



## TRUSTED SOLUTIONS

### FROM THE LEADER IN HYPER TECHNOLOGY

#### **BURCKHARDT COMPRESSION**

Burckhardt Compression is the recognized market leader in Hyper Compressors and the only manufacturer that offers the complete range of reciprocating compressor technologies, Process Gas Compressors API 618, Hyper Compressors, Laby® Labyrinth Piston Compressors and Standard High Pressure Compressors.

As the pioneer in Hyper Compressor technology since 1951, our long standing know-how and unrivalled expertise are the basis for innovative solutions for any Hyper/Secondary Compressor.

#### **LEADING HYPER COMPRESSOR TECHNOLOGY**

With our proven track record and experience we provide best in class component and service solutions. We are able to support you at every stage of the Hyper Compressor's lifecycle, including:

- Requirements evaluation
- Situation analysis
- Consulting services
- Engineering services
- Capacity change/modernization

- Service friendly parts design
- In-house manufacturing of high pressure parts
- Professional installation
- Skilled start-up assistance and adjustment for perfect running conditions

#### MAXIMIZE YOUR PLANT AVAILABILITY

All our activities are aimed to maximize your plant availability. Our close cooperation with customers and Hyper specialists allows us to satisfy market requirements in the constant quest for sustainable solutions. Our dedication to Hyper Compressor technology and our focus on evolving market needs are what motivate us to organize the highly regarded Burckhardt Compression LDPE Symposium on a regular basis. The exchange of information and ideas with internationally renowned experts inspires us to continuously improve our solutions to meet the requirements of compressor users.

Our dedicated Hyper Compressor specialists are the experts when it comes to comprehensive high pressure application know-how and experience. We are ready to provide full support for Hyper/Secondary Compressors as well as Booster/Primary Compressors of any brand and any type.







## HIGH PRESSURE PROCESS TECHNOLOGY

## FOR HIGHEST SAFETY AND AVAILABILITY

# SUPERIOR SOLUTIONS FOR EVERY PROCESS TECHNOLOGY

Burckhardt Compression's high pressure reciprocating compressors are designed to operate in autoclave, in tubular or multiple technology plants. Those plants produce a wide range of homo-polymers or Ethylene Vinyl Acetate (EVA) copolymers.

Our compressor components are suitable for customers who expect outstanding performance, process flexibility and product quality. They can be built to order for any retrofit project with the objective of enhancing the product capability and reliability of compressors of all types and brands.

Ethylene and its co-products and derivatives are vital for many segments of the economy, including the production of consumer products, packaging, housing, automotive components and other durable and non-durable goods.

#### **MARKET APPLICATIONS**

LDPE is used in a wide range of products including:

- Packaging film and bags for foodstuff and sanitary articles
- Agricultural film
- Surface protection film and lamination film
- Shrink and stretch hood film
- Bags
- Bottles and tubes
- Sheet
- Healthcare applications
- Extrusion coating
- Lids, caps and closures
- Wire & cable





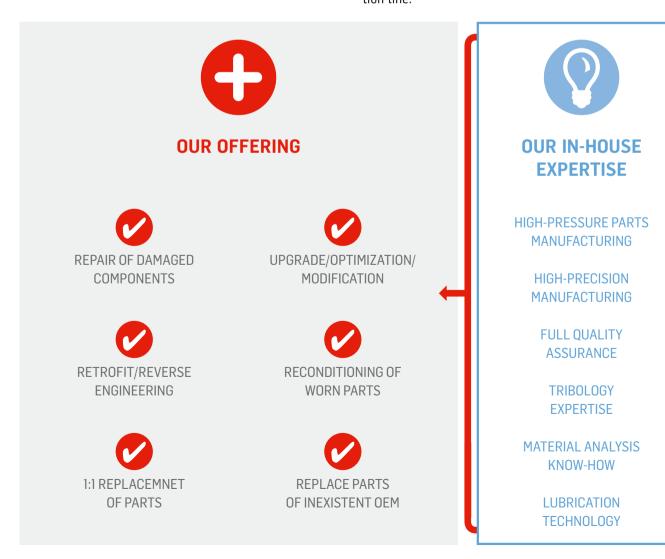
## A PERFECT FIT

### HYPER COMPONENTS AND SERVICES FOR ANY BRAND

With decades of experience and our broad in-house expertise in Hyper/Secondary Compressor components we are ideally suited to provide integrated solutions designed to maximize the safety, reliability and availability of your equipment. Comprehensive know-how and experience are crucial to design and implement perfect solutions for replacing Hyper Compressor components.

