regarding CO_2 System

LT ref. capacity: 500 kW

Compressors:

3 x Bock HGX46/345-4 S CO_2 T

Rack system:

Installer: Highland Refrigeration,

Seattle (Washington State, USA)

End-user: Global Seas

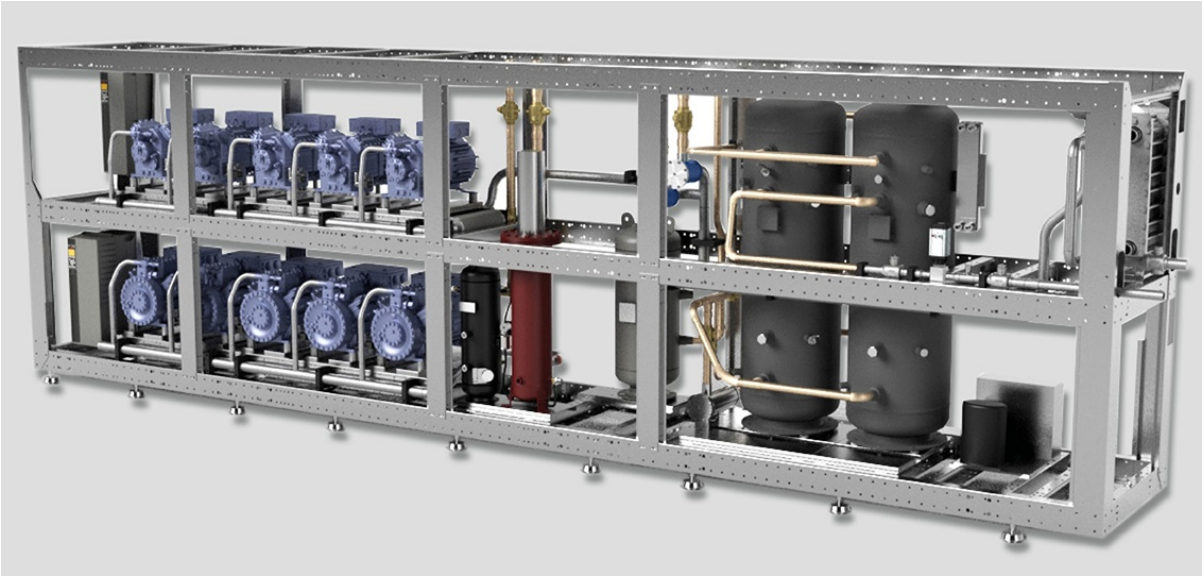
Boat: F/V Northern Defender

Application: Fisher boat with CO_2 freezer with up to 350 t of pollock (fish)

HIGHLAND REFRIGERATION

BOCK

Marine Applications



Information regarding CO_2 Booster

Compressors:

3x Bock HGX34/210-4S CO2 T

3x Bock HGX46/310-4 ML CO2 T

Rack system:

Installer: GEA Refrigeration

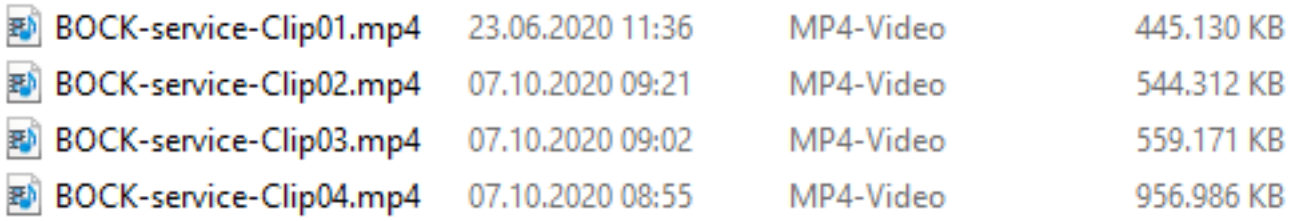
End-user: P&O Cruises (Carnival Corporation & PLC)

Application: Marine / Cruise Liner

BOCK

Thank you for your attention.

For å gå inn på VAP og BockShop bruk www.ullstromfepo.no



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BOCK-service-Clip02.mp4	07.10.2020 09:21	MP4-Video	544.312 KB
BOCK-service-Clip03.mp4	07.10.2020 09:02	MP4-Video	559.171 KB
BOCK-service-Clip04.mp4	07.10.2020 08:55	MP4-Video	956.986 KB

- How to replace, electric motor , valve plate or oil.