CO₂ // SEMI-HERMETIC
RECI PROCATING COMPRESSORS

ECOLINE // ECOLINE+ // VARISPEED

TRANSCRITICAL APPLICATIONS

WITH IQ MODULE
BITZER Innovation Targets

Products for refrigerants with low greenhouse warming potential (GWP)
// for naturally appearing substances
// for new refrigerants like R1234yf, R1234ze(E) and low-GWP-blends

These refrigerants reduce the direct contribution of refrigeration systems to global warming.

Products with high efficiency in full and part load
// Efficiency improvements of motor and mechanics
// high system efficiency in part load operation
  – by optimised mechanical capacity regulation
  – by specially developed frequency inverters

This reduces the indirect contribution to global warming by saving energy.

Simple handling and serviceability with advanced electronic modules
// Electronic components for
  – Data logging
  – Capacity regulation
  – Actuation of accessories
// Unified user software for simple configuration.
Choose compressor or condensing unit and refrigerant. Ready.

This makes it simple to fully utilize the efficiency potential of our products and optimise operation.

Semi-hermetic reciprocating compressors for CO₂

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Introduction

The refrigerant R744/CO₂ is used in many commercial and industrial refrigeration systems, as well as in heat pumps.

The ECOLINE compressors for transcritical applications are developed for medium temperature applications, heat pumps, heat recovery, and as parallel compressors in booster systems, and are also suitable for similar applications.
ECOLINE series for transcritical CO₂ applications

BITZER compressors for transcritical CO₂ applications have been used worldwide since 2004 with great success. The 2-, 4- and 6-cylinder compressors allow a wide range of applications, providing highest energy efficiency and operational reliability. By using new ECOLINE housings with flow optimized suction and discharge gas channels and high efficient motors, BITZER can offer an optimum efficiency for all CO₂ applications and markets.

Highlights and technical features

// The capacity range covers displacements from 3.3 m³/h to 38.2 m³/h
// Housing with high pressure strength and no bottom plate. Maximum permissible pressure levels:
  – High pressure side 160 bar
  – Low pressure side 100 bar
// Wear-resistant drive gear with further developed multilayer bearings
// Optimized oil management
// Quiet and low vibration
// Particularly well suited to the operation with frequency inverter in order to increase and control capacity
  Standard speed range:
  – 2MTE..2KTE: 30-75 Hz
  – 4PTC..4DTC: 25-70 Hz
  – 4CTC: 25-65 Hz
  – 6FTE..6CTE: 25-70 Hz
// High energy efficiency
  – suction gas-cooled motor – very suitable for speed regulation
  – very efficient working valves, special drive gear geometry
  – cylinder heads with separate, thermally isolated high and low pressure chambers
// Wide application range
  – in commercial and industrial refrigeration, air condition and heat pump systems

Capacity range ECOLINE series
ECOLINE + series for transcritical CO₂ applications

BITZER ECOLINE + provides the highest possible eco-efficiency. The natural refrigerant CO₂ is combined with highest efficiency. Smart electronics with easy application are added. The Line Start Permanent Magnet Motor (LSPM) improves the motor efficiency and increases the seasonal performance. A high seasonal performance reduces the TEWI (Total Equivalent Warming Impact) and operating costs and thus minimizes the refrigeration and A/C industry’s contribution to global warming.

Annual Energy Consumption [kWh]
- AS: asynchronous motor
- LSPM: LSPM motor
- SEPR (Seasonal Energy Performance Ratio)

Line Start Permanent Magnet Motor (LSPM)

// High efficiency of a synchronous motor due to permanent magnets
// Asynchronous (AS) motor start due to squirrel cage rotor
// Rotor of a LSPM motor synchronizes with the operating frequency, rotor losses become zero
// Increased efficiency over wide working range of the motor, see fig. 1
// Annual efficiency increasing in the range up to 14% due to highest improvements in the most common operating area, see fig. 2

// The technology combines the higher efficiency of the synchronous motor with the robustness and easy use of the asynchronous motor
// LSPM motors can either be connected directly to the power supply system or be operated with frequency inverter (frequency range defined by BITZER)
// A fast overcurrent protection device is required in order to avoid a demagnetization.

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Fig. 1: Comparison LSPM and AS motor: motor efficiencies versus relative power input
Fig. 2: COP improvement LSPM compared to AS motor at constant suction conditions
**ECOLINE VARISPEED series for transcritical CO₂ applications**

Due to the performance characteristics of CO₂ systems, an efficient and stepless capacity control is particularly important. For several years, BITZER has been offering its own compressors for transcritical CO₂ applications with integrated frequency inverter (FI).