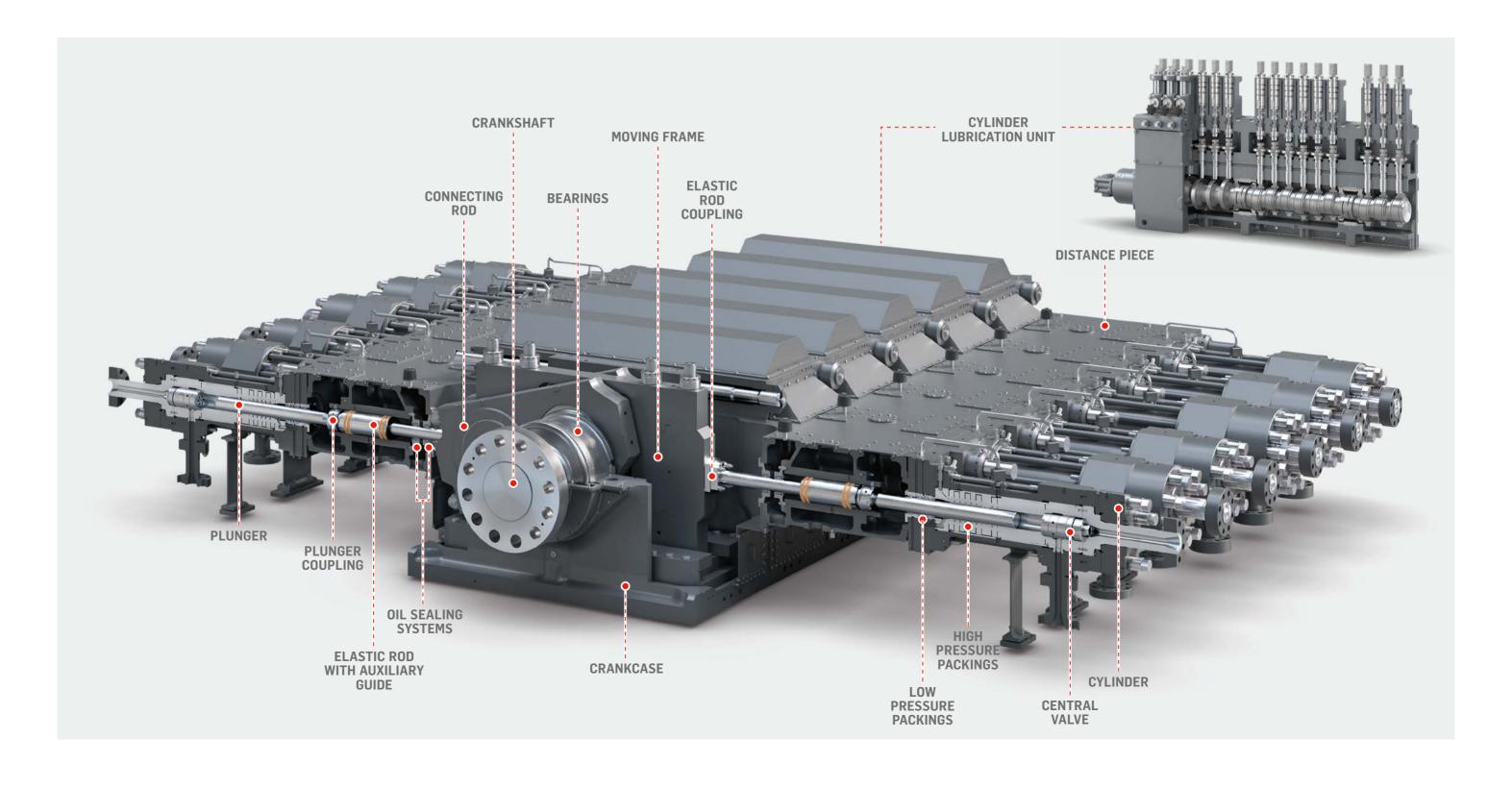
The individual components being replaced or repaired need to be perfectly matched and their interaction with other components, process parameters, the environment of the parts and auxiliary equipment must also be taken into consideration to find the optimal solution.

In close collaboration with our customers, we define the necessary scope in order to meet the requirements placed on the performance of the entire LDPE production line.



