Design Engineering with iglide®

iglide®

iglide® Plain Bearings

- high dimensional accuracy
- high compressive strength
- good heat dissipation
- low heat relaxation
- maintenance-free
- high dirt resistance
- corrosion resistance
- high vibration dampening
- very low tendency to creep

Plain Bearings Last a Long Time at Low Cost

igus® develops materials that are well-suited to the different requirements of maintenance-free plain bearings:

1. Plain bearings must be able to handle high loads over an extended period of time.
2. Maintenance-free plain bearings should have low coefficients of friction.
3. Plain bearings should have low wear rates to increase life span.

Both in material development as well as in the construction of bearings, former disadvantages of plastics can be greatly reduced. Thus, iglide® plain bearings are thin walled and some materials have especially high thermal conductivity. Both features function to rapidly dissipate heat and thus directly increase the load capacity of the bearing.

Picture 1.1: Every designer's dream: A calculable plain bearing made of high-performance plastics

The Traditional Solution is:

Hard shells with soft coating. Each lubricated bearing works according to this principle, and likewise a number of maintenance-free bearings, that are equipped with special slide layers. However, this soft slide layer is not strong enough. For high loads, compression across edges or oscillations, it becomes removed.

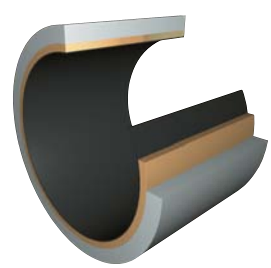

Figure 1.2: The traditional solution, bearing shells made of layers with lubricants and/or coating.

iglide® Plain Bearings Function Differently

One component of the iglide® materials acts for each function of the bearing:

- The **base plastics** are responsible for the resistance to wear
- **Fibers and filling materials** reinforce the bearing so that high forces or edge loads are possible
- **Solid lubricants**, lubricate the bearing independently and prevent friction of the system

Picture 1.3: iglide® plain bearings: Exactly the right bearing for every application

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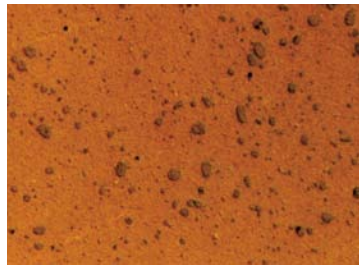
Base Plastics and Technical Fibers

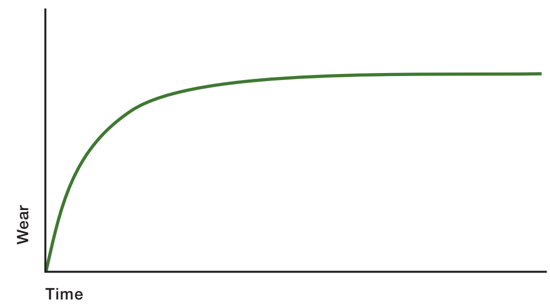
The radial pressure, with which the bearings are loaded, is received by the plastic base material. In the contact area, this material provides shaft support. The plastic base material ensures the lubricants do not receive a surface pressure that is too high. The base material is also reinforced by technical fibers or filling materials. These additional materials stabilize the bearing especially for cases of continuous stress.



Picture 1.5: Base plastics without reinforcing materials with solid lubricants, magnified 200 times, dyed.

The Start-up Phase

In the starting phase, the shaft and the iglide® plain bearing become mated to one another. During this phase, the surfaces of both partners are fitted to each other. The specific loading of the system drops since the contact surfaces of the shaft and bearing expand during the start-up. At the same time, the rate of wear decreases and approaches a linear curve. In this phase, the coefficients of friction continue to change, until finally assuming a value that is for the most part constant.



Graph 1.1: During the start-up phase, the rate of wear drops greatly.

Compressive Strength

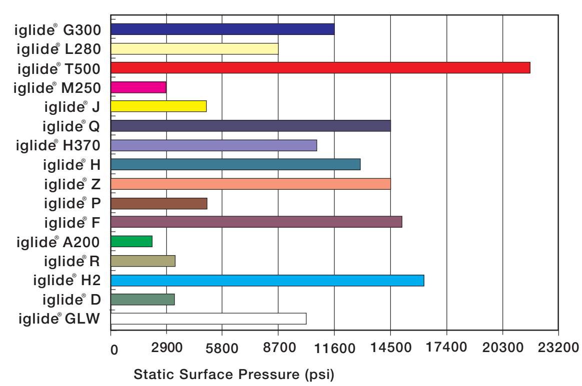
The load of a plain bearing is expressed by the surface pressure (psi). For this purpose, the radial load is determined on the projected surface of the bearing.

Radial bearing:
p = F / (d1 x b1)

For thrust bearings, the load is produced accordingly.

Axial bearing:
p = F / (d2² - d1²) x π / 4

in this process:
F load in lbs
d1 bearing inner diameter in inches (mm)
b1 bearing length in inches (mm)
d2 Outer diameter of the bearing in inches (mm)



Graph 1.2: Permissible average static surface pressure at 68°F

Permissible Average Surface Pressure

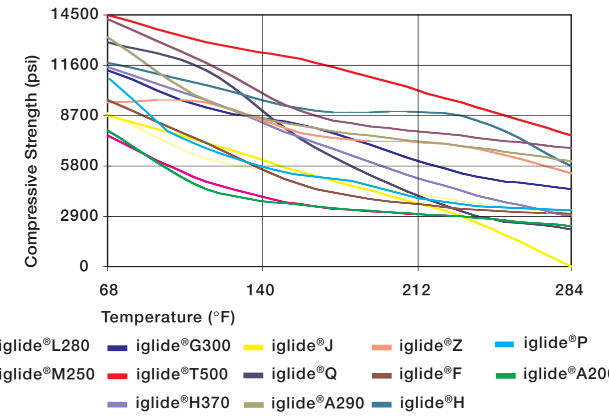
A comparative value of the iglide® material is the permissible average static surface pressure (p) at 68°F. The values of the individual iglide® plain bearings differ greatly on this point. The value (p) indicates the limit of the load of a plain bearing. The plain bearing can carry this load permanently without damage. The given value applies to static operation, only very slow speeds up to 1.97 fpm are tolerated under this load. Higher loads than those indicated are possible if the duration of the load is short. For a few minutes, the load can be more than doubled, depending on the material. Please call us if you have questions.

iglide® Plain Bearings

Pressure and Temperature

Graph 1.3 shows the permissible static surface pressure (p) of the iglide® plain bearing versus the temperature.
When using the plain bearing, the bearing temperature can be higher than the ambient temperature, due to friction. Take advantage of the opportunity presented by the predictability of the iglide® plain bearing to record these effects in advance, or determine the effective temperatures in the test.

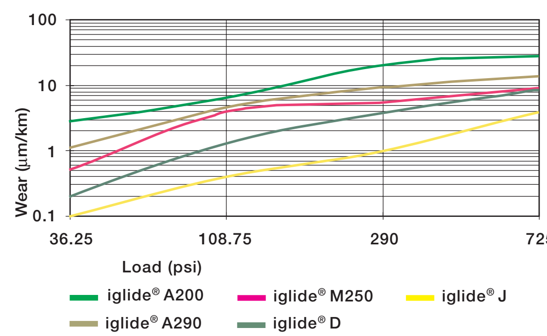
Picture 1.6: Testing of the compressive strength of iglide® plain bearings



Graph 1.3: Compression resistance of iglide® plain bearings as a result of temperature

Pressure and Speed

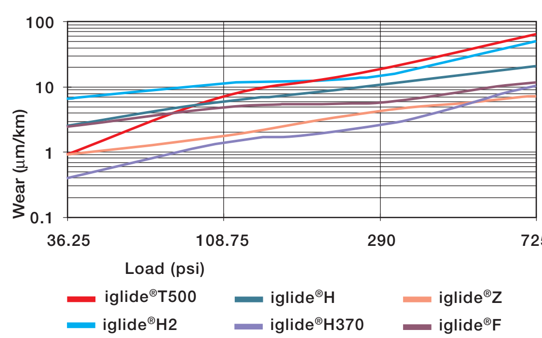
With decreasing radial load on the plain bearing, the permissible surface speed increases. The product of the load (p) and the speed (v) can be understood as a measurement for the frictional heat of the bearing
This relationship is shown by the p x v-graph that is the first in the respective chapter for each iglide® material.



Graph 1.5: Wear of iglide® plain bearings under low loads

Pressure and Wear

The load of the plain bearing has an effect on the wear of the bearing. The following graphs show the wear behavior of the iglide® bearing materials. It is easily recognized that for each load, there is an optimal plain bearing available.

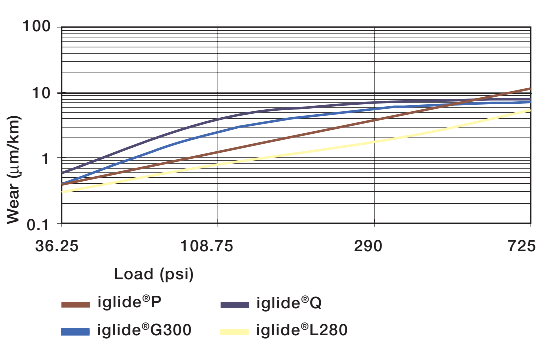


Graph 1.6: Wear of iglide® plain bearings under low loads

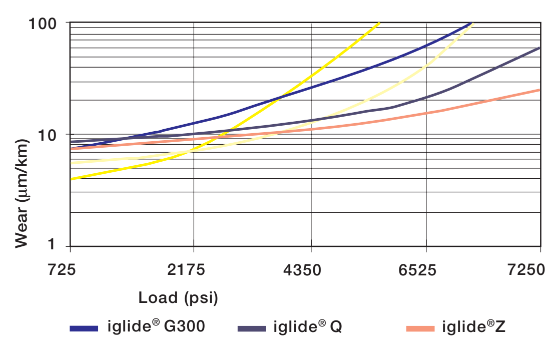
Pressure and Coefficient of Friction

With increasing load, the coefficient of friction of the plain bearing typically decreases. In this context, shaft materials and surfaces are also significant.

