

CEROBEAR®

ceramic bearing technology

— MinebeaMitsumi Group —



CEROBEAR ROLLING BEARINGS FOR THE FLUID MACHINERY INDUSTRY

ALL-CERAMIC & HYBRID BEARINGS

CEROBEAR GmbH is the renowned world leader in the design, manufacture and application engineering of bearings that feature highly advanced ceramic material technology. Our CERamic ROLLing BEARings are used in the most challenging applications where conventional rolling bearings are no longer capable of performing reliably.

In addition to serving market segments including Aerospace, Motorsports, Food and Beverage Packaging, Oil & Gas, Machine Tools, Semicon/Thin-Film Processing CEROBEAR also designs and manufactures advanced bearings for the Fluid Machinery Industry and the Petrochemical Market.

With a team of more than 100 technically oriented employees and the most modern manufacturing technology, CEROBEAR rolling bearings are produced in Herzogenrath near Aachen, in the westernmost part of Germany.

THE CEROBEAR DIFFERENCE

CEROBEAR, with its roots in the Fraunhofer Society, is more of a technology and engineering company than another ordinary bearing manufacturer. What differentiates us from other bearing makers is our strategy to focus on the most demanding, customized bearing applications, which requires a different approach:



CEROBEAR offers customized bearing designs



CEROBEAR bearings provide outstanding corrosion resistance

Simultaneous Engineering with Customers

- Specialist for joint bearing development from prototyping to production levels
- Close customer collaboration at every development stage from the design to serial usage
- Analysis, calculation and lifetime-prediction for bearings featuring ceramic components
- One to one replacement in the same space envelope

Advanced Bearing Materials

- Leading expert in the use of silicon nitride (Si_3N_4) & zirconia (ZrO_2) ceramics in rolling bearings
- A selection of advanced steels and alloys available including High Nitrogen Steels with superior corrosion resistance at 60 HRC, AISI 440 C, Inconel 718, M50 and many more
- Advanced Polymers: PEEK, Vespel, Torlon, PCTFE

Advanced Component Fabrication & Inspection

- In-house ball surface inspection yields outstanding reliability by assuring surface integrity
- In-house ceramic roller fabrication with exceptional geometry flexibility and surface integrity control
- Hard-turning for rings maximizes roundness & concentricity; enables complexity of geometry

Complete Design Consideration

- We specialize in customized designs but do bearings in DIN/ISO dimensions also
- We do offer ball and roller bearing designs since we make our own ceramic rollers – this maximizes our flexibility to meet application demands
- Custom fit and integration into all application requirements
- Assure maximum benefits from materials being used
- Maximize performance and service-life

Flexible, Quick, and Highly Certified Manufacturing

- 8–16 weeks delivery for initial non-stocked orders, depending on the complexity of the part
- Complete traceability of every bearing and every part available on demand
- Certified according to the following international standards:
 - EN 9100 (Aerospace Standard)
 - DIN EN ISO 9001 (Industrial Standard)
 - DIN EN ISO 14001 (Environment)
 - BS OHSAS 18001 (Safety & Health)
 - DIN EN ISO 50001 (Energy)

OUR PRODUCTS

CEROBEAR's product range includes customized and DIN/ISO bearings:

- Hybrid rolling bearings, a combination of steel rings and Si₃N₄ rolling elements
- All-ceramic rolling bearings made of either Si₃N₄ or ZrO₂



CEROBEAR Hybrid Deep Groove Ball Bearing

In addition to our extensive DIN/ISO bearing selection, we also customize bearing solutions for your special application needs in a close cooperation with both machine constructors and system manufacturers.

CEROBEAR rolling bearings for Fluid Machinery consist primarily of

- Biocompatible,
- FDA & USP Class VI compliant and
- Corrosion resistant materials.

MATERIALS AND TECHNOLOGY

In more than 20 years of close collaboration with world leading OEMs, CEROBEAR has developed a unique material specification for hybrid rolling bearings, which is optimized for Fluid Machinery operating conditions.