## **HYPER COMPRESSOR OVERVIEW**

## INTEGRATED SOLUTIONS



# **COMPONENTS IN DETAIL**

# CUSTOMIZED FOR BEST PERFORMANCE

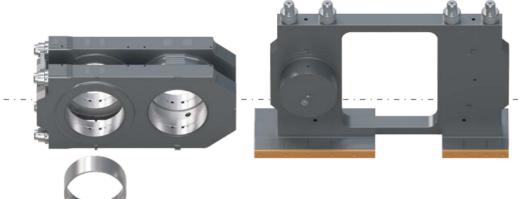


CRANKCASE



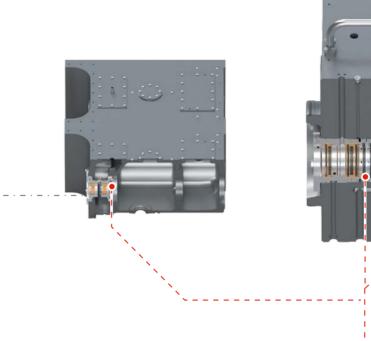


CRANKSHAFT

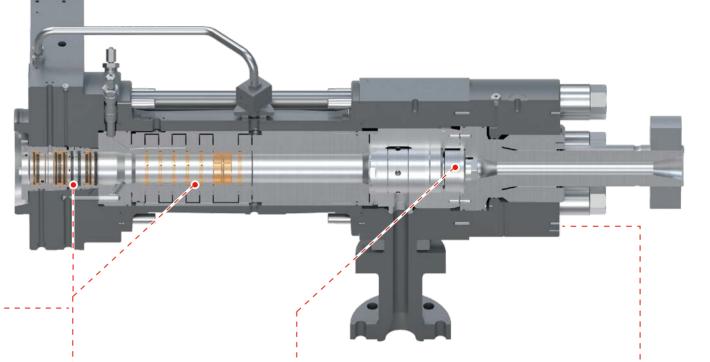


CONNECTING ROD

MOVING FRAME



DISTANCE PIECE



CENTRAL VALVE



CYLINDER LUBRICATION PUMP



CONNECTION TECHNOLOGIES

	<ul> <li>4–12 cranks / 2x8 cranks</li> <li>Max. 3'500 kN rod load</li> <li>Horizontal opposed</li> <li>Cast steel frame or welded steel construction</li> <li>Robust design aspects are focused for reliable performance</li> </ul>	<ul> <li>High precision bearings</li> <li>Hydrodynamic radial and axial thrust bearing</li> <li>Any required bearing (main-/crosshead frame)</li> <li>Single/two part design</li> <li>Anti-twist protection</li> <li>Upgrade with vibration and temperature monitoring</li> </ul>	<ul> <li>Stroke up to 450 mm</li> <li>Diameter up to 900 mm</li> <li>Rigid against torsion and bending</li> <li>Compact design</li> </ul>	lut • Hy op cro fre • Ma lev • 3-p	ubrication oil feed is integrated Hydraulic tensioning connection to provide	<ul> <li>Massive construction for smooth power transmission</li> <li>Bottom guidance for easy access</li> <li>Two shoe slide design</li> </ul>	<ul> <li>Elastic rod coupling:         <ul> <li>Prevents fretting</li> </ul> </li> <li>Elastic rod with auxiliary guide:             <ul> <li>Eliminates undesired plunger movement</li> <li>Precise plunger alignment</li> <li>Long guiding bush</li> </ul> </li> <li>Plunger coupling:         <ul> <li>Straightforward design to avoid tractive forces for less adjustment work and easy access</li> </ul> </li> <li>Plunger:         <ul> <li>upto 160 mm diameter (other dimensions upon request)</li> <li>Highest demand on surface finish and tolerances</li> </ul> </li> </ul>	<ul> <li>Single or combined distance piece</li> <li>For precise guidance of the plunger</li> <li>Prevents ethylene from entering the crank gear</li> <li>Double compartment design</li> <li>Vented interspace for extra safety</li> <li>No explosion relief valve required</li> <li>Increased safety</li> </ul>	High pressure packing Heterogeneous design based on decades of experience Highest sealing efficiency Low pressure packing Avoids flow of ethylene into distance piece Provides extra safety Includes plunger cooling N2 purge option Oil sealing systems Separate seal on crank gear and distance piece side Self-centering design Prevents mixing of crank gear and cooling/flushing oil	<ul> <li>Combined suction/discharge multi-poppet valve for compact design</li> <li>Optimized flow for best performance and longest lifetime</li> <li>Flow optimized for optimal design</li> <li>FE Analysis</li> <li>Improved single poppet design</li> </ul>	<ul> <li>Burckhardt Hypropack™ cartridge system for fast exchange and service</li> <li>Hydraulic tightening ensures even distribution of forces</li> <li>Oil cooled design</li> <li>Extra-long cylinder tie bolts and elastic design is a safety feature in case of excessive pressure inside cylinder</li> <li>Rupture disk provides extra safety in case of leakage of high pressure cups</li> </ul>	<ul> <li>In-house engineered design with hundreds of references</li> <li>One or more pumps for one lubrication point for most effective lubricant disrtibution</li> <li>Multiple adjustment possibilities for each lubrication situation</li> <li>Easily adjustable</li> <li>Quick measuring of feed rate</li> </ul>	<ul> <li>Safe and reliable connection of the different parts is crucial especially for the dependable operation of Hyper Compressors.</li> <li>Appropriate connection technology for the different connecting points:</li> <li>Hydraulic tightening device for highest forces on the connection</li> <li>Burckhardt Hypropull™ integrated hydraulic cylinder design</li> </ul>	DESIGN