➤ Coefficients of Friction, Page 1.17



Graph 1.4: Wear of iglide® plain bearings under low loads



Graph 1.7: Wear of iglide® plain bearings under medium and high loads

Surface Speed

For plain bearings, the revolution speeds always matter. The absolute rotational speed is not decisive, instead it's the relative speed between the shaft and the bearing.
The surface speed is expressed in feet per minute (fpm) and calculated from the rotational speed with the adjacent formula.

Rotations:

$$v = \frac{\text{rpm} \times d1 \times 3.14}{12} = \text{fpm}$$

Oscillating movements:

$$v = \frac{4ab}{360} \times \frac{3.14d}{12} = (\text{fpm})$$

in the process:

a = angle of motion either side of the mean position in degrees
d1 = Shaft diameter in inches, if mm convert to inches prior to calculation
b = Frequency in cycle per minute
d = inner diameter in inches, if mm convert to inches prior to calculation

Permissible Surface Speeds

iglide® plain bearings were primarily developed for low to average running speeds in continuous operation.
Table 1.1 shows the permissible surface speed of iglide® plain bearings for rotating, oscillating, and linear movements.
These surface speeds are limit values assuming minimum pressure loading of the bearing. In practice, these limit values are rarely reached due to an inverse relationship between load and speed. Each increase of the pressure load leads unavoidably to a reduction of the allowable surface speeds and vice versa.
The limit of the speed is measured by the bearing temperature. This is also the reason why different running speeds can occur for the different movement types. For linear movements, more heat can be dissipated via the shaft, since the bearing uses a longer surface area on the shaft.

	Continuous			Short Term		
Material	Rotating	Oscillating	Linear	Rotating	Oscillating	Linear
iglide® G300	197	295	787	393	492	984
iglide® L280	197	295	787	492	590	1181
iglide® T500	295	590	984	689	787	1969
iglide® M250	157	157	492	393	393	984
iglide® J	295	295	1574	590	590	1969
iglide® Q	197	197	984	393	393	1181
iglide® H370	236	246	787	295	295	984
iglide® H	197	295	590	295	393	787
iglide® Z	295	590	984	689	787	1181
iglide® P	197	295	590	393	492	787
iglide® F	157	197	590	295	295	984
iglide® A200	147	147	492	295	295	787
iglide® R	295	295	1574	590	590	1969
iglide® H2	177	236	492	197	295	590
iglide® D	295	295	1574	590	590	1969
iglide® GLW	157	197	492	197	197	590

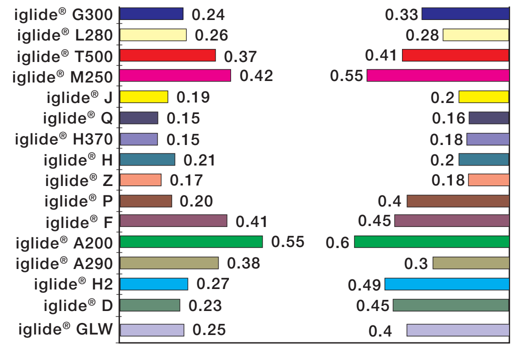
Table 1.1: Surface speeds of the iglide® plain bearing in fpm

Surface Speed and Wear

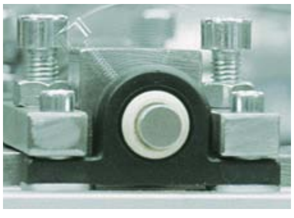
Considerations about the permissible surface speeds should also include the wear resistance of the plain bearing. High running speeds automatically bring correspondingly high wear rates with them.

Surface Speed and Coefficient of Friction

The coefficient of friction of plain bearings is a result of the surface speed in practice. High surface speeds have a higher coefficient of friction, than low surface speeds. Graph 1.8 shows this relationship in the example of a Cold Rolled Steel shaft with a load of 102 psi with 30 and 59 fpm.



Graph 1.8: Coefficients of friction of iglide® materials for different surface speeds



Picture 1.7: Experiments on wear and coefficient of friction using the example of an igubal® pillow block bearing

Picture 1.8: Determining the maximum surface speeds of an igubal rod end bearing at high rotational speeds

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P x V-value

For plain bearings, the product is given a new value depending on the specific load (p) and the surface speed (v).

The p x v value can be considered a measure of the frictional heat and can be used as an analytical tool to answer questions concerning the proper application of a plain bearing. For this purpose, the actual p x v value is a function of the shaft material of the ambient temperature and the operating time.

Material	Thermal Conductivity (W/m x k)
Steel	46
Aluminum	204
Gray cast iron	58
303 Stainless	16
Ceramics	1.4
Plastics	0.24

Table 1.2: Heat conductivity values of shaft or housing materials

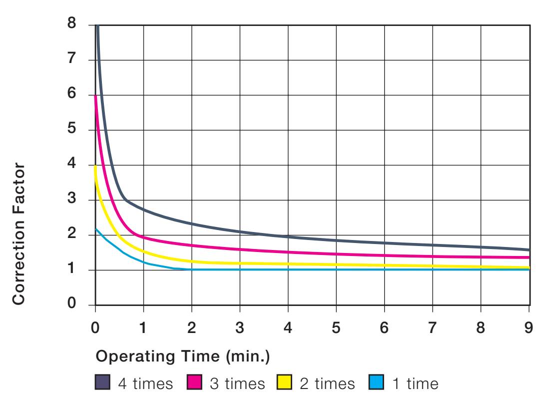
$$p \times v = \frac{(K1 \times \pi \times \lambda k \times \varnothing T)}{\mu \times s} \qquad \frac{(K2 \times \pi \times \lambda s \times \varnothing T)}{\mu \times b1 \times 2} \times 10^{-3}$$

Where:

K1, K2 = constant for heat dissipation (K1 = 0.5, K2 = 0.042)
s = bearing wall thickness in mm
b1 = bearing length in mm
μ = coefficient of friction
λs = thermal conductivity of the shaft
λk = thermal conductivity of the bearing
∅T = $(T_a - T_u)$
T_u = ambient temperature
T_a = Maximum application temperature

Correction Factor

The tolerated p x v value can be increased in intermittent operation if the bearing temperature never reaches the maximum limit because of the short operating time. Tests have shown that this is true for operating times below 10 minutes. An important qualifier here is the ratio of the operating time and pause intervals. It is known that long pauses make a greater contribution to re-cooling. The different curves of graph 1.9 represent different ratios (3x means that the pause lasts three times longer than the operating time).



Graph 1.9: Correction factor for p x v-value

Lubrication

Although iglide® plain bearings are designed to run dry, they are quite compatible with customary oils and greases. A single lubrication during the installation improves the start-up behavior and the coefficient of friction, thus reducing the frictional heat. Due to this effect, the permissible loads for plain bearings can be increased by lubrication. Numerous results from lubricated applications are available from experiments. Please contact us if necessary.
Table 1.3 shows the correction factors for p x v value using lubrication.

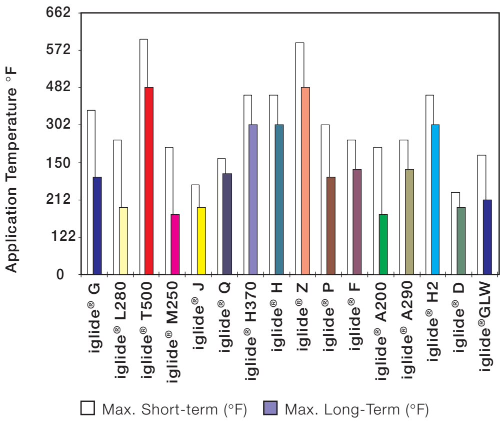
Lubrication	Correction factor
Dry run	1
During installation	1.3
Continuous, grease	2
Continuous, water	4
Continuous, oil	5

Table 1.3: Correction of the tolerated p x v-value by lubrication

Picture 1.9: Testing the properties of plastic bearings

Temperature

Plain bearings made of high-performance plastics are usually underestimated at higher temperatures. Who would believe that bearings made of plastic could be used up to over 572°F? Data is often found in the literature about the continuous use temperature. The continuous use temperature is the highest temperature, which the plastic can withstand for a period of time without a reduction in the tensile strength of the material above or below a prespecified value. Please note, these standardized test results have limited application, since bearings are almost always under load.
The material wear limits, based on application temperature are made informative.



Graph 1.10: Comparison of the continuous and short-term upper application temperatures

Application Temperatures

The minimum application temperature is the temperature below which the material is so rigid and hard that it becomes too brittle for standard applications. The maximum continuous application temperature is the temperature which the material can endure without the properties changing considerably.
The maximum, short-term application temperature is the temperature above which the material becomes so soft, that it can only withstand small external loads. "Short-term" is defined as a time period of a few minutes. If the plain bearings are moved axially or axial forces occur, there is more opportunity for the bearing to lose pressfit. In these cases, axial securing of the bearing is necessary in addition to being pressfit.
Table 1.6 shows the maximum ambient temperatures to which the plain bearings can be exposed for a short-term. If these temperatures are realized, the bearings may not be additionally loaded. In fact, a relaxation of the bearings can occur at these temperatures, even without an additional load. Thus it is necessary to ensure that the bearing cannot slide out of the bore. This is achieved by changing the bore construction or additionally securing the bearing.

