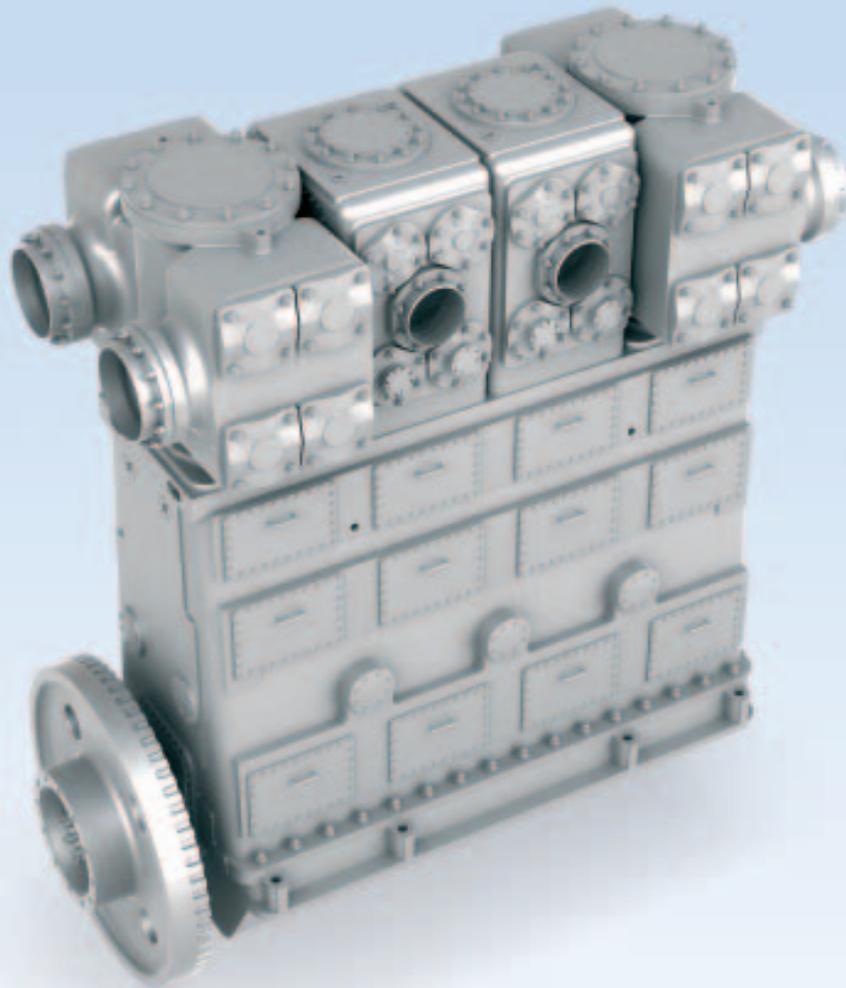


LABY® COMPRESSORS

CONTACTLESS LABYRINTH SEALING
FOR HIGHEST AVAILABILITY



MARKETS AND APPLICATIONS

FROM NATURAL GAS PROCESSING TO POLYOLEFIN PRODUCTION AND INDUSTRIAL GAS APPLICATIONS

GAS TRANSPORT & STORAGE

C_nH_m boil-off gas (BOG) handling

Liquefied natural gas (LNG)

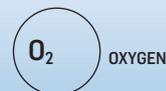
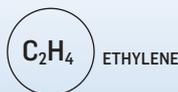
Liquefied petroleum gas (LPG)

Liquefied ethylene gas (LEG)

Natural gas handling and reliquefaction



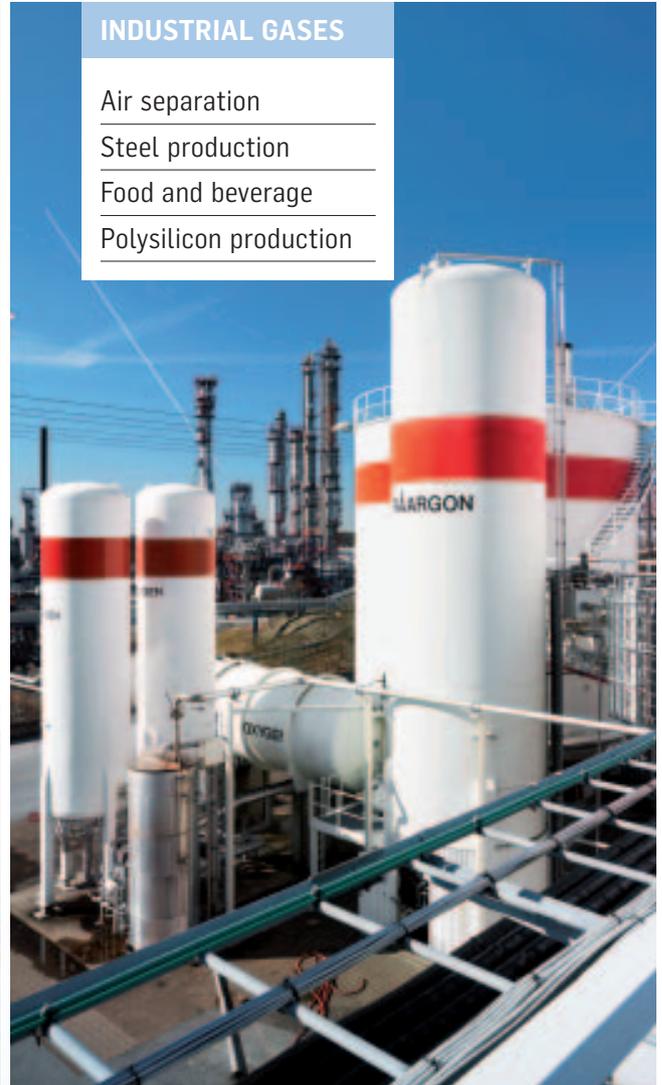
GASES HANDLED (INCLUDING CRYOGENIC, CONTAMINATED, CORROSIVE, EXPLOSIVE AND TOXIC GASES)





**PETROCHEMICAL/
CHEMICAL INDUSTRY**

- _____
Polypropylene production
- _____
Polyethylene production
- _____
Ethylene oxide
- _____
Ethylene glycol
- _____
Fertilizer production
- _____
Acetic acid production



INDUSTRIAL GASES

- _____
Air separation
- _____
Steel production
- _____
Food and beverage
- _____
Polysilicon production



BURCKHARDT COMPRESSION

INVENTOR OF THE LABY® COMPRESSOR

AND MARKET LEADER

Burckhardt Compression is recognized as the global technology leader in the reciprocating compressor world. As an OEM with over 160 years of in-house experience in developing, engineering and manufacturing compressors, we are committed to highest reliability and best quality.

75 YEARS OF CONTINUOUS DEVELOPMENT – A SUCCESS STORY

Since Burckhardt Compression first introduced the Laby® Compressor in 1935 we have been able to increase our application know-how. In close cooperation with our customers we have transferred this know-how into a second to none compressor solution with outstanding performance. Originally designed for the safe compression of ammonia, continuous improvements and further developments have made the Laby® today one of the most reliable compressor solutions for numerous applications handling complex gases:

- Bone-dry gases
- Humid gases
- Cryogenic gases
- Dirty, dust laden, contaminated gases in fouling services
- Clean gases where no pollution of the gas is allowed
- Reactive, explosive, corrosive or toxic gases

All major industrial gas suppliers, global players in the polyolefin production, renowned process licensees, international partners for gas liquefaction systems and many producers of chemicals trust Burckhardt Compression and depend on the unsurpassed reliability of Laby® Compressors. Thousands of installations underscore this long success story.

WHAT'S THE SECRET BEHIND?

The Laby® is a vertical in-line reciprocating compressor with a simple and rugged compressor design including two features which make the Laby® unique.