MANUFACTURING & MATERIALS	<ul> <li>In-house manufacturing capabilities</li> <li>State-of-the-art laser measurement guarantees highest quality standards</li> <li>Various materials (e.g. grey cast iron, steel)</li> <li>Situation/requirement analysis, comprehensive engineering services for reliable solutions: revamp projects/replacement/repair/fast track repair etc.</li> </ul>	<ul> <li>Tri-metal galvanic layers for increased wear protection</li> <li>Large diameters for low specific load</li> <li>Interchangeable shells for connecting rod "big end" and crosshead pin bearings.</li> </ul>	<ul> <li>High precision manufacturing for optimal compressor performance</li> <li>Materials: forged steel/cast iron etc.</li> <li>Bearing surfaces are ground and polished</li> <li>Situation/requirement analysis, comprehensive engineering services for reliable solutions: revamp projects/replacement/repair/fast track repair etc.</li> </ul>	• Ma	Materials: cast steel	Materials: cast steel other upon request	<ul> <li>Elastic rod auxiliary guide         <ul> <li>Remachining of bush inner diameter and use of oversize guide rings on auxiliary guide for re-use of original parts</li> </ul> </li> <li>Plunger:         <ul> <li>Solid tungsten carbide or tungsten carbide plated, depending on pressure</li> </ul> </li> </ul>	<ul> <li>Materials: cast iron</li> <li>State-of-the-art laser measurement guarantees highest quality standards</li> <li>Situation/requirement analysis, compre- hensive engineering services for reliable solutions: revamp projects/replacement/ repair/fast track repair etc.</li> </ul>	<ul> <li>Persisto® material for sealing elements</li> <li>High pressure packing cups:         <ul> <li>Specific material selection</li> <li>Special materials with enormous mechanical and chemical resistance</li> <li>Multi-ring design with the inner cup shrunk into the outer ring</li> <li>Deep rolling/roller burnishing, shot peening and autofrettage treatment</li> </ul> </li> </ul>	<ul> <li>Full metal execution withstands wear and provides longest durability</li> <li>Specific high pressure manufacturing methods to achieve superior durability and resistance:</li> <li>Autofrettage treatment</li> <li>Shot peening</li> <li>Deep rolling/roller burnishing</li> <li>Reusable valve seat</li> </ul>	Material selection according to process & pressure	Also available for other applications (e.g. reactor etc)	<ul> <li>High precision manufacturing for optimal compressor performance</li> <li>Even force distribution by hydraulic tightening.</li> <li>Fulfills high HSE standards</li> </ul>	MANUFACTURING & MATERIALS
ADDED	<ul> <li>Separate inspection covers for easy access</li> <li>Optimised material selection</li> </ul>	Improved bearing shell version for high load compressors to increase bearing lifetime	Customized engineering		ntegrated bearing temperature neasurement	Easily removable from top	Proven procedure for elastic rod reconditioning overall and in fretted coupling areas		<ul> <li>Improved oil wiper and sealing ring design to minimize oil leakage</li> <li>For any brand of Hyper compressor</li> </ul>	Poppets: specific material selection and coating for maximum lifetime	<ul> <li>Improved cylinder tie rod coating against corrosion of threads</li> <li>For any brand of Hyper compressor</li> </ul>			ADDED



OUR IN-HOUSE EXPERTISE HIGH-PRESSURE PARTS
MANUFACTURING

HIGH-PRECISION MANUFACTURING

CROSSHEAD TO PLUNGER

FULL QUALITY
ASSURANCE

TRIBOLOGY EXPERTISE MATERIAL ANALYSIS KNOW-HOW

CYLINDER

LUBRICATION TECHNOLOGY

BEARINGS

## REDURA® OIL SEALING SYSTEMS

# ELABORATE COMBINATIONS FOR HIGHEST SEALING EFFICIENCY



#### **DUAL OIL SEALING SYSTEM FOR MINIMAL LEAKAGE**

Separate seals on crank gear and distance piece side provide highest sealing efficiency. The tried and tested heterogeneously designed Redura® Oil Sealing Systems consist of 3 main elements, each with its own specific function.