Picture 1.10: iglide® T500 plain bearing in hard friction setting at high temperatures in foundries

Material	Lower application Temperature (°F)
iglide® G300	- 40
iglide® L280	- 40
iglide® T500	- 148
iglide® M250	- 40
iglide® J	- 58
iglide® Q	- 40
iglide® H370	- 40
iglide® H	- 40
iglide® Z	- 148
iglide® P	- 40
iglide® F	- 40
iglide® A200	- 40
iglide® R	- 50
iglide® H2	- 40
iglide® D	- 58
iglide® GLW	- 40

Table 1.4: Lower application temperature of the iglide® materials

Material	Securing mechanism provided starting at (°F)
iglide® G300	212
iglide® L280	140
iglide® T500	275
iglide® M250	140
iglide® J	140
iglide® Q	122
iglide® H370	212
iglide® H	264
iglide® Z	293
iglide® P	194
iglide® F	221
iglide® A200	122
iglide® R	140
iglide® H2	248
iglide® D	140
iglide® GLW	212

Table 1.5: Additional securing of the iglide® plain bearing required starting at the temperature

Material	Maximum, short-term ambient temperature (°F)
iglide® G300	428
iglide® L280	392
iglide® T500	599
iglide® M250	392
iglide® J	284
iglide® Q	392
iglide® H370	500
iglide® H	500
iglide® Z	590
iglide® P	392
iglide® F	446
iglide® A200	392
iglide® R	284
iglide® H2	230
iglide® D	122
iglide® GLW	176

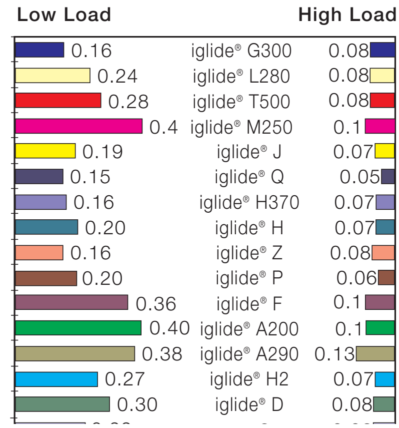
Table 1.6: Maximum ambient temperature, short-term, without loading

Temperature and Load

The compressive strength of plain bearings decreases as temperature increases. During this process, the materials react very differently from another, iglide® T500, for example, still accepts loads of 10,150 psi even at temperatures of 392°F.

Picture 1.11: Material tests are possible up to 482°F

iglide® Plain Bearings



Graph 1.11: Frictional values of iglide® materials under different loads

Coefficient of Thermal Expansion

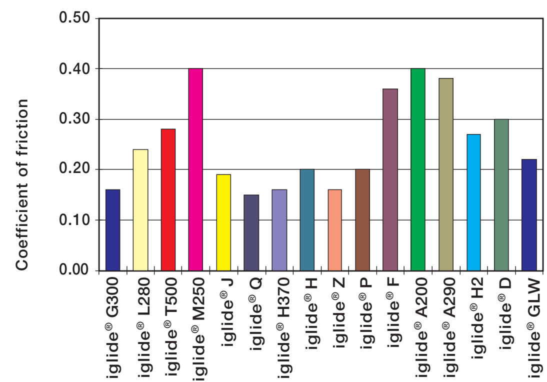
The thermal expansion of plastics is approximately 10 to 20 times higher when compared to metals. In addition to this, it also acts non-linearly in plastics. The coefficient of thermal expansion of the iglide® plain bearing is a significant reason for the required play in the bearing. At the given application temperature, seizing of the bearing to the shaft does not occur at high temperatures. The coefficient of thermal expansion of iglide® plain bearings were examined for significant temperature ranges and the results are given in the individual materials tables, at the start of each chapter.

Coefficient of Friction

iglide® plain bearings are self-lubricating by the addition of solid lubricants. The solid lubricants lower the coefficient of friction of the plain bearings and thus increase the wear resistance. The coefficient of friction measurement

$F_R = \mu \times F$

Depending on whether an application is starting from a stopped position or the movement is in progress and needs to be maintained. A choice is made between static friction coefficient and the dynamic friction coefficient.

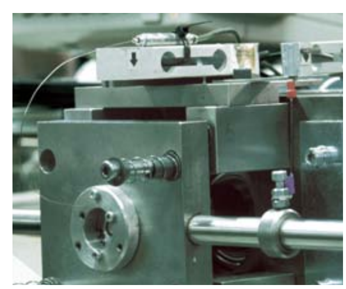


Graph 1.12: Coefficients of friction of the iglide® plain bearings for the recommended surface roughness and low load, p=108.75 psi

Coefficients of Friction and Surfaces

At study here is the relationship between coefficients of friction and surface roughness of shaft materials. It is clearly shown that the amount of friction is composed of different factors. If the shaft is too rough, abrasion levels play an important role. Small areas of unevenness that can interlock with each other must be worn off the surface.

When the surfaces are too smooth, however, higher adhesion results, i.e. the surfaces adhere to each other. Higher forces are necessary to overcome the adhesion, which results from an increased coefficient of friction. Stick-slip can be the result of a large difference between static and dynamic friction and of a higher adhesive tendency of mating surfaces. Stick-slip also occurs due to intermittent running behavior and can result in loud squeaking. Stick-slip thus represents a cause for malfunction of plain bearings. Over and over again, it is observed that these noises do not occur or can be eliminated with rough shafts. Thus for applications that have a great potential for stick-slip - slow movements, large resonance of the housings - attention must be paid to the optimal roughness of the shafts.

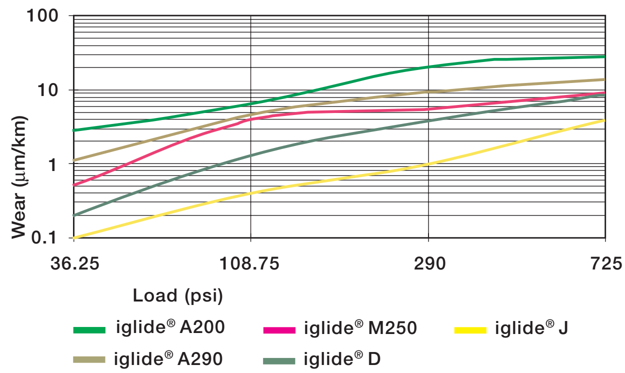


Picture 1.12: Friction experiments in the igus® laboratory

Wear Resistance

Due to the fact that the wear of machine parts is a function of so many different influences, it is difficult to make general statements about the wear behavior. Therefore, in numerous experiments, the wear is of primary importance as a measurement parameter. In testing, it has become clear what variances are possible between different material pairings. For given loads and surface speeds, the wear resistance can easily vary by a factor of 10 between materials pairings that run well together.

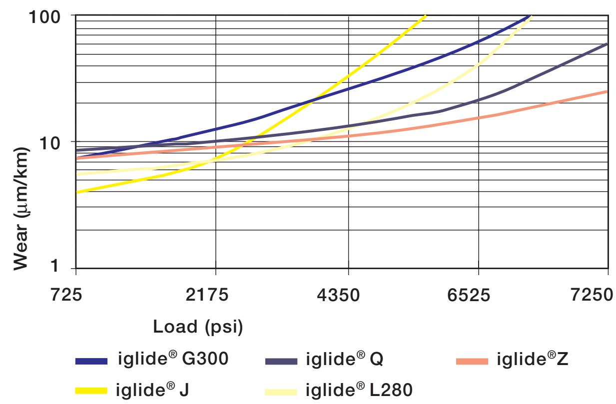
➤ Shaft materials, Page 1.11



Graph 1.13: Wear of iglide® plain bearings for small loads, shaft: Cold Rolled Steel, v=19.7 fpm

Wear and Load

Different loads greatly influence the bearing wear. Among the iglide® plain bearings, certain materials are specialized for low loads. While others are better suited for high or extremely high loads. With a hardened, ground shaft, iglide® J can be characterized as the most wear-resistant bearing material for low loads. iglide® Q, on the other hand, is specialized for extreme loads.



Graph 1.14: Wear of iglide® plain bearings for medium and high loads, shaft: Cold Rolled Steel, v=19.7 fpm

Wear and Temperature

Within wide temperature ranges, the wear resistance of the iglide® plain bearings shows little change. In the maximum temperature range, however, the temperature increases and the wear of the plain bearing increases exponentially.
The table on the following page compares the “wear limits”. One particular exception is represented by iglide® T500. The wear resistance of iglide® T500 increases greatly as temperature increases and reaches the optimum wear resistance at a temperature of 320°F . Then resistance decreases again, gradually.

Material	Wear Limit (°F)	Material	Wear Limit (°F)
iglide® G300	248	iglide® Z	392
iglide® L280	248	iglide® P	212
iglide® T500	410	iglide® F	266
iglide® M250	176	iglide® A200	176
iglide® J	128	iglide® R	248
iglide® Q	176	iglide® H2	248
iglide® H370	302	iglide® D	128
iglide® H	248	iglide® GLW	212

Table 1.7: Wear limits of iglide® plain bearings

Wear During Abrasive Dirt Accumulation

Special wear problems frequently occur if abrasive dirt particles get into the bearing. iglide® plain bearings can clearly improve the operating time of machines and systems in these situations. The high wear resistance of the materials and the self-lubrication process provide for the highest service lifetime. Because no oil or grease is on the bearing, dirt particles can not penetrate as easily into the bearing. The largest portion simply falls away from the bearing thus limiting potential damage. If however, a hard particle penetrates into the bearing area, then an iglide® plain bearing can absorb this particle. The foreign body becomes embedded in the wall of the bearing. Up to a certain point, operation can be maintained at optimal levels even when there is extreme dirt accumulation.
However, it’s not just hard particles that can damage bearings and shafts. Soft dirt particles such as, for example, textile or paper fibers, are frequently the cause for increased wear. In this instance, the dry running capability and the dust resistance of the iglide® plain bearings go into action. In the past, they were able to help save costs in numerous applications.