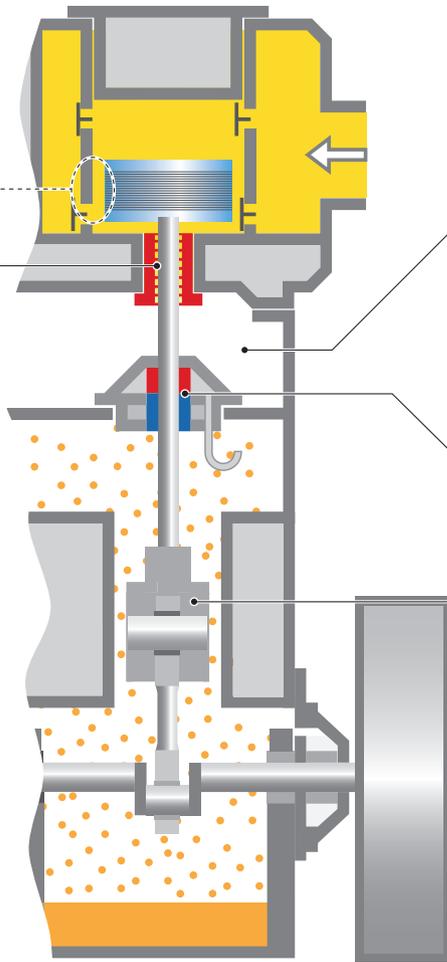
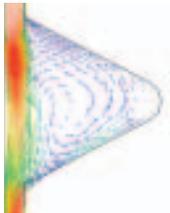
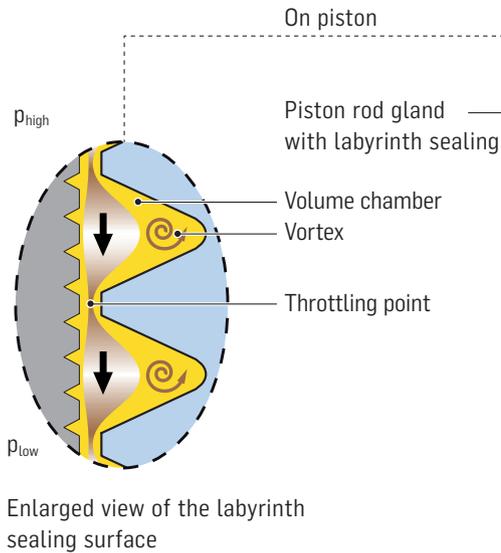
LABYRINTH SEALING – FOR CONTACTLESS, OIL-FREE COMPRESSION

The unique technology is applied between the piston and cylinder wall and between the piston rod gland and the piston rod. The labyrinth sealing effect is created by numerous tiny throttling points. At each of these throttling points, pressure energy is transformed into kinetic energy as a result of the flow restriction. The process continues at each throttling point/volume chamber combination along the piston and piston rod gland until the required reduction in pressure is attained. A small clearance volume is maintained between the adjoining surfaces. The low level amount of gas passing through the sealing system is recovered internally.

SEPARATION OF SEALING AND GUIDING ELEMENTS – FOR LOWEST WEAR AND LOWEST MAINTENANCE

The strict separation of the lubricated guiding elements in the crankgear from the contactless sealing elements of the piston and piston rod is essential for the functionality and efficiency of the compressor. The oil scraper rings, located close to the guide bearing, ensure the most efficient removal of oil from the piston rod. Lubricating oil is prevented from entering the compression room.

Contactless labyrinth sealings for highest reliability:



oil-free gas compression
 lubricated area

Cross section of a Laby® Compressor

YOUR BENEFITS

HIGHEST AVAILABILITY AND RELIABILITY

- No permanent mechanical friction in the compression area – no wear
- Minimum quantity of wear parts
- Longest MTBO
- Lowest maintenance costs

MOST ECONOMIC OPERATION

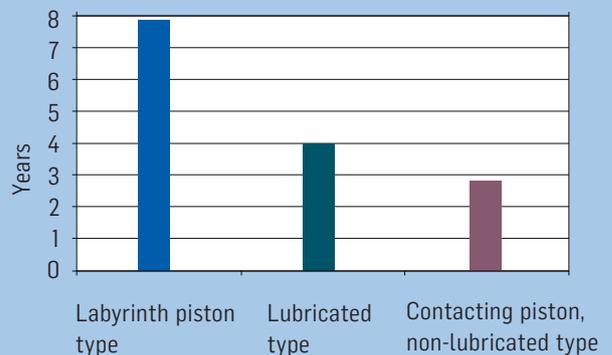
- No contamination of highly pure gases with oil or abrasives from piston rings or rider rings
- No loss of valuable product
- Lowest operating costs

HIGHEST SAFETY

- Safest compressor for oxygen service
- No friction – no hot spots in the cylinder

INDEPENDENT RESEARCH HAS REVEALED

MTBF (MEAN TIME BETWEEN FAILURE) OF RECIPROCATING COMPRESSORS



UP TO 2.5 TIMES HIGHER RELIABILITY!

Source: H.P. Bloch, Hydrocarbon Processing, January 2002

DESIGN FEATURES

FOR MAXIMUM RELIABILITY, AVAILABILITY AND DURABILITY

IN-HOUSE DESIGNED AND MANUFACTURED MAIN PARTS – FOR RELIABILITY

PISTONS AND CYLINDERS WITH LABYRINTH SEALING

- Contactless – no wear
- Oil-free compression
- No cylinder liner required
- Single or double acting
- Simple and robust 3-piece design
- Contactless sealing and applied materials allow high discharge temperatures if required by the process
- No tribological limitations – material selection according to process requirements

CAPACITY CONTROL OPTIONS

- Adaptation to process requirements
- For highest efficiency in part-load operation
- Valve unloaders
- Variable speed
- Clearance pockets

PISTON RODS

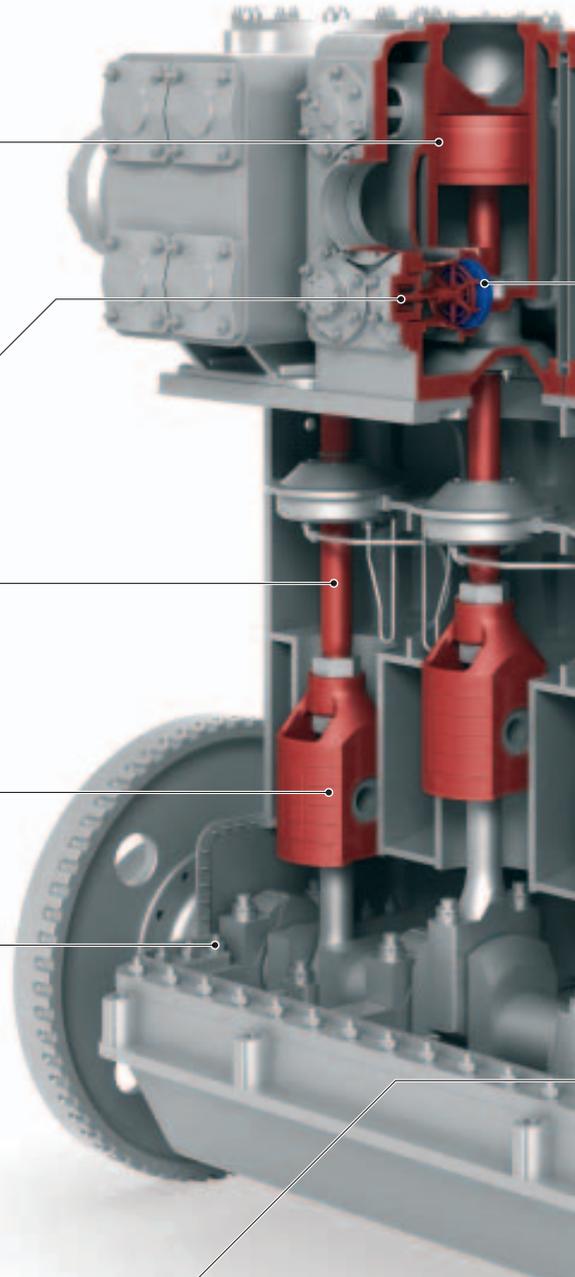
- Nitrated steel for maximum wear resistance against oil scrapers