First the **pre-wiper element LW 100**, which prevents most of oil from ever entering the oil wiper housing. The pre-wiper element is followed by a series of rings with optimally designed edges to remove all but a fine film of oil from the elastic rod. A final sealing element seals any oil mist that may have been created within the housing. The oil sealing system of the distance piece side is equipped with an additional sealing element and a pressure ring. This prevents carry-over of ethylene into the crank case.

# ADVANCED TRIBOLOGICAL IN-HOUSE RESEARCH FOR LONGEST OPERATING TIMES

Depending on the parameters, the housing and the mounting place of your Hyper Compressor, a specifically optimized solution can be designed based on your requirements. Advanced tribological in-house research provides excellent materials for longest operating times

# REDURA® LOW PRESSURE SEALING SYSTEMS

### FOR BEST PERFORMANCE

# REDURA® INCORPORATING THE PATENTED RAZOR BLADE™ TECHNOLOGY

The Redura® Low Pressure Sealing System provides additional safety; it avoids the flow of ethylene into the distance piece. Its general design consists of an individually optimized combination of different ring types.

First the **new oil wiper element LW 410** removes most of the lubricating oil and process matter coming from the high pressure cylinder side. Thanks to its superior, patented **Razor Blade™** technology it provides precise and optimal oil removal and lowest surface pressure, increasing the lifetime of the ring and the plunger.

The subsequent combination of Redura® sealing elements depends on the process parameters and gas compositions. It consists of a selection of:

#### Redura RS 300 sealing elements

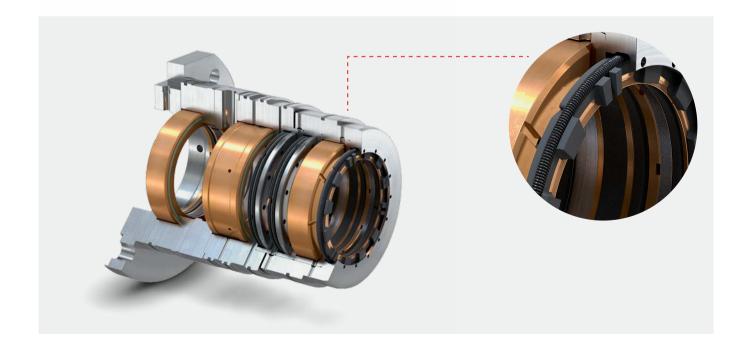
 Well established 3/6 piece sealing element. Radial tangential cut with bridge element, for outstanding sealing efficiency

#### Redura RS 900 sealing elements

 Axially pre-loaded sealing ring pair with double 3-piece sealing ring. Extremely reliable with maximum sealing efficiency for low pressure differences.

The integrated plunger seals with a self-centering design ensure that the cooling and flushing medium is kept in place. Thanks to its superior design the consumption of oil for cooling and flushing is absolutely minimized.

Tailor-made solutions backed by decades of experience in design and material selection ensure that you will receive the perfect solution for your Hyper Compressor.



# REDURA® HIGH PRESSURE SEALING SYSTEMS

## DECADES OF EXPERIENCE FOR PERFECT SOLUTIONS

## STATE-OF-THE-ART SOLUTIONS FOR ANY HYPER COMPRESSOR

Redura® High Pressure Sealing technology from Burckhardt Compression is based on decades of experience with continuous incorporation of state-of-the-art solutions and the latest quality standards for highest safety and longest MTBO.

The Burckhardt Hypropack™ cartridge system allows for extremely fast exchange and service, therefore highest possible availability of the compressor. The preassembled unit includes: base ring, high pressure cups, cups for guide bush and pressure breaker, sealing rings, shrunk liner and head core.

The packing cups consist of a multi-ring design with the inner cup shrunk into the outer ring in order to provide highest resistance against deformation.

#### **REDURA® FOR LONGEST MTBO**

The sealing system is based on a heterogeneous design which includes at least two different high pressure sealing element designs.