What makes it special:

// The frequency inverter is solidly flanged on the compressor's motor cover.
// The suction gas cooling for the power elements of the FI ensures an optimum temperature of the electrical components and therefore no fan or regular maintenance work is needed.
// Through supersynchronous operation the compressor cooling capacity can be increased by approx. 70% compared to fixed speed at 50 Hz.

The stepless capacity control minimizes suction pressure fluctuations and cycling frequencies and therefore saves energy costs.

The quality of refrigerated and frozen products or the cooling process can be increased as well. Especially in single compressor applications the control characteristics can be significantly improved and for compound systems there are also considerable advantages. Here the controlled compressor takes the basic load and adapts the capacity when switching on and off additional compressors. This allows a stepless capacity modulation of the entire unit over a wide capacity range.

The compressor's running time is optimized by speed adjustment, and in combination with the soft starting characteristics of the FI the well-known unique ECOLINE reliability is further increased.

**Frequency range ECOLINE VARISPEED series**

Operation < 50 Hz partly restricted with high pressure ratios.
Accessories

IQ MODULE CM-RC-01

The new generation of extended BITZER compressor modules reliably operates, monitors and protects reciprocating compressors and communicates with the superior system controller. Sensors and actuators are prewired and preconfigured in the BITZER factory.
Option: 4PTEU .. 6CTEU

The new, extended protection concept

Intelligent actuation of the following components to improve the system efficiency:
// Oil heater
// VARISTEP capacity control

Monitor compression parameters:
// Motor and discharge gas temperature
// High-pressure switch
// Oil pressure (with the new oil pressure switch)
or oil level

Diagnosis:
// An early warning system signals critical operating conditions
// Data log of all digital and analog inputs and outputs
// Alarm and warning history
// Runtime and load statistics

Communication:
// via Modbus (standardized interface)
// via Bluetooth
// Configuration and operation monitoring via the BEST SOFTWARE
// Status LED for quick diagnosis

Capacity control VARISTEP

New mechanical capacity control especially for CO₂ compressors. Optionally available only with IQ MODULE.

// Designed for high pressures and pressure differences in transcritical CO₂ applications
// Adaption of the capacity to the demand in a wide range from 100% to ca. 10% to
– cover the large differences between summer and winter operation
– reach exactly matching capacity in compound operation
// Innovative control piston design for higher cycling frequency
// Virtually stepless capacity control, with easy and effective modulation by the CM-RC-01 module
// Rapid reactions to system changes, and thus, minimizations of pressure fluctuations
// Increased overall system efficiency through more stable and higher average suction gas pressure

See price list for scope of delivery
VARIPACK – External BITZER frequency inverters

For easy and safe capacity control, BITZER VARIPACK series offers a new generation of intelligent frequency inverters that can be used with all BITZER reciprocating compressors. The new VARIPACK frequency inverter series was specially developed for refrigeration and operation of BITZER refrigeration compressors. The focus of the development was the easy use, the reliability and the high performance of the frequency inverters.

Selection and assignment

The VARIPACK frequency inverters are completely integrated in the BITZER SOFTWARE and can be found under the button “Accessories”.

The visualisation of the resulting application limit allows you to create an economic but yet operationally safe selection for every application, even without any extensive special knowledge of frequency inverters and manual calculation steps.

Operation

Communication with the VARIPACK frequency inverters for configuring, monitoring and reading out fault messages can be done with
// The BEST SOFTWARE,
// The control panel.

Selection and assignment

The VARIPACK frequency inverters are completely integrated in the BITZER SOFTWARE and can be found under the button “Accessories”.

Easy Configuration

// Easy device parameterization
// Storage and installation of device and compressor setups
// Safe and easy firmware update

Reliable online diagnosis

// Display of all connected sensors, e.g. pressure transmitters, temperature sensors, oil level switches, digital and analog inputs and outputs
// Current operating point in the application limit
// Current capacity control status

Comfortable analysis

// Data log download and visualization of all operating parameters
// Alarm list with integrated help function for easy maintenance and service

Communication

// Via BEST interface converter and Bluetooth

See price list for scope of delivery
Application limits
based on 10 K suction gas superheat

2MTE(U)-5(L)K, 2KTE(U)-7(L)K, 4PTE(U)-7(L)K,
4MTE(U)-10(L)K, 4JTE(U)-15(L)K, 4FTE(U)-20(L)K,
4GTE(U)-30(L)K, 4FTE(U)-30(L)K, 6FTE(U)-50(L)K

Motor 1

\[ \Delta L_{oh} = 10 \text{ K} \]