CROSSHEADS

- Heavy duty single piece design for precise linear movement of the piston
- Forced-feed lubricated
- Water cooled crosshead guide for constant tolerances and precise guiding

MECHANICAL SHAFT SEAL OPTIONS (NOT ILLUSTRATED)

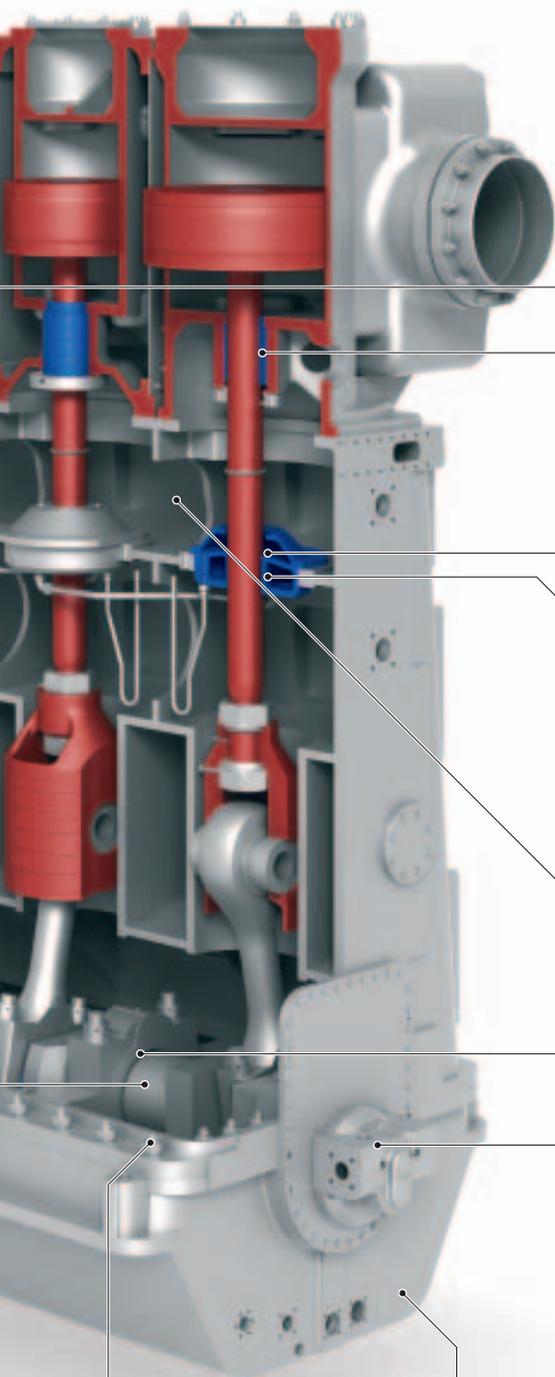
- For gastight crankgear
- No loss of gas to the environment for highest safety and efficiency



RUGGED DESIGN – FOR DURABILITY

CRANKSHAFT

- High strength forged steel



KEY COMPRESSOR COMPONENTS – FOR BEST PERFORMANCE AND LONGEST LIFETIME

COMPRESSOR VALVES

- Burckhardt Plate Valve™
- Burckhardt Poppet Valve™
- Manley® Valve, licensed by Burckhardt Compression
- Selection and custom engineering according to application requirements
- Maximum durability due to in-house leading valve technology
- Over 120 years of experience in design, manufacturing and service

PISTON ROD GLANDS WITH LABYRINTH SEALING

- Radially floating, self-centering sealing elements
- Various designs and materials for lowest wear

OIL SCRAPERS

- Highly efficient oil removal
- Separation of lubricated from non-lubricated area
- Material selection according to specific application

GUIDE BEARINGS

- For precise linear movement of piston rod and piston
- Easy exchangeable guide bearing bush

MAIN BEARINGS

- Tri-metal, babbitt design
- Interchangeable with big end bearings
- Forced-feed lubricated

CRANKGEAR

- Vertical in-line design
- Small footprint
- Various designs: open, closed or gastight up to 25 barg

OIL SUMP IN BASE PLATE

- No separate oil tank required

GEAR OIL PUMP

- Crankshaft driven
- For forced-feed lubrication

DISTANCE PIECES

- Extra-long, single compartment
- Implementation of purge or vent gas depending on application

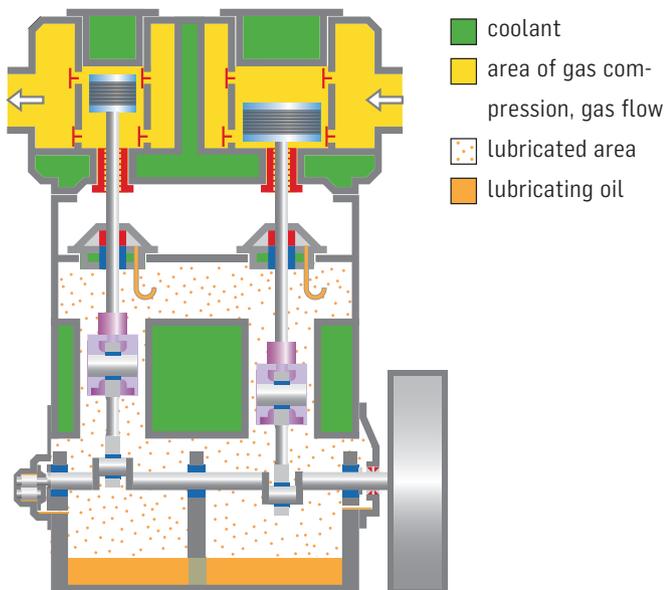
SIMPLE AND RUGGED DESIGNS OF ALL LABY® TYPES

EASY OPERATION AND LONGEST MTBO IN
YOUR APPLICATION

INDUSTRIAL GASES –
HIGHEST PURITY FOR NON-TOXIC GASES

APPLICATION EXAMPLE

Oxygen for steel production



MAIN FEATURES OF LABY® TYPE D “OPEN”

- Crankgear under atmospheric pressure
- Open distance piece (purging as option)

YOUR BENEFITS

- Delivery of pure gas
 - No contamination with oil
 - No contamination with abrasives from piston rings and rider rings
- Highest operational safety
 - No permanent mechanical friction in the cylinder
 - No hot spots

AIR SEPARATION UNIT, SWEDEN

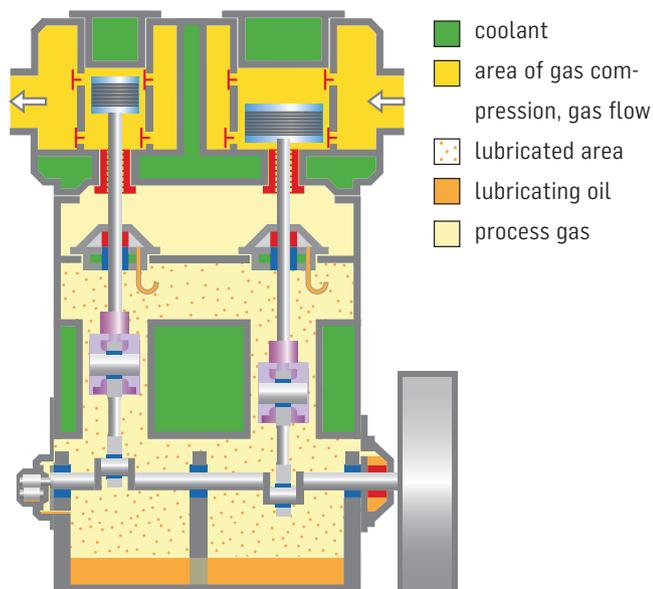


Gas	O ₂
Laby® type	4D300
Suction volume	5'340 m ³ /h
Suction temperature	10 °C
Suction pressure	1.2 bar abs
Discharge pressure	46 bar abs
Shaft power	1'030 kW
Speed	420 rpm