Picture 1.16: High wear resistance: plain bearing in contact with sand

iglide® Plain Bearings

Wear and Surfaces

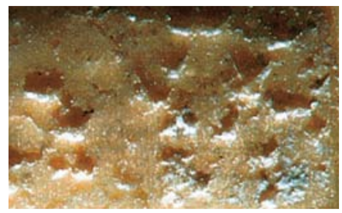
Shaft surfaces are important for the wear of bearing systems. Similar to the considerations for coefficients of friction, a shaft can be too rough in regard to the bearing wear, but it can also be too smooth. A shaft that is too rough acts like a file and during movement separates small particles from the bearing surface. For shafts that are too smooth, however, higher wear can also occur. An extreme increase in friction results due to adhesion. The forces that act on the surfaces of the sliding partner can be so large that regular material blow-outs occur.
It is significant to note that wear by erosion is non-linear. Moreover, it is subject to chance and can not be accurately predicted in advance.

Shaft Materials

The shaft is, next to the plain bearing itself, the most important parameter in a bearing system. It is in direct contact with the bearing, and like the bearing, it is affected by relative motion. Fundamentally, the shaft is also worn, however, modern bearing systems are designed so that the wear of the shafts is so small that it can not be detected with traditional methods of measurement technology.

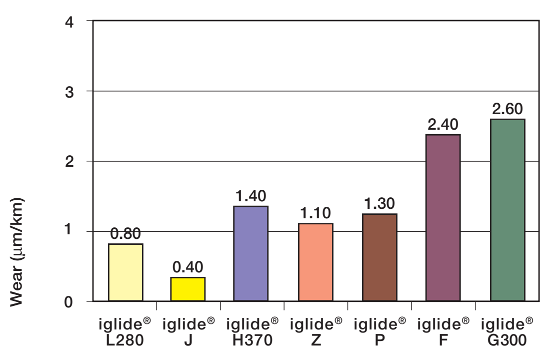
Shafts can be distinguished and classified according to their hardness and according to the surface roughness. The effect of the surface is described on the preceding pages:

➤ Coefficients of friction, Page 1.8
➤ Wear resistance, Page 1.9

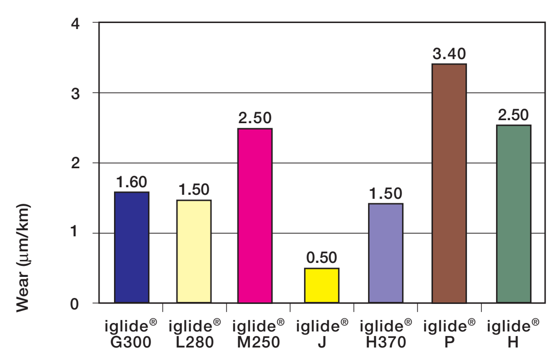


Picture 1.13: Erosion damage due to shafts that are too smooth

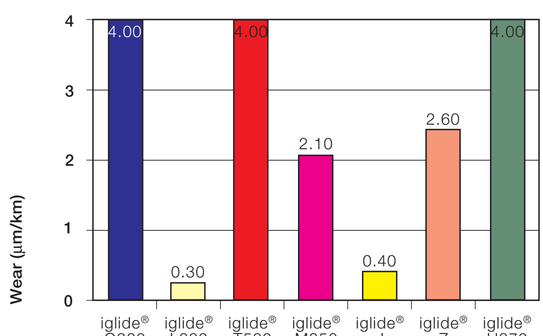
Picture 1.17: Wear experiments with aluminum shafts



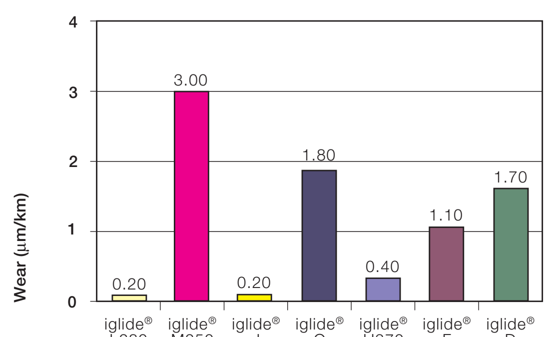
Graph 1.14: Wear with shaft Cold Rolled Steel, p = 108.75 psi, v = 98 fpm, Ra = 8 rms



Graph 1.16: Wear with shaft HR Carbon Steel, p = 108.75 psi, v = 98 fpm Ra = 8 rms



Graph 1.15: Wear with shaft 303 Stainless Steel, p = 108.75 psi, v = 98 fpm Ra = 8 rms



Graph. 1.17: Wear with hard-chromed shaft, p = 108.75 psi, v = 98 fpm, Ra = 8 rms

Shaft Materials (Continued)

The hardness of the shaft also plays an important role. When the shafts are less hard, the shaft is smoothed during the break-in phase. Abrasive points are worn off and the surface is rebuilt. For some materials, this effect has positive influences, and the wear resistance of the plastic bearing increases.

In the following graphs, the most common shaft materials are listed and the iglide® materials that are best suited are compared. For easier understanding, the scaling of the wear axis is the same in all graphs.

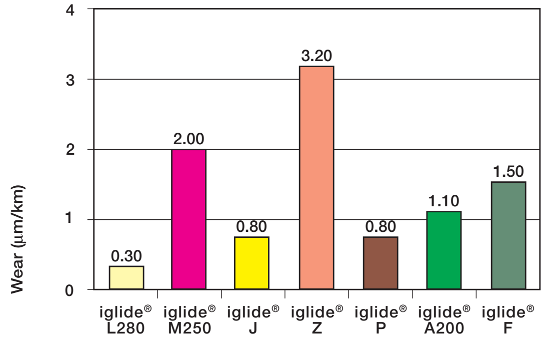
Especially impressive is the small wear results of the systems with hard-chromed shafts. This very hard, but also smooth shaft acts beneficially on the wear behavior in many bearing pairs. The wear of many iglide® plain bearings is lower on this shaft than on any other shafting partner tested. However, it should be pointed out that because of the typically small surface roughness, the danger of stick-slip on hard-chromed shafts is especially high.

Such an overwhelmingly positive influence is not as readily available in the other shaft materials.
For example, with shafts made of 303 Stainless with low loads, good to very good values can be obtained with the right bearing material. However, it must also be stated that no other shaft material produces a larger variance in wear among the bearing materials. For materials such as 303 Stainless Steel, therefore, the selection of suitable bearing materials is especially important.

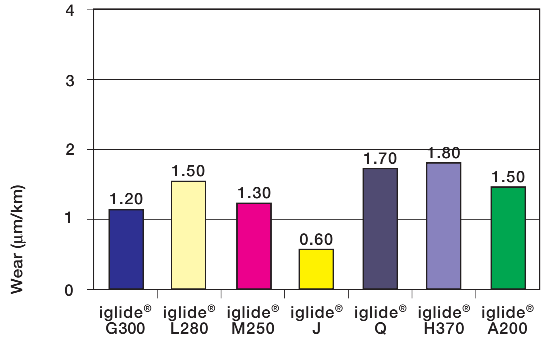
Other soft shaft materials, obtain a slightly different view with different bearing materials. With machining steel, the wear values of the seven best iglide® bearing materials are in a narrow range between 0.6 and 1.8. For many other shafts, the influence of the shaft materials is much larger, resulting in a difference, up to 10 times, between the best and the worst of the bearings tested.

If the shaft that you have chosen for your application is missing in this overview, please call us. The test results give only a sample of the existing data. All of the results given were obtained under the same loads and speeds:

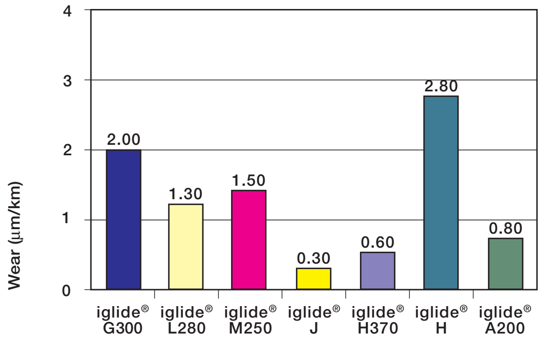
All of the results shown were made with the loads p = 108.75 psi and v = 98 fpm. You can call us for the data for other p x v combinations.



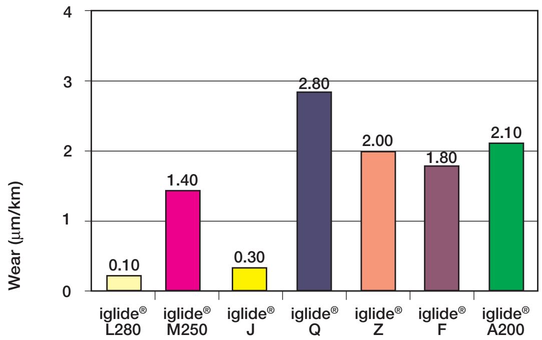
Graph 1.18: Wear with a silver steel shaft, p=108.75 psi, v=98 fpm, Ra=8 rms



Graph 1.20: Wear with a machining steel shaft, p=108.75 psi, v = 98 fpm, Ra = 8 rms



Graph 1.19: Wear with an aluminum shaft, p=108.75 psi, v=98 fpm, Ra=8 rms



Graph 1.21: Wear with shaft X90, p = 108.75 psi, v = 98 fpm, Ra = 8 rms

Chemical Resistance

iglide® plain bearings can come into contact with many chemicals during their use. This contact can lead to changes of the structural properties. The behavior of plastics toward a certain chemical is dependent on the temperature, the length of exposure, and the type and amount of the mechanical loading. If iglide® plain bearings are resistant against a chemical, they can be used in these media. Sometimes, the surrounding media can even take on the role of a lubricant.

With the most resistant iglide® material, the iglide® T500, the medium can even be hydrochloric acid. All iglide® plain bearings can be used in greatly diluted acids and diluted lyes. Differences can result at higher concentrations or higher temperatures.

