When movement meets extreme environments.
Solid-lubricated rolling bearings for extreme operating conditions.
The Künemund Group comprises manufacturing companies, trading enterprises and a computer centre. All of the companies are networked with each other and are ready to meet your tasks with bundled expertise.
Extreme temperatures and pressures are a problem for rolling bearings. Apart from ours.

Olga und Karl Fink, Produktion, Compound GmbH Hochtemperatur Wälzlager

Particularly demanding conditions apply to rolling bearings in the steel, ceramics and glass industries, for example, because of high temperatures and, in vacuum applications, low pressures. Compound GmbH develops and produces solid-lubricated systems and rolling bearings with special greases, which safeguard the operational capability of rolling bearings under extreme operating conditions.

Products
- Solid-lubricated rolling bearings
- High-temperature rolling bearings up to 350 °C
- Specially greased deep-groove ball bearings
- Rolling bearing coatings

Compound GmbH Hochtemperatur Wälzlager in Kehl am Rhein is a Künemund Group company. It manufactures rolling bearings with solid lubrication which guarantee long, maintenance-free running times even under extreme conditions.
Under normal operating conditions, rolling bearings are usually lubricated with greases or oils. However, lubrication by means of greases and oils is insufficient for some fields of application in which the lubricant loses its lubricating properties or does not remain effective for long enough as the result of chemical and/or physical effects occurring at the lubrication point.

Such fields of application are characterized by the following:

- extremely high or low temperatures
- penetration by aggressive mediums
- very low pressure (vacuums)
- air flowing through the bearing
- operation of the bearings after a long period out of operation
- penetration of hard and soft particles
- stress exerted on the bearing (e.g. centrifugal, gravitational, etc.)

Dry lubrication on the basis of various compounds or coatings can ensure full functionality of rolling bearings under the extreme operating conditions set forth above.

**Types and properties of the most important solid lubricants**

<table>
<thead>
<tr>
<th>Property</th>
<th>Graphite C</th>
<th>Molybdenum disulphide MoS₂</th>
<th>Polytetrafluoroethylene PTFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>black</td>
<td>grey</td>
<td>white</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>1.4–2.4</td>
<td>4.8–4.9</td>
<td>2.1–2.3</td>
</tr>
<tr>
<td>Metal adhesion</td>
<td>moderate</td>
<td>good</td>
<td>poor</td>
</tr>
<tr>
<td>Friction coefficient</td>
<td>0.1–0.4</td>
<td>0.04–0.1</td>
<td>0.04–0.09</td>
</tr>
<tr>
<td>Melting point (°C)</td>
<td>3500</td>
<td>180</td>
<td>327</td>
</tr>
<tr>
<td>Operational temp. (°C)</td>
<td>below -30 to +430</td>
<td>-180 to +350</td>
<td>-250 to +170</td>
</tr>
</tbody>
</table>

Lubricating behaviour at low/high load:
- good/good
- good/very good
- very good/poor

Applicability with:
- inert gases: poor, good
- high degree of dampness: good, moderate, good
- vacuums: poor, very poor, good
- corrosion:
- very good, moderate, good
- chemicals: very good, good, moderate, very good
- Vibrational friction: good, poor, very good
- Stick-slip effect: yes, no
- Decomposition products: CO, CO₂, MoO₃, SO₂, C₂F₄

**COMPOUND 1 (COMP1):**
- from -30°C to +280°C (or higher for short periods), in damp environments or if media is utilised (diesel, water, benzine, etc.). COMP1 should never be utilised in a vacuum, in a dry atmosphere or under inert gases such as nitrogen.

**COMPOUND 2 (COMP2):**
- from -180°C to +300°C (or 350°C for short periods), in dry to slightly damp or inert (e.g. nitrogen) atmospheres. Through its special mixture of solid lubricants, COMP2 covers a wide range of applications. We therefore recommend COMP2 for individual cases where the environmental influences are not precisely known. However, COMP2 is only suitable to oscillating movements up to a certain extent.

**COMPOUND 4 (COMP4):**
- This COMPOUND was developed specifically for vacuum applications. It is temperature resistant up to 300°C, or 350°C for short periods. Note that the COMPOUND begins to outgas at temperatures higher than 300°C.