INDUSTRIAL GASES –
HIGHEST SAFETY FOR TOXIC, CORROSIVE OR EXPLOSIVE GASES

APPLICATION EXAMPLE

Carbon monoxide for acetic acid production



MAIN FEATURES OF LABY® TYPES D AND K
“GASTIGHT”

- Gastight crankgear
- Crankgear under suction pressure
- Mechanical crankshaft seal
- Closed distance piece

YOUR BENEFITS

- Highest operational safety
 - No permanent mechanical friction in the cylinder
 - No hot spots
 - No decomposition of carbon monoxide
 - No leakage of toxic process gas to the atmosphere

PETROCHEMICAL PRODUCTION, MALAYSIA

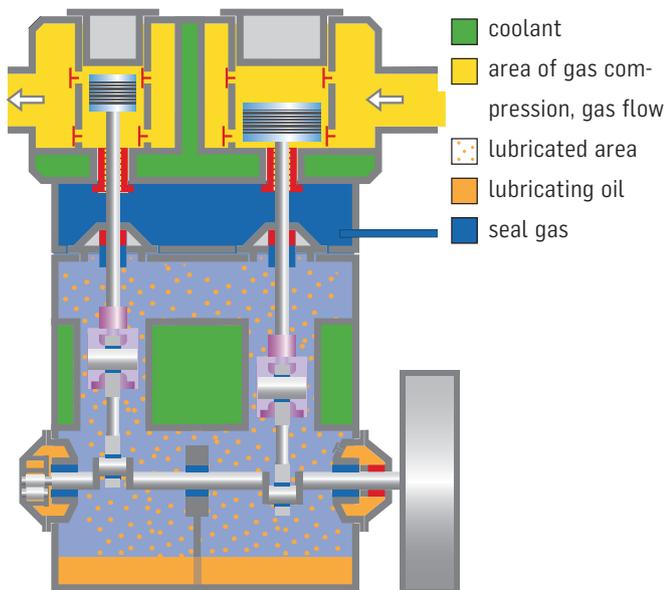


Gas	CO mix
Laby® type	4D250
Suction volume	2'620 m ³ /h
Suction temperature	35 °C
Suction pressure	1.5 bar abs
Discharge pressure	26 bar abs
Shaft power	575 kW
Speed	490 rpm

PETROCHEMICAL/CHEMICAL INDUSTRY – HIGHEST RELIABILITY FOR CONTAMINATED GASES

APPLICATION EXAMPLE

Polypropylene/polyethylene, EO/EG production



MAIN FEATURES OF LABY® TYPES D AND K “GASTIGHT”

- Gastight crankgear
- Mechanical crankshaft seal
- Closed distance piece
- Seal gas

YOUR BENEFITS

- Highest reliability
 - Absolutely unaffected by particles in the gas (polymerisation product, catalyst fines, dust, dirt, etc.)
- Highest efficiency
 - No loss of valuable product
- Highest operational safety
 - No leakage of process gas to the atmosphere

POLYPROPYLENE PRODUCTION, BELGIUM



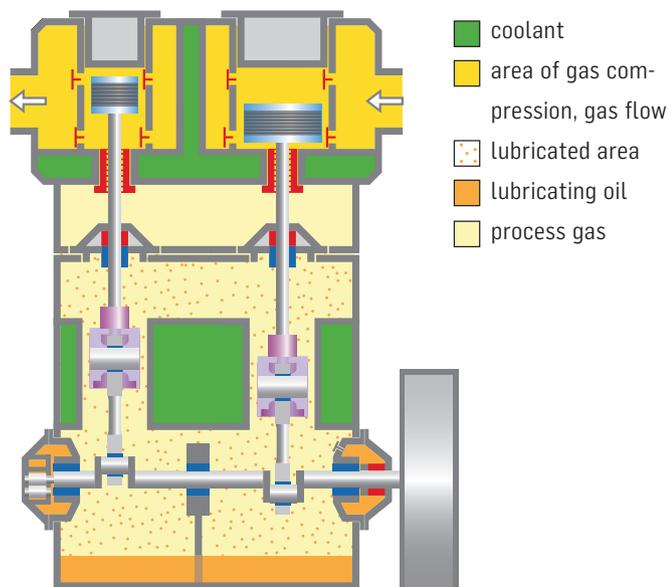
Gas	C ₃ H ₆
Laby® type	3K160
Suction volume	725 m ³ /h
Suction temperature	30 °C
Suction pressure	6.8 bar abs
Discharge pressure	24.9 bar abs
Shaft power	228 kW
Speed	494 rpm

GAS TRANSPORT AND STORAGE –

HIGHEST FLEXIBILITY FOR LNG, LPG, LEG, C_nH_m BOG

APPLICATION EXAMPLE

Boil-off gas handling



MAIN FEATURES OF LABY® TYPES D AND K “GASTIGHT”

- Gastight crankgear
- Mechanical crankshaft seal
- Closed distance piece

YOUR BENEFITS

- Highest flexibility
 - Insensitive to fluctuating suction conditions (pressure, temperature, gas composition)
 - No cool down required for cryogenic gases
- Highest efficiency
 - No loss of valuable product
 - No purge gas required
- Highest operational safety
 - No leakage of process gas to the atmosphere

LNG BOG, SPAIN

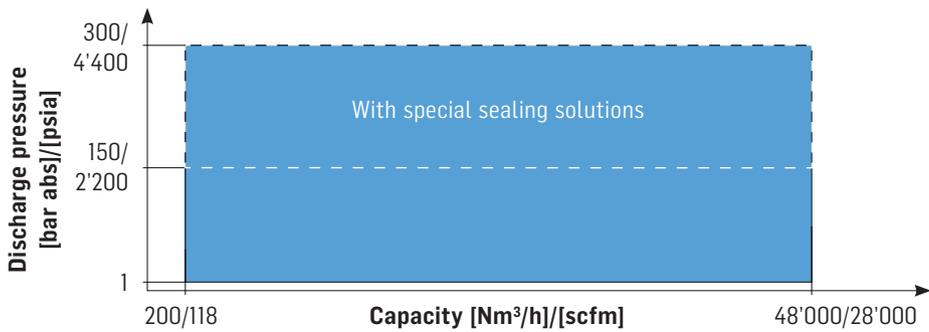


Gas	C ₂ H ₄ mix
Laby® type	2D250
Suction volume	3'015 m ³ /h
Suction temperature	–150 °C
Suction pressure	1.17 bar abs
Discharge pressure	10.3 bar abs
Shaft power	520 kW
Speed	495 rpm