2MTE(U)-4(L)K, 2KTE(U)-5(L)K, 4PTE(U)-6(L)K,
4MTE(U)-7(L)K, 4KTE(U)-10(L)K, 4JTE(U)-10(L)K,
4HTE(U)-15(L)K, 4GTE(U)-20(L)K, 4FTE(U)-20(L)K,
6DTE(U)-25(L)K, 6CTE(U)-30(L)K, 6FTE(U)-35(L)K,
6DTE(U)-40(L)K, 6CTE(U)-50(L)K

Motor 2

\[ \Delta L_{oh} = 10 \text{ K} \]

2MTE(U)-4(L)K, 2KTE(U)-5(L)K, 4PTE(U)-6(L)K,
4MTE(U)-7(L)K, 4KTE(U)-10(L)K, 4JTE(U)-10(L)K,
4HTE(U)-15(L)K, 4GTE(U)-20(L)K, 4FTE(U)-20(L)K,
6DTE(U)-25(L)K, 6CTE(U)-30(L)K, 6FTE(U)-35(L)K,
6DTE(U)-40(L)K, 6CTE(U)-50(L)K

Motor 1

\[ \Delta L_{oh} = 10 \text{ K} \]


Motor 2

\[ \Delta L_{oh} = 10 \text{ K} \]

4PTE-7.F3K

Suction gas superheat > 10 K causes a reduced application range –
requires, if necessary, controlled refrigerant injection into the suction
line and thermal protection by means of a discharge gas temperature
sensor.

\[ t_0 \] Evaporating temperature (°C)

\[ \Delta L_{oh} \] Suction superheat (K)

\[ p_o \] Suction pressure abs. (bar)

\[ p_h \] High pressure abs. (bar)

\[ \circ \] Range with limitations for the compressors 4PTEU

Mind operating parameters

- minimize suction pressure variations
- consider maximum cycling frequency
Consultation with BITZER is recommended.

Oil charge

BSE85K: Standard
BSG68K: Option as standard oil charge and recommended with
suction pressure >40 bar and/or high pressure
>120 bar (e. g. heat pumps)
The BITZER SOFTWARE is available in many languages as download for Windows or online version. It is compatible with all browsers and always up to date. The program is ideal for tablets and smartphones.

The BITZER SOFTWARE covers:

- Performance data for all common refrigerants at freely selectable operating conditions
- All relevant technical data
- Calculation results and individually designed performance tables for compressors
- Seasonal calculation
- Parallel compounds
- Available accessories and their selection
- All relevant technical documents
- More BITZER products

www.bitzer-software.com
ASERCOM certified performance data

The Association of European Refrigeration Component Manufacturers (ASERCOM) has implemented a procedure of certifying compressor performance data. The high standard of this certification is assured by

- plausibility checks of the data performed by experts
- regular random tests at independent institutes

These high efforts result in the fact that only a limited number of compressors can be submitted. Due to this not all BITZER compressors are certified yet.

Performance data of compressors which meet the strict requirements may carry the label “ASERCOM certified product”. All certified compressors and further information are listed on the ASERCOM website (www.ASERCOM.org).

In the BITZER SOFTWARE the appropriate compressors are marked with this label.

Explanation of model designation

Example

<table>
<thead>
<tr>
<th>4 M T E U</th>
<th>10 L .F4 K</th>
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Index for number of cylinders

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<tr>
<th>4 M T E U</th>
<th>10 L .F4 K</th>
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</table>

Identification letter for bore x strake

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</table>

Identification letter for transcritical CO₂ application

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<th>4 M T E J</th>
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Identification letter BITZER ECOLINE

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Identification letter BITZER ECOLINE +

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Code for motor size

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Motor codes: LSPM motor

<table>
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Code for frequency inverter

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Identification letter for oil charge

K = BSE85K, Z = BSG68K
Technical data and performance data

Performance data 50 Hz

based on 10 K suction superheat and compressors with suction and discharge shut-off valve.

Condenser and gas cooler conditions: $i_{CC} = 35 \degree C$, $p_r = 90$ bar.

<table>
<thead>
<tr>
<th>Compressor type</th>
<th>Motor version</th>
<th>Displacement at 50 Hz</th>
<th>Number of cylinders</th>
<th>Refrigerating capacity $Q_0$ (kW)</th>
<th>$l_0 = -10 \degree C$</th>
<th>$l_0 = +5 \degree C$</th>
<th>Power consumption $P_0$ (kW)</th>
<th>Oil charge (l)</th>
<th>Weight (kg)</th>
<th>Pipe connections</th>
<th>Motor</th>
<th>Electrical data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$l_0 = -10 \degree C$</td>
<td>$l_0 = +5 \degree C$</td>
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<td></td>
<td></td>
<td></td>
<td>Max. operating current</td>
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<td>m³/h</td>
<td>kW</td>
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</tbody>
</table>

Tentative data

KP-130-10 EN
Technical data and performance data

Performance data
based on 10 K suction superheat and compressors with suction and discharge shut-off valve.