**Special version P:MoS₂:**
- At very low pressures and, at the same time, high temperatures, the gas evolution of COMP4 can disturb the surrounding vacuum to such an extent that a utilisation of this particular compound is out of the question. For this reason, we also offer a manganese-phosphate bearing in whose surfaces various different solid lubricants (MoS₂ in this case) are drummed or rotated in.

**Lubrication concept of the COMPOUND bearings**

As solid lubrication consumes the lubricating agents, long service lives can only be achieved if the solid lubricants that have been consumed are constantly replenished (transfer lubrication). For this reason, the space between the bearing rings and the rollers is filled with a mixture of dry lubricants and a binding agent (COMP1, COMP2 or COMP4) which, once the compound has stabilized, runs with the cages. With each turn, the rollers take on dry lubricant and pass this on to the gliding surfaces, providing a continuous re-lubrication and a long, maintenance-free service life.
Suitable rolling bearing types

Which types of rolling bearings are suitable as COMPOUND bearings?

- Deep groove ball bearings of all series and sizes
- Thin-ring bearings and miniature ball bearings
- Angular ball bearing
- Self-aligning ball bearings
- Spherical roller bearings
- Cylindrical roller bearings
- Tapered roller bearings
- Rollers
- Housing units

Pedestal bearing housings with a COMPOUND bearing and Tecoflon seal

Housing units
**COMPOUND bearings – general data**

**Dimensions**
As COMPOUND bearings are manufactured from the standard rolling bearings of leading manufacturers, the main dimensions of all COMPOUND bearings conform to German industrial standards (DIN 625, 626, 628, 635, 730 and DIN 616).

**Tolerances**
As COMPOUND bearings are subjected to a hardening process, there may be slight variations to the tolerances defined as standard (DIN 620). On manganese-phosphate surfaces, an increase in the diameter of the outer ring and reduction of the diameter of the inner ring must be taken into consideration.

**Bearing clearance**
In principle, a dry lubricant requires increased radial clearance regardless of the operating temperature in order to compensate for kinematic imbalances arising from the coating processes and unavoidable penetration of particles causing wear. For this reason, Compound bearings are only manufactured from rolling bearings with increased bearing clearances (C4, C5 or higher). All COMPOUND bearings should have a C3 clearance as a minimum under operating conditions.

**Cages**
Depending on the type of bearing, COMPOUND bearings are supplied with pressed cages of either steel or brass (such as e.g. spherical roller bearings).

**Heat stabilisation**
As structural transformation of materials occur at temperatures of above 120°C which is accompanied by changes and dimensions of the materials as well as loss of hardness and stability, the dimensions of the rolling bearings are stabilized (depending the operating temperature) at different stages (S0 through S4).

However, COMPOUND bearings are only manufactured to order from stabilized rolling bearings for two reasons:
- high costs and long delivery times
- bearing tests have proven that stabilized roller bearings do not attain greater endurance at higher temperatures than non-stabilized roller bearings.

Therefore the changes in dimensions of the steel at higher temperatures is compensated for by a suitable choice of bearing clearance (C4, C5 or higher).

**Speeds**
As dry lubrication consumes the lubricating agent, the user only has a limited choice of speeds. The total number of speeds is, however, essentially dependent upon the following:
- the type of bearing used, the lubricating agent (mixture) and the operational environment. Therefore, lower speeds are the real domain of COMPOUND bearings.

**Bearing load, dimensioning**
For maximum endurance the load on the COMPOUND bearings should not exceed 25% (even better: 10%) of the original bearing’s static loading capacity. Please remember this when determining the bearing dimensions.

**Fits**
Due to the necessity of increased radial clearance, fits should be relatively loose (for example H7, h7). Strong press fits lead to reduction of clearances which can strongly impair the functions of COMPOUND bearings. This is to be particularly taken into consideration with the manganese-phosphate versions.