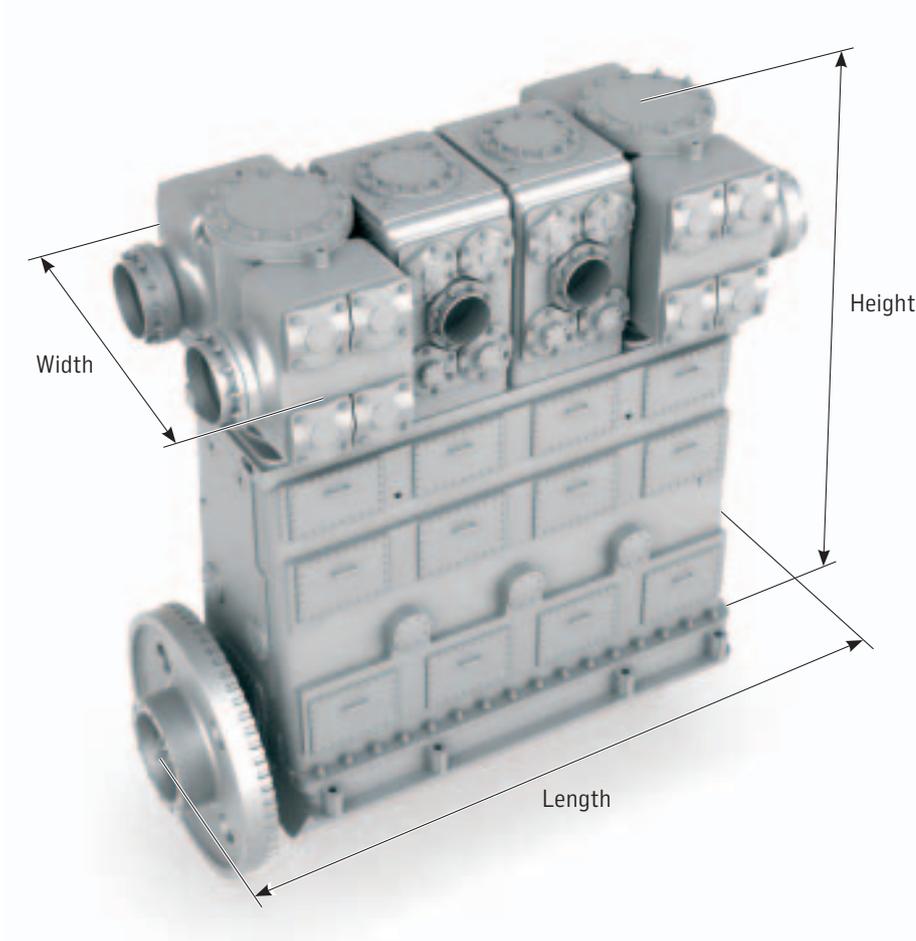
TECHNICAL DATA

LARGE VARIETY OF COMPRESSOR FRAME SIZES FOR A WIDE RANGE OF APPLICATIONS

PERFORMANCE RANGE



TECHNICAL DATA AND DIMENSIONS



K-TYPE COMPRESSORS – GASTIGHT DESIGN

Type	Cranks	Stroke [mm]/[in]	Max. Speed [rpm]	Rated Power ¹⁾ [kW]/[hp]	Width [mm]/[in]	Height [mm]/[in]	Length [mm]/[in]	Weight [kg]/[lbs]
2K90	2	90/3.5	1'000	115/154	640/25	1'500/59	950/37	1'900/4'100
2K105	2	105/4.1	1'000	188/252	530/21	1'720/68	1'150/45	2'500/5'500
2K120	2	120/4.2	880	226/303	760/30	1'720/68	1'150/45	2'300/5'000
2K140	2	140/5.5	850	303/406	880/35	2'080/82	1'330/52	4'700/10'300
2K158	2	158/6.2	750	485/665	910/36	2'340/92	1'600/63	5'800/12'700
2K160	2	160/6.3	750	485/665	1'500/59	2'280/90	1'480/58	5'500/12'100
2K250	2	250/9.8	500	1'660/2'226	970/38	3'570/141	2'310/91	18'300/40'300
3K120	3	120/4.2	750	350/469	900/35	2'290/90	1'750/69	6'100/13'400
3K140	3	140/5.5	750	485/665	1'040/41	2'280/90	2'140/84	9'000/19'800
3K160	3	160/6.3	750	485/665	1'010/40	2'340/92	2'140/84	9'000/19'800
4K165	4	165/6.5	750	1'042/1'397	1'110/44	2'400/94	2'850/112	16'000/35'200