CEROBEAR material specification:

The core components of CEROBEAR hybrid bearings are races made of specially heat treated High Nitrogen Steel, Si₃N₄ rolling elements and a cage made of PEEK or brass. For reduced friction and longer lifetime, CEROBEAR offers special coatings of races and cages.

Raceway material:

High Nitrogen Steel, also available with a special anti-corrosion heat treatment, developed by CEROBEAR

- Corrosion resistance (against harsh chemicals)
- Superior lifetime due to 2.5x higher overrolling resistance than conventional bearing steels

Corrosion resistant high nitrogen steel (approved in 192h salt spray test)



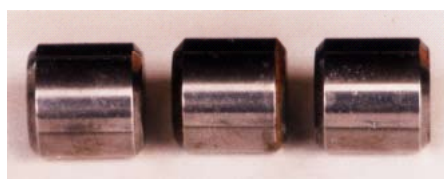
SAE 52100 ("conventional bearing steel")



SAE 52100 chromium plated



AISI 440 C ("corrosion resistant bearing steel")



High Nitrogen Steel (HNS)
CEROBEAR specification

Courtesy of: Engergietechnik Essen

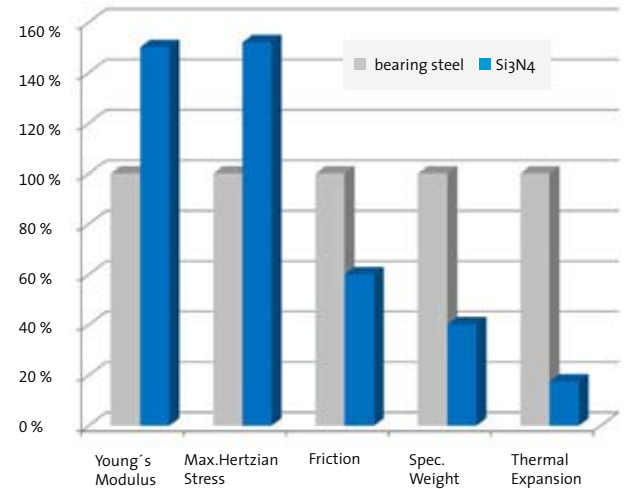
ALL-CERAMIC & HYBRID BEARINGS

Rolling elements: Pressure densified, high purity silicon nitride ceramic (Si_3N_4)

- Absolute stable chemical structure; inert, micro-welding with metal is impossible
- Extreme hardness of 1550 HV (~ 80 HRC); much less wear
- 40% lower coefficient of friction compared to conventional steel/steel contact
- Enables media lubrication or dry running (very good emergency operation features)
- Less wear and constant low friction

Cage: Polyetheretherketone (PEEK) or Brass

- Corrosion resistant against most chemicals
- Temperature resistant
 - PEEK up to 400 °F (~ 200 °C);
 - Brass up to 572 °F (~ 300 °C)
- Flexible (PEEK)
- Low friction



Properties of Si_3N_4 vs. bearing steel

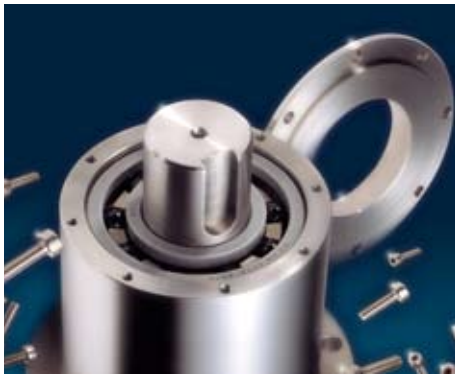
Lubricant: depending on the application

CEROBEAR offers a wide range of greases for very different applications (for example: food-compatible, high temperature, high speed, vacuum and many more).

Seals or shields: depending on the application

CEROBEAR chooses from a range of materials the best option based on the customers application data (for example: FPM Viton, PEEK or HNS).