**Corrosion protection**
Contrary to greased rolling bearings, COMPOUND bearings offer no protection against corrosion. In cases where there is a risk of corrosion, we offer two possibilities for protection:
- phosphating of the surfaces
- rolling bearings made of corrosion-proof steel

**Phosphating**
To improve the gliding properties (better adhesion of the solid lubricants to the gliding surfaces) and protection against corrosion, we usually offer phosphating of the roller bearings.

There are two options:
- iron-phosphating: very thin (1 - 3 µm), low protection against corrosion
- manganese-phosphating: relatively thick (7 - 10 µm), low protection against corrosion

When determining the bearing fit, the changes to dimensions occurring during manganese-phosphating must be taken into consideration.

**Enquiries**
As there are a number of types and combinations of solid lubricants, please provide details of where and how the bearing is to be installed as well as the operating and ambient conditions when enquiring about a specific type of bearing, e.g.:
- operating temperature
- speed
- bearing load rating
- special atmospheric ambient conditions such as incoming dust, dry or damp air, nitrogenous atmospheres, vacuums (x mbar), etc.
Service life of COMPOUND bearings

Generally speaking, the service life (or duration of lubrication effect) of a solid lubricating film depends on the type of solid lubricant utilised and its ability to adhere to the contact surfaces as well as the thickness of the film itself. As solid lubrication also has a wearing effect, it fails as soon as the dry lubricant is worn down. At present there is no generally accepted basis for calculating the service life of solid lubricated rolling bearings. For this reason, the user must fall back on his own experience and trial and error for all applications.

Advantages of COMPOUND bearings

- Lubrication of rolling bearings across a wide range of temperatures (-80°C to +350°C)
- Maintenance-free
- To a certain extent, extremely higher endurance
- Utilisation of expensive special greases whose effect on the environment is doubtful, is rendered superfluous
- Cost intensive central lubricating system no longer necessary
- No contamination of the area around the bearing by surplus grease which is expensive to dispose of
- Low starting torque regardless of the temperature
- To a certain extent, extremely higher endurance

Remarks on the utilisation of COMPOUND bearings

- Never oil or grease COMPOUND bearings.
- COMPOUND bearings should be installed with relative care as the dry lubricating compound is a relatively brittle material.
- The sealing effect of COMPOUND bearings do not correspond to those of a roller bearing with abradent sealing such as, for example, 2RS.
- COMPOUND bearings in non-phosphate versions have no protection against corrosion.

Special rolling bearing greases

- Deep groove ball bearings, self-aligning ball bearings, cylindrical roller bearings, needle bearings, spherical plain bearings, pillow type bearings, yoke type track rollers, cam followers, etc.
- Wide range of greases and oils from all leading manufacturers
- Defined grease quantity
- Deep groove ball bearings shielded (2Z, 2RS, etc.) or open
- No minimum quantity (also 2x)

Special greases

Coatings and special solutions for spindles

Wide range of rolling bearing greases and oils
The Künemund Group

Dr Kai Dürr, Managing Director, Künemund GmbH & Co. KG

We not only supply you with products, but also solutions.
Because we are not just distributors but also manufacturers.

Dr Kai Dürr, Managing Director, Künemund GmbH & Co. KG

Further added value

- **Group know-how:** there is a constant exchange of knowledge taking place within the Group. This ensures that we are familiar with all products across the board and that our know-how is completely up to date.

- **Commercial competence:** at each of our six trading enterprises you have access to the entire range of products supplied by the Künemund Group – roller bearings, seals and linear technology.

- **Flexible sales:** our professional field staff will be happy to visit you to offer advice.

- **Fast order processing:** six distribution centres and our own production facilities ensure high levels of product availability.

- **Full-range supplier:** we supply products from top manufacturers such as GMN, GRW, Koyo, Schaeffler, Timken etc.

- **Merchandise management competence:** RZ Horlacher GmbH takes care of reliable provision of all IT solutions within the Künemund Group.

A strong network: Künemund Group’s manufacturing and trading companies are situated in various locations across Germany.

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4 Künemund Wälzlager Halle GmbH, 06179 Teutschenthal-Holleben
5 Künemund GmbH, 77694 Kehl am Rhein
6 Künemund GmbH & Co. KG, 70565 Stuttgart
7 Künemund Dichtungstechnik GmbH, 47918 Tönisvorst
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