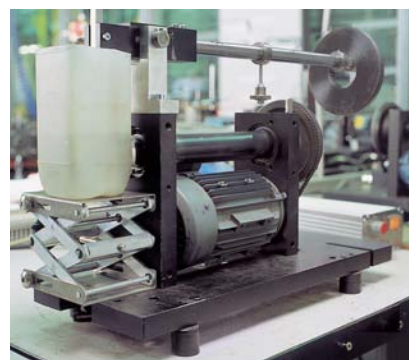
For all iglide® plain bearings, their resistance against traditional lubricants applies in the same way. Therefore plain bearings may also be used lubricated. However, in dirty environments, a traditional lubricant can decrease the wear resistance when compared to running dry.

The following overview should quickly assist you:
If it is not completely clear in a design application which of the different chemicals can occur or in which concentration, plain bearings made out of iglide® T500 should be used. They have the best resistance and are only attacked by a few concentrated acids. You'll find a detailed list of chemical resistances in the rear of the catalog

➤ Chemical resistance, Page 1.16

Material	Diluted Acids	Diluted Lyes	Alcohol	Solvents
iglide® G300	-	+	0	0
iglide® L280	-	+	0	0
iglide® T500	+	+	+	+
iglide® M250	-	0	0	0
iglide® J	0	+	0	0
iglide® Q	0	0	0	0
iglide® H370	+	+	+	+
iglide® H	+	+	+	+
iglide® Z	+	+	+	+
iglide® P	0	0	0	0
iglide® F	0	0	0	0
iglide® A200	-	0	0	0
iglide® R	-	+	0	0
iglide® H2	+	+	+	+
iglide®D	0	+	0	0
iglide® GLW	-	+	0	0

Table 1.8: Chemical resistance



Picture 1.18: Rotational testing stand for underwater and/or chemicals

Use in the Food Industry

For the special requirements made of machines and systems for producing food and pharmaceuticals, the iglide® product line offers two specially developed bearing materials. The material of the iglide® A200 bearing has approval of the FDA.

However, there are also a number of other iglide® materials that can be used without hesitation, since their material contents are physiologically harmless. This applies especially for iglide® M250, iglide® H, iglide® Q, and iglide® L280 and iglide® T500.

For all other iglide® plain bearings, direct contact with food should be avoided.

iglide® Plain Bearings
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QuickSpec: www.igus.com/qs/iglide.asp

High-Energy Radiation

A comparison of the resistance to radioactive radiation is shown in the adjacent graph. By a wide margin, iglide® T500 and iglide® Z are the most resistant material.

Material	Radiation resistance
iglide® T500, Z	1 x 10^5 Gy
iglide® A200,	1 x 10^4 Gy
M250	
iglide® P	5 x 10^2 Gy
iglide® G300,	3 x 10^2 Gy
R, J, L280,	
F, Q, D	
iglide® H, H2	2 x 10^2 Gy
H370	

Table 1.9: Comparison of the radiation resistance of iglide® plain bearings

UV Resistance

Plain bearings can be exposed to constant weathering when they are used outside. The UV resistance is an important measure and indicates whether a material is attacked by UV radiation. The effects can extend from slight changes in color to brittleness of the material. A comparison of the materials to each other is shown in the following table. The results show that iglide® plain bearings are suitable for outside use. Only for a few iglide® materials are any changes expected.

Material	Points UV resistance
iglide® G300	+++++
iglide® L280	+++
iglide® T500	+++++
iglide® M250	++++
iglide® J	+++
iglide® Q	++
iglide® H370	+++++
iglide® H	++
iglide® Z	+++++
iglide® P	+++++
iglide® F	+++++
iglide® A200	++++
iglide® R	+++++
iglide® H2	+
iglide® D	+++++

Table 1.10: UV resistance of iglide® plain bearings

Vacuum

iglide® plain bearings can be used in a vacuum to a limited extent. Only a small amount of outgassing takes place. In most iglide® plain bearings, the outgassing does not change the material properties.

Electrical Properties

In the product line of the maintenance-free, self-lubricating iglide® plain bearings, there are both insulating as well as electrically conductive materials. The most important electrical properties are given in detail in the individual material descriptions. The adjacent table compares the most important electrical properties of iglide® plain bearings.

The iglide® plain bearings not mentioned here are electrically insulating. Please observe that for some materials the properties can be changed by the material's absorption of moisture. In experiments, it should be tested whether the desired properties are also stable when the conditions are changing.

Material	Surface resistance (Ω)
iglide® F	1.5 x 10^1
iglide® H	8.8 x 10^1
iglide® H370	2.8 x 10^3
iglide® T500	6.9 x 10^2

Table 1.11: Electrical properties of conductive iglide® plain bearings

iglide® Plain Bearings

Tolerances and Measurement System

The installation dimensions and tolerances of the iglide® plain bearings are a function of the material and wall thicknesses. For each material, the moisture absorption and the thermal expansion are imperative. Plain bearings with low moisture absorption can be obstructed when there is a minimal amount of tolerance. For wall thickness, the rule is: The thicker the bearings are, the larger the tolerances must be.

Thus, different tolerance classes exist for iglide® plain bearings:
Within these tolerances, iglide® plain bearings can operate in the permissible temperature range and in humidity conditions up to 70% according to the installation recommendations. Should higher air moisture levels be present, or the bearing is operated under water, our application advice is available to help you use your bearings correctly.

Dimensions in Microns (1000ths of a mm)

Dimensions	mm	1 / =3		>3 / =6		>6 / = 10		> 10 / = 18		> 18 / = 30		> 30 / = 50		> 50 / = 80	
H 7	mm	+0	+10	+0	+12	+0	+15	+0	+18	+0	+21	+0	+25	+0	+30
E 10	mm	+14	+54	+20	+68	+25	+83	+32	+102	+40	+124	+50	+150	+60	+180
F 10	mm	+6	+46	+10	+58	+13	+71	+16	+86	+20	+104	+25	+125	+30	+150
D 11	mm	+20	+80	+30	+105	+40	+130	+50	+160	+65	+195	+80	+240	+100	+290
f 6	mm	-6	-12	-10	-18	-13	-22	-16	-27	-20	-33	-25	-41	-30	-49
d 13	mm	-20	-160	-30	-210	-40	-260	-50	-320	-65	-395	-80	-470	-100	-560
h 6	mm	-0	-6	-0	-8	-0	-9	-0	-11	-0	-13	-0	-16	-0	-19
h 7	mm	-0	-10	-0	-12	-0	-15	-0	-18	-0	-21	-0	-25	-0	-30
h 9	mm	-0	-25	-0	-30	-0	-36	-0	-43	-0	-52	-0	-62	-0	-74
h 13	mm	-0	-140	-0	-180	-0	-220	-0	-270	-0	-330	-0	-390	-0	-460

Dimensions in inches

Dimensions	inch	0.0393"/=.1181"		>0.1181"/=0.23622"		>0.2362"/=0.3937"		>0.3937"/=.7086"	
H 7	inch	+0.0000	+0.0004	+0.0000	+0.0005	+0.0000	+0.0006	+0.0000	+0.0007
E 10	inch	+0.0006	+0.0021	+0.0008	+0.0027	+0.0010	+0.0033	+0.0013	+0.0040
F 10	inch	+0.0002	+0.0018	+0.0004	+0.0023	+0.0005	+0.0028	+0.0006	+0.0034
D 11	inch	+0.0008	+0.0031	+0.0012	+0.0041	+0.0016	+0.0051	+0.0020	+0.0063
f 6	inch	-0.0002	-0.0005	-0.0004	-0.0007	-0.0005	-0.0009	-0.0006	-0.0011
d 13	inch	-0.0008	-0.0063	-0.0012	-0.0083	-0.0016	-0.0102	-0.0020	-0.0126
h 6	inch	-0.0000	-0.0002	-0.0000	-0.0003	-0.0000	-0.0004	-0.0000	-0.0004
h 7	inch	-0.0000	-0.0004	-0.0000	-0.0005	-0.0000	-0.0006	-0.0000	-0.0007
h 9	inch	-0.0000	-0.0010	-0.0000	-0.0012	-0.0000	-0.0014	-0.0000	-0.0017
h 13	inch	-0.0000	-0.0055	-0.0000	-0.0071	-0.0000	-0.0087	-0.0000	-0.0106

Dimensions	inch	> 0.7086"/=1.18111"		>1.1811"/=1.9685"		>1.9685"/=3.1496"	
H 7	inch	+0.0000	+0.0008	+0.0000	+0.0010	+0.0000	+0.0012
E 10	inch	+0.0016	+0.0049	+0.0020	+0.0059	+0.0024	+0.0071
F 10	inch	+0.0008	+0.0041	+0.0010	+0.0049	+0.0012	+0.0059
D 11	inch	+0.0026	+0.0077	+0.0031	+0.0094	+0.0000	+0.0000
f 6	inch	-0.0008	-0.0013	-0.0010	-0.0016	-0.0012	-0.0019
d 13	inch	-0.0026	-0.0156	-0.0031	-0.0185	0.0000	0.0000
h 6	inch	-0.0000	-0.0005	-0.0000	-0.0006	-0.0000	-0.0007
h 7	inch	-0.0000	-0.0008	-0.0000	-0.0010	-0.0000	-0.0012
h 9	inch	-0.0000	-0.0020	-0.0000	-0.0024	-0.0000	-0.0029
h 13	inch	-0.0000	-0.0130	-0.0000	-0.0154	-0.0000	-0.0181

Testing Methods

iglide® plain bearings are pressfit bearings for bores set to our recommendations. This pressfitting of the bearing affixes the bearing in the housing, and the inner diameter of the plain bearing is also formed upon pressfit.

The bearing test is performed when the bearing is installed in a bore with the minimum specified dimension; both using an indicating caliper and a Go No-Go gauge.

- the "Go-Side" of the Go-No-Go gauge, pressfit into the bore, must pass easily through the bearing
- With the 3 point probe, the inner diameter of the bearing after pressfit must lie within the prescribed tolerance on the measurement plane, See Figure 3.