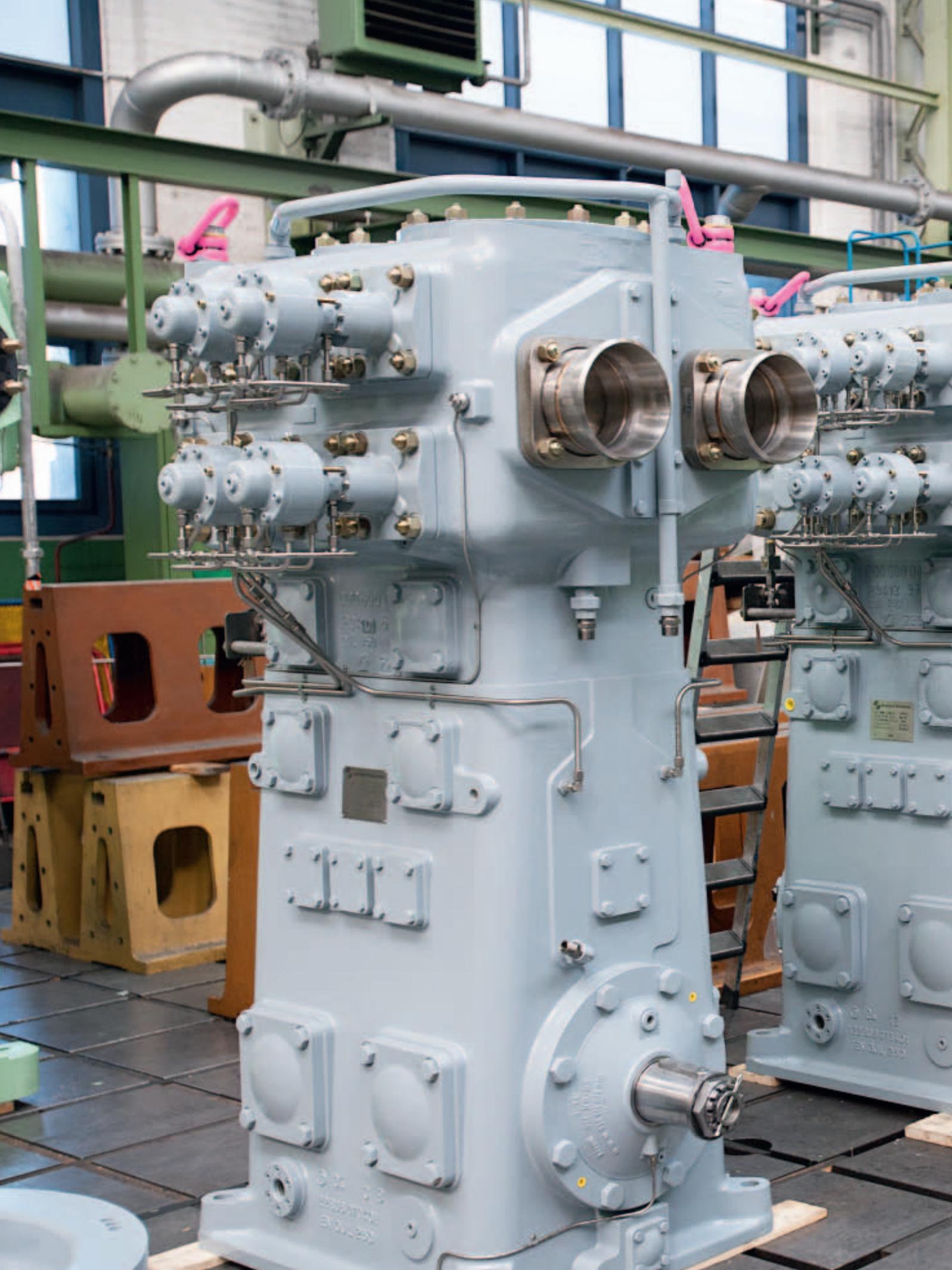
D-TYPE COMPRESSORS

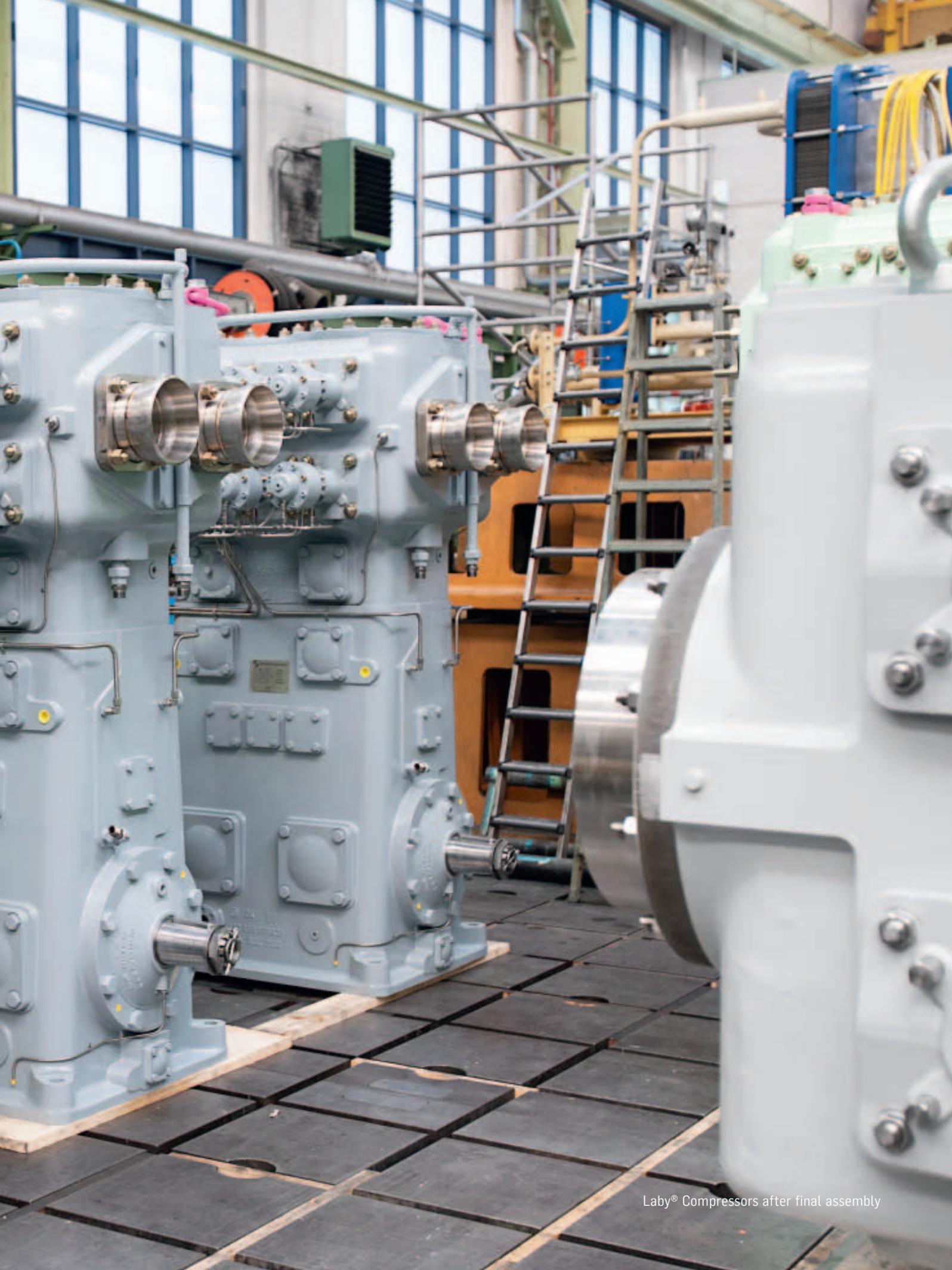
Type	Cranks	Stroke [mm]/[in]	Max. Speed [rpm]	Rated Power ¹⁾ [kW]/[hp]	Width [mm]/[in]	Height [mm]/[in]	Length [mm]/[in]	Weight [kg]/[lbs]
2D140	2	140/5.5	1'000	174/233	760/30	2'060/81	1'160/46	2'700/5'900
2D160	2	160/6.3	750	304/407	370/26	2'280/90	1'250/49	3'900/8'600
2D200	2	200/7.9	600	480/643	830/33	3'000/118	1'480/58	5'700/12'500
2DL200 ³⁾	2	200/7.9	600	480/643	1'200/47	3'100/122	1'300/51	8'000/17'600
2D205	2	205/8.1	600	700/938	980/39	2'900/114	1'650/65	7'400/16'300
2D250 ³⁾	2	250/9.8	520	1'700/2'279	1'180/46	4'080/161	2'140/84	6'300/13'800
2DL250	2	250/9.8	520	1'760/2'350	1'980/78	3'720/146	2'630/104	21'000/46'200
3D130	3	130/5.1	750	185/248	730/29	2'270/89	1'390/55	3'900/8'500
3D160	3	160/6.3	750	304/407	850/33	2'580/102	1'500/59	6'300/13'800
3D200 ³⁾	3	200/7.9	600	490/657	1'060/42	3'080/121	2'110/83	9'400/20'700
4D150	4	150/5.9	750	304/407	830/33	2'480/98	1'900/75	10'500/23'100
4D200	4	200/7.9	600	500/670	950/37	2'850/112	2'290/90	12'000/26'400
4D225 ³⁾	4	225/8.9	600	726/973	1'000/39	2'970/117	2'700/106	13'900/30'600
4D250 ³⁾	4	250/9.8	520	1'025/1'374	1'180/46	3'290/130	3'230/127	18'400/40'500
4D300 ³⁾	4	300/11.8	450	1'533/2'055	1'200/47	3'300/130	3'230/127	27'600/60'800
4D375 ³⁾	4	375/14.8	380	2'055/2'755	1'600/63	4'380/172	4'180/165	43'400/95'600
6D375 ³⁾	6	375/14.8	380	2'055/2'755	1'670/66	4'380/172	5'370/211	49'100/108'200
6LP190 ²⁾	6	190/7.4	750	1'500/2'010	1'200/47	2'900/114	4'700/185	20'000/44'000
6LP250 ²⁾	6	250/9.8	520	4'000/5'360	2'200/86	4'800/189	5'600/220	50'000/110'000

¹⁾ Higher rated power possible with special crankshaft materials

²⁾ Fully balanced design available

³⁾ Gastight design available





Laby® Compressors after final assembly

KEY COMPRESSOR COMPONENTS

LATEST TECHNOLOGY FOR BEST PERFORMANCE AND LONGEST LIFETIME



Top quality crossheads, connecting rods, bearings, piston skirts and crankshafts for highest reliability

Always having the best MTBO (mean time between overhaul) and lowest life cycle costs in mind, we develop, design and manufacture a wide range of top quality compressor components. We select the technology and materials and engineer all compressor components according to your application-specific requirements and operating conditions.

We supply our compressor components for all your reciprocating compressors.