#### Redura® RB 100H pressure breaker

 High performance pressure breaker to withstand the dynamic pressure component and protect the subsequent sealing elements

#### Redura® RG 900H guide ring

 Robust guide ring provides reliable plunger guidance and high durability

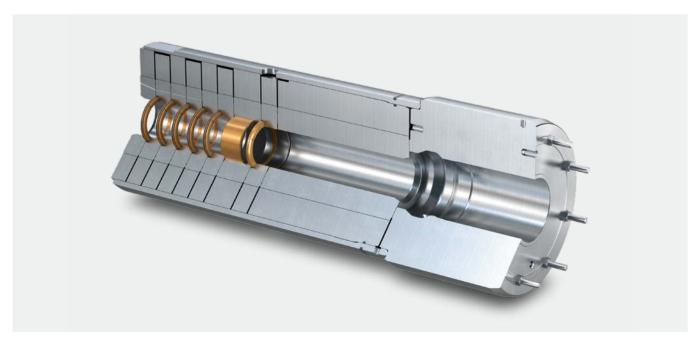
#### Redura® RS 300H sealing element

 3/6 piece classic sealing element for outstanding sealing efficiency

#### Redura® RS 310H sealing element

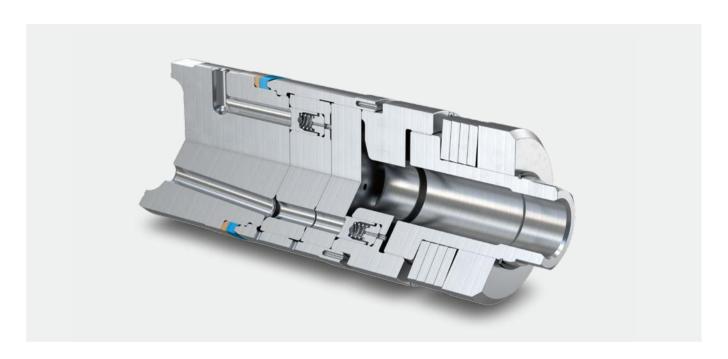
Very robust 3/3 piece sealing element for extended

Customized designs ensure the optimal solution for your Hyper Compressor.



## **CENTRAL VALVES**

### FOR IMPROVED LIFETIME AND INCREASED RELIABILITY



#### ABSOLUTE PRECISION FOR MAXIMUM SAFETY

The central valves have to operate with absolute reliability at the highest pressure levels, up to 3'500 bara. They must be engineered, designed, manufactured and installed with absolute precision and care.

Minuscule imperfections on parts exposed to these extreme pressure levels can lead to major damage.

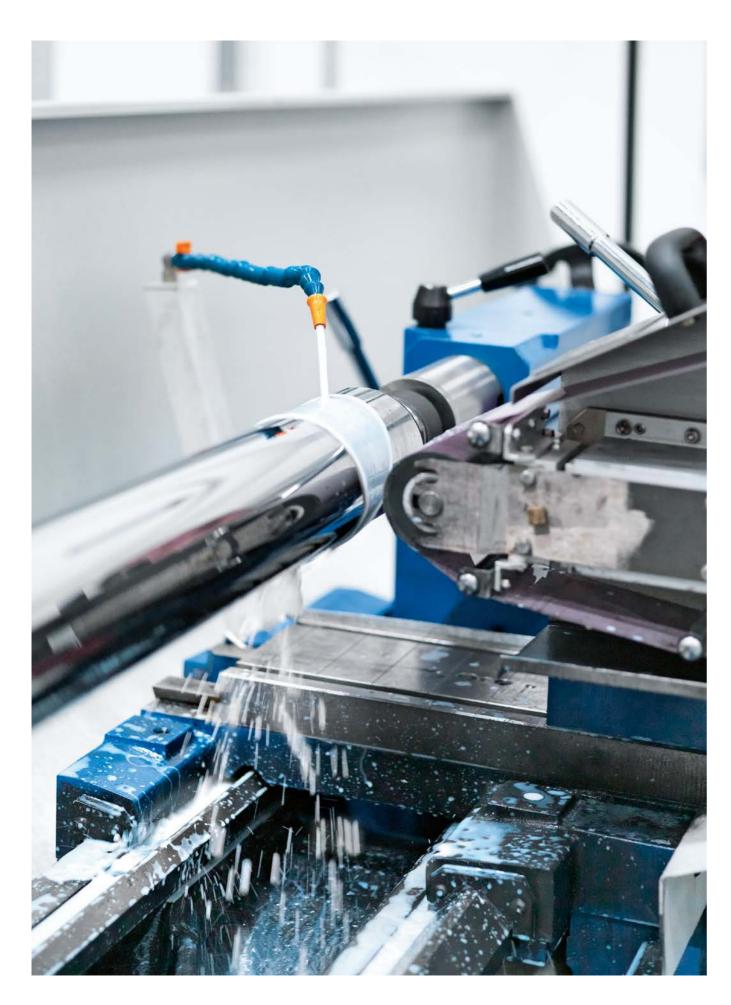
Our tried-and-tested multi-poppet design results in lower poppet weight and therefore substantially lower kinetic energy. This leads to significantly longer lifetime of poppet and valve seat.