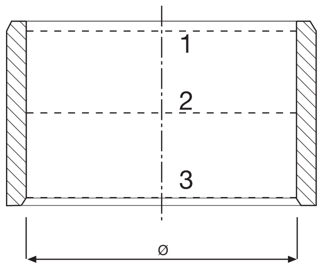


Figure 3: The position of the measurement planes (x=.02 inches)

Picture 1.19: Measurement of the inner diameter of a pressfit plain bearing

Machining

iglide® plain bearings are delivered ready-to-install. The extensive product line makes it possible to use a standard dimension in most cases. If for some reason, a subsequent machining of the plain bearing is necessary, the table above left shows the machining standard values.

The subsequent machining of the bearing surfaces is to be avoided if possible. Higher wear rate is most often the result. An exception is the iglide® M250, which is very suitable for secondary machining. In other iglide® plain bearings, disadvantages of a sliding surface machining can be counteracted by lubrication during installation.

Process	Turning	Boring	Milling
Cutting material	SS	SS	SS
Forward feed (mm)	0.1…0.5	0.1…0.5	to 0.5
Tool orthogonal clearance	5…15	10…12	
Tool orthogonal rake	0…10	3…5	
Cutting speed (m/min)	656…1640	164…328	to 3281

Table 1.12: Guidelines for machining

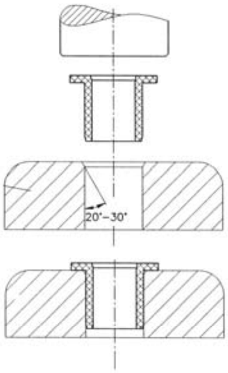
Installation

iglide® plain bearings are produced oversized as standard program. The inner diameter adjusts only after being pressfit in the proper housing bore with a recommended tolerance. The before pressfit oversized dimension can be up to 2% of the inner diameter. In this manner, the secure pressfitting of the bearing is achieved. Axial or radial shifts in the housing are also prevented.

The bore in the housing should be finished in the recommended tolerance for all bearings and be smooth, flat, and chamfered when possible.

The installation is done using an arbor press. The use of centering or calibrating pins can cause damage to the bearing and create a larger amount of clearance.

Picture 1.20: The installation



Picture 1.21: Section view: pressfit of the bearing

Adhesion

Adhering of the bearing is normally not necessary. If the pressfit of the bearing could be lost because of high temperatures, the use of a plain bearing having a higher temperature resistance is recommended.

If however, the securing of the bearing by adhesives is planned, individual tests are necessary in each case. The transfer of successful results to other application cases is not possible.

iglide® Plain Bearings - Chemical Resistance Table

Chemicals, iglidur®	A200, C, G, GLW, igumid G, L100, L250, M250, W300	A500, X, UW500	A290, F	T220	Z	P	A180, J200, R, UW	J	D	Q	V400	H H2 H370 H4	PEP	B
Acetaldehyde (aqueous), 40%	o	+	o	x	x	x	+	+	x	o	x	x	o	x
Acetamide (aqueous), 50%	+[1]	+	+[1]	x	x	x	+	+	x	+[1]	x	x	+[1]	x
Acetic acid, 2%	x	+	+[1]	x	+	x	x	x	x	o	+	+	x	–
Acetic acid, 10%	x	+	o	+	+	x	+	o	x	o	+	+	o	–
Acetic acid, 90%	–	o	–	–	+	–	–	–	–	–	+	+	–	–
Acetone	+	+	o	–	+	–	+	+	x	+	+	+	+	x
Acrylnitrile	+	+	+	x	x	x	x	+	x	+	x	x	+	x
Aluminium chloride (aqueous), 10%	o	+	o	+	x	o	o	o	o	o	x	+	o	x
Aluminium cleaner	–	+	–	x	x	x	x	x	–	–	x	o	–	x
Aluminium sulphate (aqueous), 10%	o	+	o	+	+	o	o	o	o	o	x	+	o	x
Allyl alcohol	o	+	o	+	+	x	x	+	x	+	x	+	+	x
Ammonia gas	o	+	o	x	x	x	x	x	x	x	x	+	x	x
Ammonium (aqueous), 10%	+[1]	+	+[1]	x	+	x	+	x	x	o	x	+	x	x
Ammonium carbonate (aqueous), 10%	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	x
Ammonium chloride (aqueous), 10%	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	x
Amyl acetate	+	+	+	x	+	x	x	x	x	+	x	+	x	x
Amyl alcohol	+	+	+	+	o	x	+	+	+	+	x	+	+	x
Aniline (sat'd. aqueous)	o	+	o	x	x	x	o	o	x	o	x	+	o	x
Anisole	+	+	+	x	o	x	x	x	x	+	x	+	x	x
Antimony trichloride (aqueous), 10%	–	+	x	x	x	x	x	x	x	o	x	x	x	–
Barium chloride (aqueous), 10%	o	+	x	+	+	+	+	+	+	+[1]	x	+	+[1]	x
Barium sulphate (aqueous), 10%	o	+	x	+	+	+	+	+	+	+[1]	x	+	+[1]	x
Benzaldehyde	o	+	o	x	x	x	+	o	x	o	x	o	o	x
Benzene	+	+	+	–	+	–	o	o	–	x	x	+	x	–
Benzoic acid (aqueous), 3%	o	+	o	+	+	x	o	o	x	o	x	x	o	x
Benzyl alcohol	o	+	o	x	o	x	+	o	x	o	x	x	o	x
Bitumen	o	+	o	x	+	x	+	o	x	o	x	x	o	x
Bleaching solution	–	+	x	–	+	–	–	–	–	o	x	x	–	–
Bleaching solution (aqueous), 10%	–	+	x	–	+	–	–	–	–	o	x	+	–	–
Boric acid (aqueous), 10%	o	+	x	–	+	–	+	+	–	+[1]	x	x	+[1]	x
Brake fluid	o	+	x	x	+	x	o	o	x	+	+	+	o	x
Brandy vinegar	o	+	o	x	+	x	x	o	x	o	x	+	o	x
Bromine (aqueous), 25%	–	+	–	x	o	–	–	–	–	–	x	–	–	–
Butanol	+	+	+	+	o	x	+	+	x	+	x	+	+	–
Butter	+	+	+	+	+	x	+	+	x	+	x	+	+	o
Butyl acetate	+	+	o	o	+	o	+	o	x	o	x	+	o	x
Butylglycol	+	+	+	+	+	x	+	+	x	+	x	+	+	x
Butyric acid	o	+	o	+	+	x	+	x	x	x	x	+	x	x
Butyrolactone	o	+	x	x	+	x	x	x	x	o	x	x	x	x
Calcium chloride (sat'd. solution)	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	x
Camphor	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Carbon disulphide	+	+	+	x	x	x	x	+	x	+	x	+	+	x
Carbon tetrachloride	+	+	+	–	o	–	o	o	x	+	x	o	o	x
Carnallite (aqueous)	x	+	+	x	+	x	x	x	x	+	x	x	x	x
Catechol	o	+	o	x	+	x	x	x	x	o	x	x	x	x
Caustic soda (aqueous), 50%	o	+	o	x	+	x	x	o	x	x	x	x	x	x
Chlorinated hydrocarbon	+	+	+	x	o	–	x	x	–	+	x	+	x	x
Chlorine gas	–	–	x	–	x	–	–	–	–	–	+	–	–	–
Chlorine water (sat'd. solution)	–	+	x	–	o	–	–	–	–	o	+	x	–	–
Chloroacetic acid (aqueous), 10%	–	+	x	–	x	–	–	–	–	–	x	x	–	–
Chlorobenzene	o	+	+	–	+	–	o	+	–	+	x	+	+	–
Chlorobromomethane, 98%	o	+	o	x	x	x	x	x	x	o	x	x	x	x
Chloroform	–	+	o	x	o	–	–	–	–	–	x	o	–	x
Chlorosulphuric acid (aqueous)	–	–	o	x	+	x	–	x	x	o	x	–	x	x

Resistance classification: **+** resistant; **o** conditionally resistant; **–** not resistant; **x** no data available

[1] The bearings are not chemically attacked by these substances. However, there may be a dimensional change due to moisture absorption.

iglide® Plain Bearings

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QuickSpec: www.igus.com/qs/iglide.asp