Condenser and gas cooler conditions:
\( t_{GC} = 35^\circ C, \ p_h = 90 \text{ bar.} \)

<table>
<thead>
<tr>
<th>Compressor type</th>
<th>Motor version</th>
<th>Displacement at 87 Hz</th>
<th>Number of cylinders</th>
<th>Refrigerating capacity</th>
<th>Power consumption</th>
<th>Oil charge</th>
<th>Weight</th>
<th>Pipe connections</th>
<th>FU connection</th>
<th>Electrical data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( Q_0 (kW) ) ( t_0 = -10^\circ C ) 28 Hz 87 Hz</td>
<td></td>
<td></td>
<td>( P_e (kW) ) ( t_0 = -10^\circ C ) 28 Hz 87 Hz</td>
<td></td>
<td></td>
<td></td>
<td>DL</td>
<td>SL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>m(^3)/h kW kW kW dm(^3) kg mm mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4PTE-7.F3K</td>
<td>1</td>
<td>7,5 4 3,4 14,1</td>
<td>281 9,23</td>
<td>2,0 123 18 22</td>
<td>18,5 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4MTE-10.F4K</td>
<td>2</td>
<td>11,5 4 5,55 23,0</td>
<td>4,48 14,72</td>
<td>2,0 123 18 22</td>
<td>27,0 17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4KTE-10.F4K</td>
<td>2</td>
<td>16,8 4 8,32 34,5</td>
<td>6,36 20,9</td>
<td>2,0 123 18 22</td>
<td>38,0 25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Explanations

1. Tolerance (+10%) based on mean value of voltage range. Other voltages upon request.
2. For the selection of contacts, cables and fuses the max. working current/max. power consumption must be considered. A fast overcurrent protection device is required.
3. Contactors: operational category AC3
4. Data for compressors with voltage 380...420 V (220...240 V) are based on an average voltage of 400 V (230 V).
5. Conversion factors: 380 V (220 V) 0,95 420 V (240 V) 1,05
6. PW: motor for part winding start winding partition 50%/50%
7. Select motor contactors for approx. 60% of the max. operation current.
8. Pipe connections may vary depending on the selected shut-off valve. See operating instructions KB-130.
9. Reduced voltage range: - 380...400/3/50 - 440...460/3/60
10. Input frequency inverter
11. Oil charge: BSE85K
12. Including frequency inverter

Oil heater

// 230V
- 2MTE-4K..4KTE-10K: 0..120 W
- 4JTE-10K..6CTE-50K: 0..140 W
- 4PTEU..4KTEU: 0..120 W
- 6FTEU..6CTEU: 0..140 W
- 4PTE-7.F3K..4KTE-10.F4K: 0..120 W
- Self-regulating PTC heater

Oil heater is generally required due to high solubility of CO\(_2\) in the oil.

\[ t_e \] Evaporating temperature (\( ^\circ C \))
\[ p_h \] High pressure abs. (bar)
\[ l_{GC} \] Gas cooler outlet temperature (\( ^\circ C \))

Tentative data
Dimensional drawings

2MTE-4K..2KTE-7K

4PTE-6K..4KTE-10K

4JTE-10K..4FTE-20K, 4JTEU-10LK..4FTEU-20LK

Connection positions see page 15
Dimensional drawings

**4FTE-30K..4CTE-30K, 4FTEU-30LK..4CTEU-30LK**

**6FTE-35K..6CTE-50K, 6FTEU-35LK..6CTEU-50LK**

**4JPTE-7.F3K..4KTE-10.F4K**

Connection positions see page 15
Connection positions

1  High pressure connection (HP)
2  Low pressure connection (LP)
3  High pressure connection (HP)
4  Oil fill plug
5  Oil drain
6  Oil drain
7  Connection for oil and gas equalization (parallel operation)
8  Crankcase heater
9  Oil pressure connection +
10 Oil pressure connection –
11 Oil pressure connection +
12 Oil pressure connection –
13 Connection for oil monitoring
14 Connection for oil monitoring
15 Connection for oil monitoring
16 Connection for oil monitoring
17 Connection for oil monitoring
18 Connection for oil monitoring
19 Connection for oil monitoring
20 Connection for oil monitoring
21 Connection for oil monitoring
22 Pressure relief valve to the atmosphere (HP)
23 Connection for pressure relief valve (LP) to the atmosphere

SL  Suction shut-off valve
DL  Discharge shut-off valve