APPLICATIONS AND CONDITIONS



CEROBEAR All-Ceramic Bearings operate seamlessly in media lubricated cartridges

CEROBEAR hybrid bearings for Fluid Machinery applications are being broadly used in state-of-the art machines, like:

- Mixers
- Pumps
- High Pressure Low Density Polyethylene or EVA Autoclaves
- Decanters
- Compressors.

CEROBEAR hybrid bearings are capable of the most challenging operating conditions in which conventional steel bearings under-perform and provide short lifetimes.

CEROBEAR bearings offer superior performance:

- Resistance against harsh chemicals
- Cleanability (open design)
- Constant and low friction
- Capability of running media lubricated or completely dry
- No particle emission
- Special designs possible
- Resistance against humidity
- Operation at high temperature and pressure.

Easy Machinery Integration

The implementation of CEROBEAR hybrid bearings into existing machines does not require any additional modifications. CEROBEAR engineers design each bearing type particularly to the environment and application. An easy integration is your benefit.

Starved Lubrication / Media Lubrication / Dry Run

Ultra-clean, chemically aggressive or high pressure processes require bearings which do not pollute the product at any time while withstanding harsh operating conditions. Standard rolling bearings need to be lubricated by grease or oil, otherwise they fail by an adhesive wear mechanism known as galling.

In CEROBEAR hybrid bearings, galling is not possible, because the Si_3N_4 ceramic of the rolling bodies provides a completely stable chemical structure and is completely inert and thus not capable of reacting with the steel of the races.

ADVANCED BEARING TECHNOLOGY FOR FLUID MACHINERY

In special types of mixers, pumps and high pressure autoclave reactors bearings cannot be completely sealed to gaseous or liquid process media. High temperature and aggressive chemicals shorten the life time of standard or stainless steel bearings, with wear particles contaminating the process media. Unpredictable behavior of the bearing material in the non-standard environment leads to decreased reliability and unforeseen application shut downs.

The arrival of a new generation of rolling bearing technology, introduced by CEROBEAR more than a decade ago, has set a milestone in reliability improvement and life time increase.

Extremely corrosion resistant, through-hardened bearing steels, carefully heat treated by a specifically in-house developed annealing process, in combination with Si_3N_4 ceramic rolling elements enabled totally new machinery designs, where bearings are no longer capsuled but exposed to the corrosive environment.

By sharing our experience and engineering expertise with you, we provide complimentary support, to maintain your next generation equipment state-of-the-art technology.



CEROBEAR Hybrid Spherical Thrust Roller Bearing
specification for high pressure autoclave reactors



All-Ceramic Bearings in a chemical pump application
courtesy of Klaus Union GmbH

BEARINGS IN PUMPS AND COMPRESSORS

In a wide range of the process industry, pumps and compressors are used under extreme challenging conditions. Additional operating costs, caused by a too short Mean Time Between Failure (MTBF) and the persistent trend towards downsizing require new bearing solutions to fulfill severe application demands and the customers need for increased reliability and service life.

Our team of project and application engineers will help OEMs as well as end-users to find the proper solution at each stage of the project.

Special demands at cryogenic pump applications

LNG pumps are used for receiving and discharging LNG to storage tanks. In this application, the bearings support the main shaft of the motor and are floated by Liquefied Natural Gas at -259°F (-162°C) and used at rotational speeds of up to 4000 rpm.

To fulfill these challenging demands, CEROBEAR develops custom made rolling bearing solutions, adapted to the requirements of the individual application. We use rings made of High Nitrogen Steel, a material with an outstanding resistance towards overrolling fatigue as well as corrosion. To cope with the media lubrication, our rolling elements are made of the chemically inert material silicon nitride. Therefore CEROBEAR rolling bearing solutions are not faced to the adhesion problems of a steel/steel contact as galling and cold welding. The bearing cage is made of PCTFE, a plastic with an excellent chemical resistance and a remaining high tenacity, even at cryogenic temperatures of -328°F (-200°C).