iglide® Plain Bearings - Chemical Resistance Table

Chemicals, iglidur®	A200, C, G, GLW, igumid G, L100, L250, M250, W300	A500, X, UW500	A290, F	T220	Z	P	A180, J200, R, UW	J	D	Q	V400	H H2 H370 H4	PEP	B
Chromic acid, 10%	o	+	o	o	o	–	–	–	–	–	+	–	–	x
Chromic acid (aqueous), 1%	–	+	o	x	o	x	o	o	x	o	+	–	o	x
Citric acid (aqueous), 10%	+[1]	+	+[1]	+	+	x	+	+	x	o	x	+	o	x
Citric acid (conc. solution)	o	+	o	x	+	x	x	o	x	–	x	o	–	x
Cooking fat	+	+	+	x	+	x	x	+	x	+	x	+	+	o
Cooking oils	+	+	+	x	+	x	x	+	x	+	x	+	+	o
Copper sulphate (sat'd. solution)	o	+	o	x	+	x	x	o	x	o	x	+	o	x
Copper sulphate, 0.5%	o	+	o	x	+	x	+	+	+	o	x	+	o	x
Cresol	–	+	–	x	+	x	x	x	x	–	x	+	x	x
Cyclohexane	+	+	+	+	+	–	+	+	–	+	x	+	+	–
Cyclohexanol	o	+	o	x	+	x	+	o	x	o	x	+	o	x
Decahydronaphthalene	+	+	+	o	+	–	+	+	–	+	x	+	+	–
Dibutyl phthalate	+	+	+	+	+	x	+	+	x	+	x	+	+	x
Dichloroethylene	x	+	x	x	+	–	–	o	–	x	x	+	x	x
Diesel	+	+	+	+	+	x	+	+	x	+	x	+	+	–
Diesel oil	+	+	x	x	+	x	x	+	x	+	x	+	+	–
Diethylether	o	+	+	x	+	x	o	+	x	+	x	x	+	x
Dimethylformamide	+	+	+	+	+	x	+	+	x	+	+	+	+	x
Dioctyl phthalate	+	+	+	+	+	x	+	+	x	+	x	+	+	x
Dioxane	+	+	+	+	+	x	o	o	x	+	x	+	o	x
Ethanol (aqueous), 96%	o	+	o	–	o	–	+	o	+	o	+	+	o	o
Ethyl acetate	+	+	+	–	+	–	+	+	x	+	x	x	+	x
Ethylene chloride	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Ethylene diamine	+	+	+	x	+	x	+	+	x	+	+	o	+	x
Ethylene glycol (aqueous), 95%	o	+	o	+	+	x	+	+	x	o	+	+	o	x
Fat, cooking fat	+	+	+	x	+	x	x	+	x	+	x	+	+	o
Ferrous chloride (aqueous), 5%	o	x	o	x	+	x	+	x	x	o	x	+	x	x
Ferrous chloride (aqueous), 10%	o	+	o	x	x	x	x	x	x	o	x	x	x	x
Ferrous chloride (sat'd. aqueous)	o	x	o	x	+	x	+	x	x	o	x	+	x	x
Ferrous sulfide, 10%	o	+	o	x	+	x	x	x	x	o	x	x	x	x
Fluorinated hydrocarbons	+	+	x	x	o	x	x	+	x	+	x	+	+	x
Formaldehyde (aqueous), 30%	+[1]	+	+[1]	+	+	x	+	+	x	+[1]	x	+	+[1]	x
Formamide	o	+	o	x	+	x	+	+	x	o	x	x	o	x
Formic acid (aqueous), 2%	–	o	x	+	+	o	o	–	–	–	x	+	–	–
Formic acid, 90%	–	x	–	x	x	–	–	–	–	–	x	o	–	–
Furfurol	o	+	x	+	+	x	+	+	x	+	x	+	+	x
Fusel oil	+	+	+	x	+	x	x	x	x	+	x	+	x	–
Gear oil by Esso	o	+	o	x	+	–	–	–	–	+	+	+	–	–
Glycerine	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Glycol	o	+	o	+	+	x	+	o	x	o	x	+	o	x
Heating oil	+	+	+	+	+	x	+	+	x	+	x	+	+	–
Heptane	+	+	+	+	+	–	+	+	–	+	x	+	+	–
Hexane	+	+	+	+	+	–	+	+	–	+	+	+	+	–
Hydraulic oils	+	+	+	x	+	x	+	+	x	+	x	+	+	–
Hydrobromic acid, 10%	–	+	x	o	+	–	–	–	–	x	x	o	–	–
Hydrochloric acid, 2%	–	o	x	–	+	–	o	–	–	o	+	o	–	–
Hydrochloric acid, 10%	–	+	–	o	+	–	–	–	–	–	+	–	–	–
Hydrochloride (aqueous)	o	–	o	x	x	x	x	x	x	o	x	x	x	x
Hydrofluoric acid (aqueous), 4%	–	+	–	–	x	–	–	–	–	–	–	–	–	–
Hydrogen peroxide, 1%	+[1]	+	+[1]	x	+	x	x	+	x	+[1]	x	+	+[1]	x
Hydrogen peroxide, 30%	–	+	–	x	x	x	–	o	–	–	x	–	–	–
Hydrogen sulphide (sat'd. solution)	+[1]	+	x	x	+	x	x	x	x	+[1]	x	+	x	x
Hydroquinone	–	+	x	+	+	x	x	x	x	o	x	x	x	–
Indian Ink	+[1]	+	+[1]	x	+	x	x	+	x	+[1]	x	+	+[1]	x

Resistance classification: **+** resistant; **o** conditionally resistant; **–** not resistant; **x** no data available

[1] The bearings are not chemically attacked by these substances. However, there may be a dimensional change due to moisture absorption.

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iglide® Plain Bearings - Chemical Resistance Table

Chemicals, iglidur®	A200, C, G300, GLW, igumid G, L100, L250, M250, L280	A500, T500, UW500	A290, F	T220	Z	P	A180, J200, R, UW	J	D	Q	V400	H H2 H370 H4	PEP	B
Ink, colour	+[1]	+	+[1]	+	+	x	+	+	x	+[1]	x	+	+[1]	x
Iodine tincture, 3%	–	+	x	x	+	x	x	x	x	o	x	+	x	–
Iron-III-chloride (aqueous), acidic	–	x	x	x	+	–	–	–	–	o	x	+	–	–
Iron-III-chloride (aqueous), neutral, 10%	+[1]	o	o	x	+	x	o	o	o	x	x	+	x	x
Iron-II-cyanide, 30%	o	+	x	x	+	x	x	x	x	x	x	x	x	x
Iron-III-cyanide, 30%	o	x	o	x	+	x	x	x	x	x	x	x	x	x
Isooctane	+	+	+	+	+	–	+	+	–	+	x	+	+	–
Isopropyl alcohol	+	+	+	+	o	x	+	+	x	o	x	+	o	x
Isopropyl ether	+	+	+	x	+	x	x	x	x	+	x	x	x	x
Lead acetate (aqueous), 10%	o	+	o	x	+	x	+	+	+	o	x	x	o	x
Lead oxide (fine dust)	x	x	x	x	+	x	x	–	–	x	x	x	–	x
Lead stearate	+	+	+	x	+	x	x	x	x	+	x	+	x	x
Linseed oil	+	+	+	+	+	x	+	+	x	+	x	+	+	–
Lithium bromide (aqueous), 50%	o	+	o	x	+	x	x	+	x	o	x	x	o	x
Magnesium chloride (aqueous), 10%	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	+
Magnesium hydroxide (aqueous)	+[1]	+	+[1]	x	+	x	x	+	x	x[1]	x	+	x[1]	x
Maleic acid (conc. solution)	–	+	x	x	+	x	x	x	x	o	x	+	x	–
Malonic acid (conc. solution)	o	+	o	x	+	x	x	x	x	o	x	+	x	x
Manganese sulphate (aqueous), 10%	o	+	o	x	+	x	x	x	x	o	x	+	x	x
Mercuric chloride, 6%	–	+	–	x	x	x	x	–	x	–	x	o	–	–
Mercury	+	+	+	x	+	x	o	o	x	+	x	+	o	x
Methanol	o	+	o	+	o	x	+	+	+	o	x	o	o	+
Methyl acetate	+	+	+	o	+	o	o	o	x	+	x	+	o	x
Methycyclohexane	–	+	x	x	x	x	x	x	x	x	x	+	x	x
Methylene chloride	o	x	o	–	o	–	o	o	–	o	+	+	o	x
Methyl-ethyl-ketone	+	+	+	–	+	–	o	o	x	+	x	+	o	x
Milk	+[1]	+	+[1]	+	+	x	+	+	+	+[1]	x	+	+[1]	x
Milk acid (Lactic acid), 90%	o	+	o	x	+	x	+	x	x	o	x	+	x	x
Mineral fertiliser, dry	x	+	o	x	+	x	x	x	x	+	x	+	x	x
Mineral fertiliser, moist	x	+	–	x	+	x	x	x	x	o	x	+	x	x
Mineral oil	+	+	+	+	+	x	+	+	x	+	+	+	+	–
Molykote lubricating grease	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Naphthalene	+	+	+	+	+	x	+	+	x	+	x	+	+	x
Nitric acid (aqueous), 0.1%	–	+	x	x	+	–	x	o	–	o	+	–	o	–
Nitric acid (aqueous), 0.5%	–	+	–	x	+	–	–	–	–	–	+	–	–	–
Nitrobenzene	o	+	o	+	x	–	o	o	–	o	+	o	o	x
Nitrogen fertiliser, dry (white)	x	+	+	x	+	x	x	x	x	+	x	x	x	x
Nitrogen fertiliser, moisture saturated (white)	x	+	+	x	+	x	x	x	x	+	x	x	x	x
Nitromethane	o	+	o	x	+	–	x	x	–	x	x	o	x	x
Nut oil	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Oil, cooking oil	+	+	+	+	+	x	+	+	x	+	x	+	+	o
Oil, lubricating oil	+	+	+	x	+	x	x	+	x	+	x	+	+	–
Oleic acid	+	+	+	+	+	x	+	+	x	+	x	+	+	x
Oleum (oil)	–	–	–	–	o	–	–	–	–	–	x	–	–	–
Olive oil	+	+	+	+	+	x	+	+	x	+	x	+	+	o
Oxalic acid (aqueous), 10%	o	+	o	+	+	x	x	x	x	o	x	x	x	x
Ozone	–	+	x	–	+	–	–	–	–	o	x	–	–	–
Paraffin oil	+	+	+	+	+	–	+	+	–	+	x	+	+	–
Perchloric acid, 10%	x	+	o	x	+	x	x	x	x	o	x	x	x	x
Perchloroethene	o	+	o	x	+	o	x	o	x	o	x	+	o	x
Petrol	o	+	o	+	+	–	+	o	–	o	+	+	o	–
Petroleum ether	+	+	+	+	+	–	+	+	–	+	x	+	+	x
Phenol, 75%	–	o	–	–	+	–	–	–	–	–	x	+	–	–

Resistance classification: **+** resistant; **o** conditionally resistant; **–** not resistant; **x** no data available

[1] The bearings are not chemically attacked by these substances. However, there may be a dimensional change due to moisture absorption.