COMPRESSOR VALVES

We offer all three types of compressor valve technologies:

- Burckhardt Poppet Valve™
- Burckhardt Plate Valve™
- Manley® valve, licensed by Burckhardt Compression



In-house engineered valve technology

SEALING AND GUIDING TECHNOLOGY



Piston rod gland and single sealing elements with labyrinth sealing

- Piston rod glands: various designs and materials according to application requirements

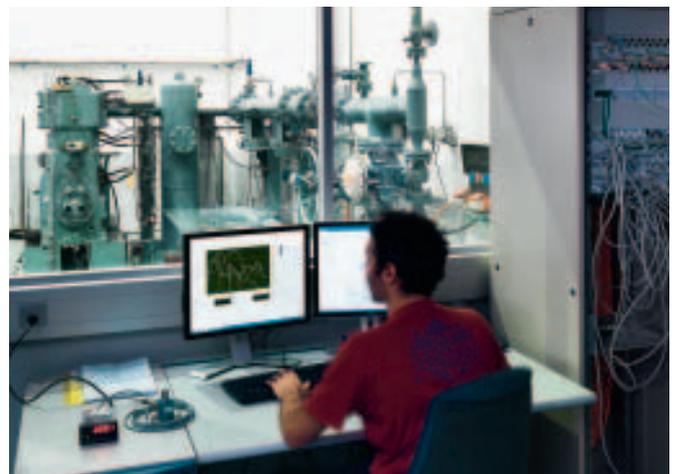


Oil scraper and guide bush for guide bearing

- Oil scraper ring: single-piece metal or 3-piece plastic design
- Guide bearing bush: tribology research and laboratory tests for highest durability

RESEARCH & DEVELOPMENT

The Laby® design and the unique labyrinth sealing technology are continuously upgraded according to technological developments made in our own R&D department. Constantly, we examine the flow behavior of gases in oscillating sealing labyrinths. Bench tests and computer simulations lead to constant refinements of labyrinth shape and size, labyrinth clearance and other parameters. New materials and different design types are continuously being tested. By selecting the optimum materials and design, the lifetime of compressor components and complete compressor systems will be extended.



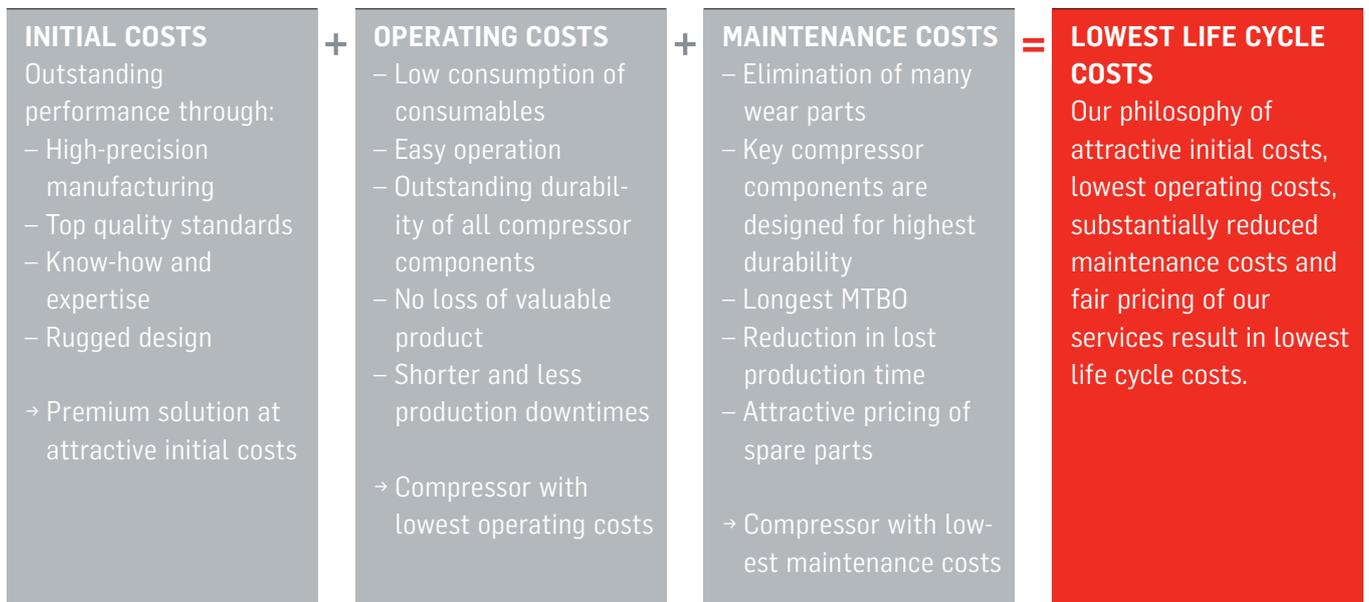
New materials and different design types get developed and in-house long-term tested

BURCKHARDT COMPRESSION'S KEY COMPRESSOR COMPONENTS STAND FOR:

- Longest mean time between overhaul and operation time
- Shortest downtimes
- Less operating costs

LEADING COMPRESSOR TECHNOLOGY FOR LOWEST LIFE CYCLE COSTS

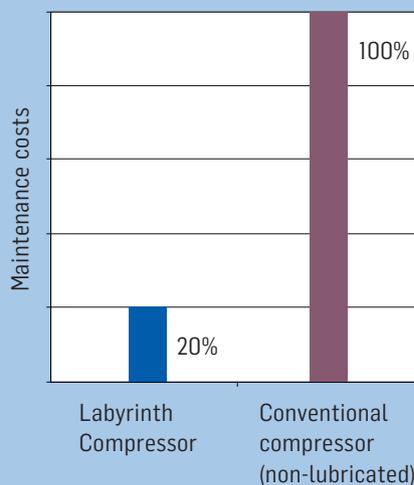
The Laby® Compressors are the great result of the vast experience gained by Burckhardt Compression over many decades. The unique design has been accomplished through close collaboration with our customers throughout the world. Based on their needs, Burckhardt Compression provides a rugged and reliable compressor of Swiss design and manufacture. Certified Swiss manufacturing, quality management and a committed workforce ensure a constant high level of quality.



80% LESS MAINTENANCE COSTS

“The comparison between labyrinth and conventional units (...) involves the exact same service in the same size range; there, the maintenance cost for lube-free conventional machines exceeded that of the labyrinth machines by almost five to one.”

Source: H.P. Bloch,
Chemical Engineering, July 18, 1988



MANUFACTURING

WITH STATE-OF-THE-ART MACHINING TECHNOLOGY



Cutting-edge 3D CNC Measurement Machine for quality inspection



Dörries Scharmann, Heavyspeed CNC Milling Machine
Centric table load: 23'000 kg, spindle stroke: 1000 mm



Okuma MacTurn550, CNC Multitasking Center.
One of the 10 machining centers



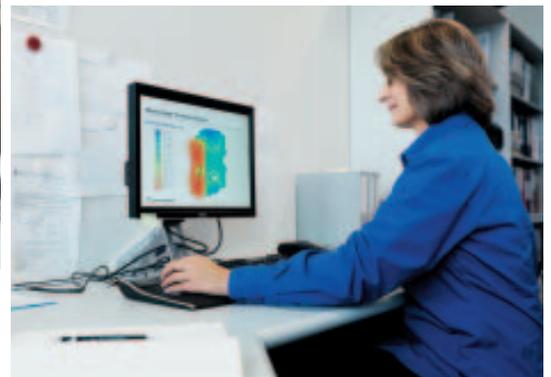
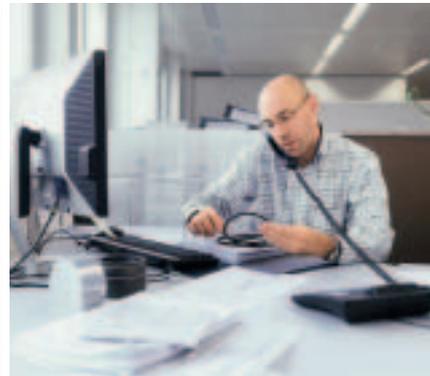
Okuma MacTurn350, Multitasking Center. Fully automatic parts feeding



Dörries Scharmann, CNC Boring Mill
4 tables, spindle stroke: 600 mm

BURCKHARDT COMPRESSION

THE RECIPROCATING COMPRESSOR COMPANY
WITH THOROUGH IN-HOUSE EXPERTISE ...