ALL-CERAMIC & HYBRID BEARINGS

Cerobear solutions for Screw Compressors

In advanced compressor applications bearings are exposed to a combination of excessive speed and high load. A compact assembly combined with long service life are the key design requirements.

CEROBEAR addresses these challenges by individually adapted bearing internals combined with highest quality component materials, to create hybrid rolling bearings with superior load ratings, resulting in an outstanding fatigue life at compact bearing dimensions. The dedicated contact angle with angular contact ball or Four-Point bearings allows an optimized thrust load capacity. High Nitrogen Steel for the races in combination with PEEK cages and Si₃N₄ rolling elements are the basis for bearings which operate seamlessly at excessive speeds and loads, even under media lubrication or at high operating temperatures. CEROBEAR's project engineers will find the best solution for every individual application.

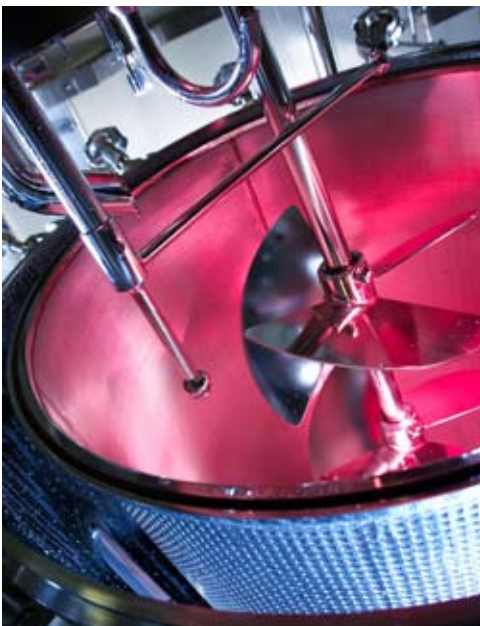


CEROBEAR All-Ceramic Ball Bearings provide extreme corrosion resistance

Features of CEROBEAR pump and compressor bearing solutions

- High load capacity: Thanks to High Nitrogen Steel in combination with Si₃N₄ rolling elements and an individually adapted inner geometry.
- High rotational speed: An individual cage design and the choice from more than 20 materials allow higher rotational speeds.
- High precision: Individually designed bearings with integrated functions allow high precision applications.
- Individual arrangement: Back-to-back, face-to-face or tandem. Whatever the best solution for the application is – we match the bearings for your operation.
- Individual clearance/preload: To allow a precise positioning of the shaft, we adapt the clearance and preload individually.
- High performance cages: More than 20 materials cope with challenging conditions like corrosive media, high rotational speeds and extremely high or low temperatures.

ROLLING BEARING SOLUTIONS PROVIDING ASEPTIC QUALIFICATION FOR MIXER APPLICATIONS



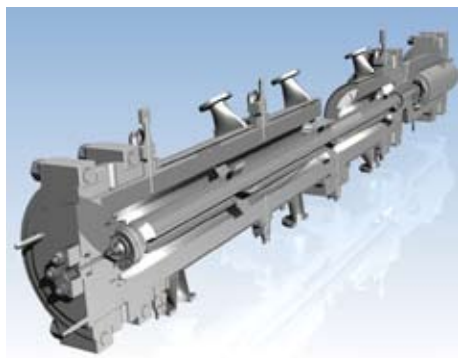
Bearings for pharmaceutical mixers require perfect cleanability,
courtesy of liquittec ag

Especially for mixer applications, CEROBEAR offers a variety of materials which are certified for aseptic and medical use and are proven in numerous applications:

- All-ceramic bearings, using rings made of ZrO₂ or Si₃N₄
- FDA and USP Class VI compliant cage materials
- Chemically inert Si₃N₄ rolling elements.