#### SUPERIOR TECHNOLOGIES FOR CENTRAL VALVES

Our customized processes for best individual performance:

- FE Analysis
- In stationary fluid dynamics simulation
- Rigorous material selection
- Application of special high pressure manufacturing technologies such as: Autofrettage, shot peening or deep rolling/roller burnishing at the essential locations
- Meticulous assembly and installation executed by dedicated Hyper Compressor specialists
- Uncompromising quality assurance throughout all the process steps

Our comprehensive Hyper Compressor component know-how and experience allow us to carefully evaluate the possibilities to adapt our superior design to any other Hyper Compressor brand and type, or improve the existing single poppet design based on your requirements. 16 HYPER/SECONDARY COMPRESSOR COMPONENTS
HYPER/SECONDARY COMPRESSOR COMPONENTS



# COMPONENTS RECONDITIONING AND REPAIR SERVICES

## MAXIMIZE RELIABILITY AND AVAILABILITY

#### RECONDITIONING

To maximize reliability and availability of your Hyper Compressor equipment, well serviced Hyper Compressor components are crucial.

We provide outstanding reconditioning service for all major components of any Hyper Compressor brand and design.

- High pressure packing
- Low pressure packing
- Oil sealing system
- Central valves
- High pressure lubrication unit
- Auxiliary guide
- Plunger
- Check valves

#### **CUSTOMIZED SERVICES**

- Requirements and situation analysis
- Thorough examination
- Complete disassembly
- Inspection of individual parts
- Recording the condition of the main parts
- OEM engineering evaluation if required
- Thorough cleaning (glass bead blasting and/or ultrasonic cleaning if necessary)
- Repair and re-machining
- Lapping and grinding of all sealing surfaces
- Dimensional checking
- Replacement of worn and damaged parts with new Burckhardt Compression quality parts
- Careful reassembly
- Quality inspection including required testing
- Corrosion protection and adequate packing

#### **COMPONENT REPAIR**

Our offering also includes repair work for basically any Hyper/secondary compressor component of any type or model.

Our repair service stands for high quality and rapid turnaround in close cooperation with our customers.

- Situation analysis
- Evaluation (e.g. dye penetration etc.)
- Engineering for repair procedures
- Processes like laser cladding, nitrate hardening etc.

#### **UPGRADES/MODERNIZATIONS**

We are constantly striving to optimally support our customers regarding the requirements on LDPE plants for Hyper/Secondary Compressor systems as well as for primary compressors; we not only focus on compressor components but also on solutions supporting the entire system and our customers' processes.

This has led us for example to the development of a cup lifter tool for fast and easy assembly and disassembly of high pressure packings. Or to innovative high pressure cylinder lubrication pipe insulation for quick installation and best insulation values and absolutely stable temperatures of the pipes and the lubricants.

## **SAFETY MONITORING/SUPERVISION**

## MINIMIZE RISK - REDUCE COST

#### MONITORING THE CRUCIAL PARTS

Preventing accidental breakdowns is vital. They can have serious consequences, such as risks for plant safety and the environment, production loss, expensive consequential damages, etc.

Main measurements points for monitoring are:

- Crankshaft trigger for the crankshaft position
- Vibration acceleration on intermediate crosshead and cylinder
- Vibration velocity on crank gear
- Temperature on: plunger/crankshaft bearing/intermediate crosshead/crosshead guide plate/crosshead bearing/crankshaft journal
- Indirect measurement of the cylinder pressure by strain gauge technology
- Measurement of the plunger vibrations

#### INDIVIDUAL SOLUTIONS FOR YOUR REQUIREMENTS

Depending on your needs we can provide the best solution for safety monitoring and supervision including installation engineering. A combination of individual sensors and measuring systems is possible:

- Spring loaded or radar pulse sensors for cross head bearing temperature
- Proximity sensors for plunger vibrations
- Elongation measuring ring for cylinder pressure
- Resistance temperature sensors (PT100) for various measuring points

To meet most stringent requirements on safety monitoring and supervision an online system is recommended.