...ENSURING COMPREHENSIVE SUPPORT BOTH FOR EPC CONTRACTORS AND PLANT OPERATORS

RESEARCH & DEVELOPMENT

- Tribology incl. test beds
- Finite element analysis
- Mechatronics
- Labyrinth sealing technology
- Material research

CUSTOMER SUPPORT SERVICE

- Engineering services
- Spare parts logistics
- Revamps
- Field service
- Valve service
- Component repair
- Technical support
- Monitoring and diagnostics
- Training

COMPRESSOR DESIGN

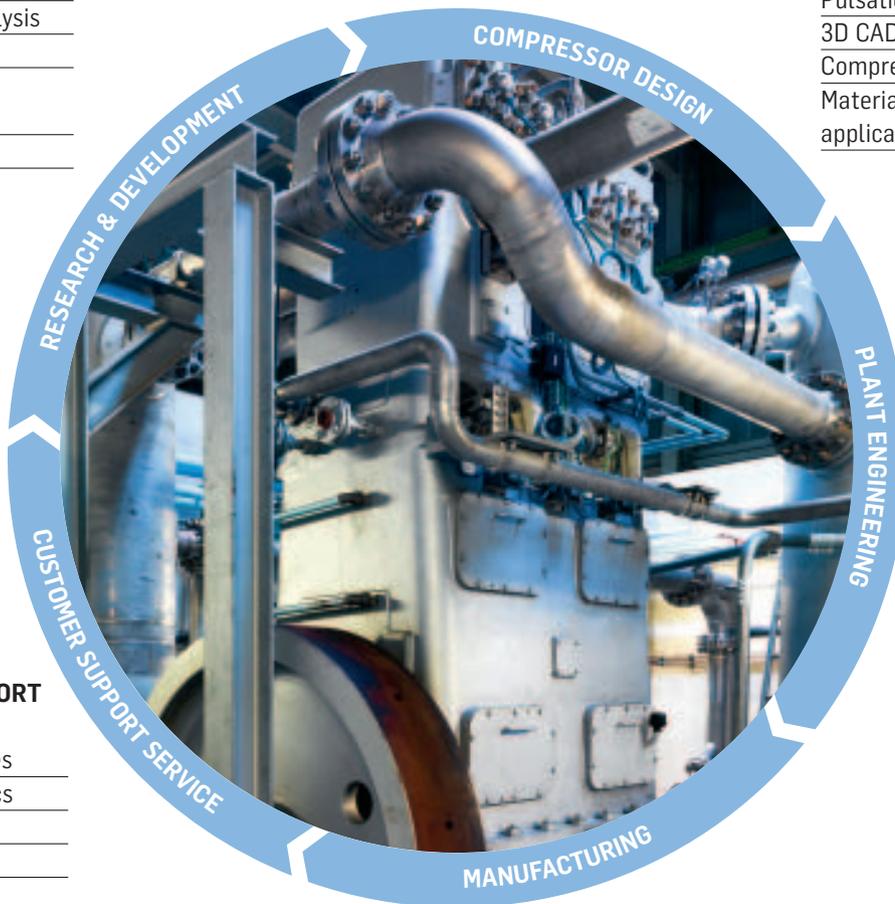
- Instationary fluid dynamics
- Pre-sales support, incl. detailed documentation
- Engineering analysis
- Feasibility study
- Selection and sizing
- Pulsation and vibration studies
- 3D CAD
- Compressor valves
- Material selection according to application requirements

PLANT ENGINEERING

- Contracting
- Customer and standard specifications
- Compressor and auxiliaries on modules
- Cooling water system
- Instrument and control, motors
- PLC programming
- Turn-key projects

MANUFACTURING

- State-of-the-art machining technology
- CAM in-house machining
- Purchasing
- Assembly
- Test beds
- Quality assurance



CUSTOMER SUPPORT SERVICE

ENHANCE YOUR MAINTENANCE

BURCKHARDT VALVE SERVICE

FAST VALVE SERVICE WITH EXTENSIVE GUARANTEE

- Analysis of valve condition
- Tracking of valve history
- OEM valve engineering
- Valve cleaning and overhauls
- Complete quality inspection
- State-of-the-art leak test
- Root cause analysis
- Corrosion protection

SPARE PARTS LOGISTICS

OEM GUARANTEE AND BEST LIFE CYCLE COSTS

- Original spare parts with OEM guarantee
- Spare parts frame agreements
- Stock recommendations
- Express service for emergencies
- Over 16'000 parts on stock
- 12 month guarantee
- Save time and money: use the Burckhardt e-Shop™ – the easy spare parts identification and ordering system

FIELD SERVICE

ONSHORE AND OFFSHORE: BENEFIT FROM OUR SKILLED RECIP EXPERTS

- On-site assembly and installation
- Erection/commissioning
- High safety standards – SCC and HUET certified
- Turn-key installations
- Start-up support
- Service contracts/preventive maintenance
- Plant overhaul/revision
- 12 month guarantee

TECHNICAL SUPPORT

PROFESSIONAL SUPPORT FROM OUR WELL TRAINED AND EXPERIENCED SPECIALISTS

- Performance analysis for optimized and efficient compressor operation
- Start-up support
- Troubleshooting
- Root cause analysis
- Emergency availability 24/7
- On-site failure analysis
- Online diagnostic support
- Consulting

COMPONENT REPAIR

SAVE MONEY AND GET "AS NEW" GUARANTEE

- Condition analysis
- Recommendations concerning which parts can be repaired or need to be replaced
- Incorporation of the latest technology where possible
- 12 month guarantee
- Repair of crossheads, piston rods, guide bearings, bearings, pistons

ENGINEERING SERVICES

SOPHISTICATED IN-HOUSE SIZING AND ANALYSIS TOOLS

- State-of-the-art pulsation and vibration analysis
- Finite element analysis
- Unique analysis models for high pressure application up to 3'500 bar
- Reverse engineering and reengineering for own as well as for other brand compressor systems
- Dynamic analysis for any compressor parts

REVAMPS

REJUVENATE OR TUNE YOUR COMPRESSOR

- Modernizing
- Upgrades/retrofits
- Relocation of machines
- Debottlenecking
- Turn-key installations
- Operation mode studies for own as well as for other brand compressor systems
- Conversion from lubricated to non-lubricated conversions

MONITORING AND DIAGNOSTICS

EXTEND MEAN TIME BETWEEN OVERHAUL

- Support for system evaluation
- Comprehensive customized service from diagnostic service to predictive maintenance
- Full-service agreements for maximum availability
- Online diagnostic services
- Broad experience through compressor installations in various processes

Burckhardt Compression recommends  **PROGNOST**

TRAINING

HAVE YOUR OWN COMPRESSOR SPECIALISTS

- Theoretical and practical training from our compressor experts
- Training center with full-size equipment (Laby®, Process Gas and Hyper Compressor)
- Standard trainings, customer specific programs on request

SERVICE CENTERS WORLDWIDE

- Service Center and field engineer base
- Burckhardt Compression Authorized Service Center

**24 hours emergency:
+41 (0)52 262 53 53**



RECIPROCATING COMPRESSORS

LEADING TECHNOLOGY FOR
LOWEST LIFE CYCLE COSTS

**Laby®
Compressors**
Contactless
and oil-free



**Laby®-GI
Compressors**
Fully balanced



**Process Gas
Compressors**
API 618 –
full compliant



**Hyper
Compressors**
Safe and reliable
up to 3'500 bar



COMPRESSOR COMPONENTS

BEST PERFORMANCE
AND LONGEST LIFETIME

Valves:

- Burckhardt Poppet Valve™
- Burckhardt Plate Valve™
- Manley® valve, licensed by
Burckhardt Compression

Piston rings

Guide rings

Piston rod packings

Packing rings

Oil scrapers

Hyper/secondary
compressor parts

CUSTOMER SUPPORT SERVICE

THE FULL RANGE OF SERVICES

Burckhardt Valve Service

Spare parts logistics

Field service

Technical support

Component repair

Engineering services

Revamps

Condition monitoring
& diagnostics

Training

FOR ALL YOUR RECIPROCATING COMPRESSORS

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