The application adapted CEROBEAR rolling bearing design combines highest performance and perfect cleanability. All utilized materials do withstand sterilization processes, whether they are conducted by hot steam or aggressive cleaning detergents. Special inner geometries provide high load ratings without generating dead space. Carefully chosen materials allow low friction running and guarantee particle emission free operation, e.g. in the production of vaccines.

BEARINGS IN HIGH PRESSURE LOW DENSITY POLYETHYLENE (LDPE) AUTOCLAVE REACTORS



Section through a LDPE reactor

courtesy of UHDE High Pressure Technology GmbH

The first LDPE autoclave process was introduced in 1938. In this type of application, a mix of pressurized ethylene gas and catalysts is stirred at high temperature in a vessel. The stirrer is agitated by an electric motor which is in line with the vessel.

The operating pressure in a range of 1300 - 3500 bar, the process temperature varies between 100 - 300 deg Celsius. As the bearings of the stirrer and the motor have to operate in the pressurized zone they can be lubricated by the incoming ethylene gas or the reacted product only. Under these compromised lubrication conditions conventional bearings suffer adhesive wear after very short time and have therefore been the weak link in the process from the start of this technology.

This changed to the better with the introduction of CEROBear hybrid ball and roller bearings in 1998. As hybrid bearings do not suffer adhesive wear due to the inertness of Si₃N₄ the bearing damage related service life of reactors using this advanced bearing technology could be increased by factor 4 to 8, depending on the operating conditions. The arrival of the new bearing technology helped manufacturers to cut downtime, production loss and maintenance costs dramatically.



CEROBear Hybrid Spherical Roller Bearing in LDPE specification

The CEROBear Rolling Bearing Solution

In 2008 CEROBear first introduced hybrid spherical roller bearings as a further improvement and is since then capable to offer bearing solutions for all licensors reactor types. Particularly spherical roller bearings possess perfect properties for the demanding stirrer shaft application: high load capacity in combination with angularity and the capability to carry thrust and radial loads. For the bearing rings CEROBear offers High Nitrogen Steel and M50 for superior wear resistance at temperatures of up to 450 deg Celsius.

Worldwide collaboration with the customers

CEROBear works worldwide directly with LDPE or EVA manufacturers as well as with licensors and reactor OEMs. The typical approach to convert a reactor using conventional bearings is to replace them by hybrid bearing types one to one. In the next step CEROBear project engineers analyze the wear pattern of a set of used hybrid bearings to recommend changes of the internal bearing design or to suggest better suited bearing types, to further increase bearing performance and to help customers to improve their process and reduce their total operating costs.

REDUCED TOTAL COST OF OWNERSHIP

In many areas standard steel bearings present the weakest link in a machine and define the down-time of the entire production process. Scheduled but short service outages and unplanned stops caused by avoidable bearing failures result in lower productivity and margin.

The investment in CEROBear's most advanced hybrid and all-ceramic bearing technology makes before mentioned scenarios a thing of the past. The superior service life of CEROBear hybrid and all-ceramic bearings, whether used in pumps, mixers, high pressure polyethylene reactors or compressors enhances the machinery availability and thus reduces the total cost of ownership. For this reason, the world's leading LDPE producing companies trust in CEROBear's unrivaled products and engineering services for almost 15 years, while companies worldwide benefit from a quick return on investment due to increased reliability and output.



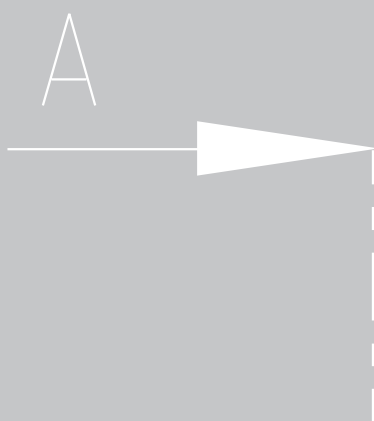
We welcome your enquiries from around the world and look forward to hearing from you.

For more information on CEROBear and our unique technology and products, please contact us:

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