iglide® Plain Bearings - Chemical Resistance Table

Chemicals, iglidur®	A200, C, G300, GLW, igumid G, L100, L250, M250, L280	A500, T500, UW500	A290, F	T220	Z	P	A180, J200, R, UW	J	D	Q	V400	H H2 H370 H4	PEP	B
Phenol (aqueous), 6%	–	x	x	–	+	–	–	–	–	–	x	+	–	–
Phenol, molten	–	x	–	–	+	–	–	–	–	–	x	–	–	–
Phenylethyl alcohol	o	+	x	x	o	x	x	x	x	+	x	+	x	x
Phosphoric acid (aqueous), 0.3%	o	+	x	+	+	–	+	+	–	o	x	o	o	x
Phosphoric acid (aqueous), 3%	o	+	x	+	+	–	+	+	–	o	x	o	o	x
Phosphoric acid (aqueous), 10%	–	+	–	+	+	–	+	–	–	–	x	–	–	x
Phthalic acid (conc. solution)	o	+	o	+	+	x	+	x	x	o	x	o	x	x
Polyester resin (with styrene)	+	+	+	x	+	x	o	+	x	+	x	+	+	x
Potash	+	+	+	x	+	x	x	x	x	+	x	+	x	x
Potassium acetate (aqueous), 50%	x	+	+	x	+	x	x	x	x	+	x	+	x	x
Potassium bichromate (aqueous), 5%	o	+	o	x	+	x	x	o	x	o	x	x	o	x
Potassium bromide (aqueous), 10%	+[1]	+	+[1]	x	+	x	x	+	x	+[1]	x	+[1]	+	x
Potassium carbonate (aqueous), 60%	+[1]	+	+[1]	x	+	x	x	+	x	+[1]	x	+[1]	+	x
Potassium chloride (aqueous), 90%	+[1]	+	+[1]	x	+	x	x	+	x	+[1]	x	+[1]	+	x
Potassium hydroxide solution, 10%	+[1]	+	+[1]	x	+	x	x	o	x	x	x	+	x	x
Potassium hydroxide solution, 20%	o	+	o	x	+	x	x	–	x	x	x	+	–	x
Potassium nitrate (aqueous), 10%	+[1]	+	+[1]	+	+	x	+	+	+	+[1]	x	+[1]	+	+
Potassium permanganate (aqueous), 1%	–	+	x	+	+	x	+	x	x	o	x	–	x	–
Potassium silicate (aqueous)	+[1]	+	+[1]	x	+	x	x	x	x	+[1]	x	x[1]	x	x
Potassium sulphate (sat'd. solution)	+[1]	+	+[1]	x	+	x	x	+	+	+[1]	x	+[1]	+	x
Propane gas	+	+	+	+	+	x	+	+	x	+	x	+	+	x
Propanol	+	+	+	+	o	x	+	+	x	+	x	o	+	x
Pyrocatechol (aqueous), 6%	–	+	x	x	+	x	x	x	x	x	x	x	x	–
Pyridine	+	+	+	x	+	x	o	o	x	+	x	+	o	x
Resorcin	–	+	–	x	x	x	x	–	x	–	x	o	–	–
Salicylic acid	+	+	+	o	+	–	–	–	–	+	x	+	–	x
Sebum	+	+	+	x	+	–	o	+	–	+	x	+	+	–
Silicon hydrogen fluoride, 10%	x	+	o	x	x	x	x	–	x	o	x	x	–	x
Silicone oils	+	+	+	x	+	x	x	+	x	+	+	+	+	x
Silver nitrate	+[1]	+	+[1]	x	+	x	x	+	x	+[1]	x	+	+[1]	x
Soap solutions	+[1]	+	+[1]	+	+	x	+	+	x	+[1]	x	+	+[1]	x
Soda ash solution, 10%	+[1]	+	+[1]	+	+	x	+	+	x	+[1]	x	+	+[1]	x
Sodium acetate (aqueous), 46.5%	+[1]	+	+[1]	x	+	x	x	x	x	+[1]	x	+	x	x
Sodium bicarbonate solution, 10%	+	+	+	+	+	x	+	+	x	+	x	+	+	x
Sodium bisulphate (aqueous), 10%	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	x
Sodium bromide (aqueous), 10%	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	+
Sodium carbonate, 5%	+[1]	+	+[1]	x	+	x	x	x	x	+[1]	x	+	x	x
Sodium carbonate (aqueous), 21.5%	+[1]	+	+[1]	x	+	x	x	x	x	+[1]	x	+	x	x
Sodium carbonate (aqueous), 50%	+[1]	+	+[1]	x	+	x	x	x	x	+[1]	x	+	x	x
Sodium chloride (sat'd. solution)	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	+
Sodium hydroxide solution, 10%	–	+	x	–	+	–	+	o	–	o	+	+	o	–
Sodium hypochlorite	o	+	o	x	x	x	o	o	x	o	x	o	o	x
Sodium nitrate (aqueous), 10%	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	+
Sodium sulphate, 10%	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	+
Sodium sulphite, neutral, 2%	+[1]	+	+[1]	x	+	x	x	o	o	+[1]	x	+	o	x
Sodium thiosulphate, 10%	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	x	+	+[1]	x
Styrene	+	+	+	x	+	–	o	+	–	+	x	+	+	–
Sulphur	+	+	+	+	+	x	+	+	x	+	x	+	+	x
Sulphur acid, 2%	–	+	x	+	+	–	–	–	–	o	+	–	–	–
Sulphur acid, 10%	–	+	–	o	+	–	–	–	–	–	+	–	–	–
Sulphuric acid (conc.), 98%	–	–	–	–	o	–	–	–	–	–	–	–	–	–
Tar	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Tartaric acid	o	+	x	x	+	x	x	+	x	+	x	+	+	x
Tetrahydrofurane (solvent)	+	+	+	x	+	x	–	o	x	+	+	+	o	x

Resistance classification: **+** resistant; **o** conditionally resistant; **–** not resistant; **x** no data available

[1] The bearings are not chemically attacked by these substances. However, there may be a dimensional change due to moisture absorption.

iglide® Plain Bearings - Chemical Resistance Table - Troubleshooting Guide

Chemicals, iglidur®	A200, C, G300, GLW, igumid G, L100, L250, M250, L280	A500, T500, UW500	A290, F	T220	Z	P	A180, J200, R, UW	J	D	Q	V400	H H2 H370 H4	PEP	B
Tetraline	+	+	+	+	+	–	+	+	–	+	x	+	+	x
Thionyl chloride	o	+	o	x	x	x	–	x	x	o	x	x	x	x
Toluene	+	+	+	x	+	–	o	+	–	+	+	+	+	–
Transformer oil	+	+	+	+	+	x	+	+	x	+	x	+	+	–
Trichloroethylene	o	+	o	x	+	–	o	–	–	o	x	o	–	x
Triethanolamine, 90%	+[1]	+	+[1]	+	+	x	+	+	x	+[1]	x	+	+[1]	x
Trisodiumphosphate, 90%	+[1]	+	+[1]	x	+	x	x	x	x	+[1]	x	+	x	x
Urea	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Vaseline	o	+	+	x	+	x	o	+	x	+	x	+	+	o
Vinyl chloride	+	+	+	x	x	–	x	+	–	+	x	+	+	x
Violet oil	+	+	+	x	+	x	x	+	x	+	x	+	+	x
"Washing machine cleaner														
(Phosphoric acid and nitric acid)"	o	+	o	+	+	x	+	–	x	o	x	+	–	x
Water – sea, river, and spring water	+[1]	+	+[1]	+	+	+	+	+	+	+[1]	+	+	+[1]	o
Water-glass	+[1]	+	+[1]	x	+	x	x	+	x	+[1]	x	+	+[1]	x
Water vapour	–	+	x	–	+	–	x	x	x	o	o	+	x	–
Wax, molten	+	+	+	x	+	x	x	+	x	+	x	+	+	x
White spirit	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Wine	+[1]	+	+[1]	+	+	x	+	+	x	+[1]	x	+	+[1]	x
Xylene	o	+	+	o	+	–	o	+	–	+	x	+	+	x
Zinc chloride (aqueous), 10%	o	+	o	x	+	x	+	+	+	–	x	+	–	x
Zinc oxide	+	+	+	x	+	x	x	+	x	+	x	+	+	x
Zinc sulphate (aqueous), 10%	+[1]	+	+[1]	x	+	x	x	+	x	+[1]	x	+	+[1]	x

Resistance classification: **+** resistant; **o** conditionally resistant; **–** not resistant; **x** no data available

[1] The bearings are not chemically attacked by these substances. However, there may be a dimensional change due to moisture absorption.

The data was determined using laboratory specimens or based on comparisons with similar chemicals. Therefore, this data can only act as a reference. The chemical resistance of actual parts should be tested under application conditions. All data given concerns the chemical resistance at room temperature. Other temperatures may lead to different classifications of the chemical resistance. The data is based on our current knowledge. Future discoveries may lead to changes in the classification of the chemical resistance.

Troubleshooting

In spite of careful manufacturing and assembly of the bearings, variances and questions regarding the recommended installation dimensions and tolerances can result.
For this reason, we have compiled a list of the most frequent reasons for variance. In many cases, with this troubleshooter, the reasons for the variances can be found quickly.

Symptom	Action/Solution
Bearing is oversized before pressfit	Check dimensions only after pressfit
Removal of material when pressed into housing	Add chamfer to housing bore, check bore size
Bearing is over/under sized after pressfit	Check housing bore dimension, check housing bore material Softer
	bore materials (plastic, aluminum can expand upon pressfit
Operating Clearances are too large/small	Check ID of bearing after press, housing bore, shaft diameter
Bearing noise/squeak	Check shaft surface finish/ Possibly roughen shaft
Bearing wears, material deposits on shaft	Operating clearance may be too small/ Increase clearance
Chattering noise	Operating clearance too large, excessive speed/Reduce speed and operating clearance
Shaft wear	Shaft material too soft/ Change shaft material or hardness, switch
	to alternative iglide material
Bearing seizes on shaft	Operating clearances too small, temperature or moisture may be causing materlal expansion
Loss of pressfit	Bearings overheated/ Axial secure bearing into housing or select alternative material grade

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