# ONLINE CONDITION MONITORING AND DIAGNOSTICS

WE RECOMMEND PROGNOST®

#### **MORE THAN 25 YEARS OF EXPERIENCE**

Monitoring of machines in LDPE (Low Density Polyethylene) service demands a highly adaptable and reliable technology.

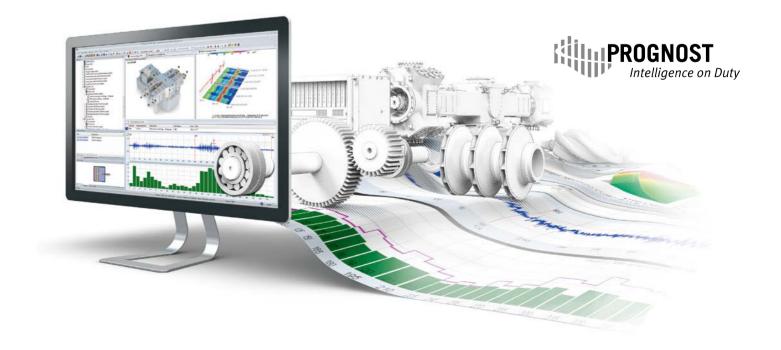
PROGNOST®-NT is the leading system for monitoring Booster/Primary and Secondary Compressors in LDPE plants. PROGNOST monitors hundreds of machines in the LDPE industry at all major production companies.

Burckhardt Compression recommends PROGNOST Systems – the technological leader in safety protection and online monitoring with more than 25 years of experience.

PROGNOST®-NT is an automated machinery diagnostic system incorporating SIL 2-certified and online condition monitoring. It has been developed specifically for reciprocating machinery but is also used for different kinds of rotating equipment. It detects pending failures at an early stage and identifies the affected components. Operation-critical damages are avoided and maintenance work can be performed efficiently.







20 HYPER/SECONDARY COMPRESSOR COMPONENTS HYPER/SECONDARY COMPRESSOR COMPONENTS 21

# **UNEQUALED CAPABILITIES**

## FOR YOUR HYPER EQUIPMENT



#### **REQUIREMENTS & SITUATION ANALYSIS**

- Process Compressor condition change
- Improved design to replacement parts with excessive wear
- Damaged parts/failure

- Worn out parts
- Precarious or unsafe operating conditions
- Troublesome parts
- Maintenance and spare parts logistic scheduling





- Root cause analysis/failure analysis Risk/Condition and Material analysis
- Feasibility studies
- Finite Element Analysis (FEA) Studies



- Non-destructive testing (NDT)
- Stock recommendations
- 3D Modelling
- Computer Fluid Dynamics (CFD) Analysis





#### **ENGINEERING**

- On-site, and/or in-house measurements of components
- Recalculation and dimensioning
- Engineering for repair procedures

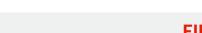
- Reverse engineering/Retrofit
- Material selection and sizing
- Load optimization
- Thermodynamics





#### **MANUFACTURING**

- Highest quality assurance
- Reproduction (1:1 replacement incl. integration of latest quality standards)
- In-house precision manufacturing of parts
- Fast track production upon request
  - OEM quarantee
  - Specific in-house manufacturing (e.g. Autofrettage)



#### **FIELD ACTIVITIES**

- Extensive service network with our specialized field service engineers/troubleshooters
- Spare parts framework agreements
- Worldwide distribution and service center network
- Dismantling/Reassembly of parts
- Large parts stock
- Burckhardt e-Shop™ spare parts identification and ordering system



















LEADING HYPER/SECOND-ARY COMPRESSOR TECH-NOLOGY SINCE DECADES



COMPREHENSIVE SOLUTIONS FOR YOUR LDPE PLANT



SUPERIOR PARTS DESIGN FOR PRESSURES UP TO 3'500 BARA



IN-HOUSE MANUFACTURED
HIGH PRESSURE COMPONENTS
FOR LONGEST LIFETIME
AND HIGHEST AVAILABILITY

#### **COMPRESSOR COMPONENTS**

BEST PERFORMANCE AND LONGEST LIFETIME

Compressor valves

Redura® rings & packings

Capacity control systems

Capital parts

Labyrinth piston compressor components

Hyper/secondary compressor components

#### **SERVICES**

THE FULL RANGE

Burckhardt Valve Service

Spare parts logistics

Field service

Technical support

Revamps & upgrades

Component repair

Condition monitoring & diagnostics

Training

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