plastic bearings have staying power

igus®

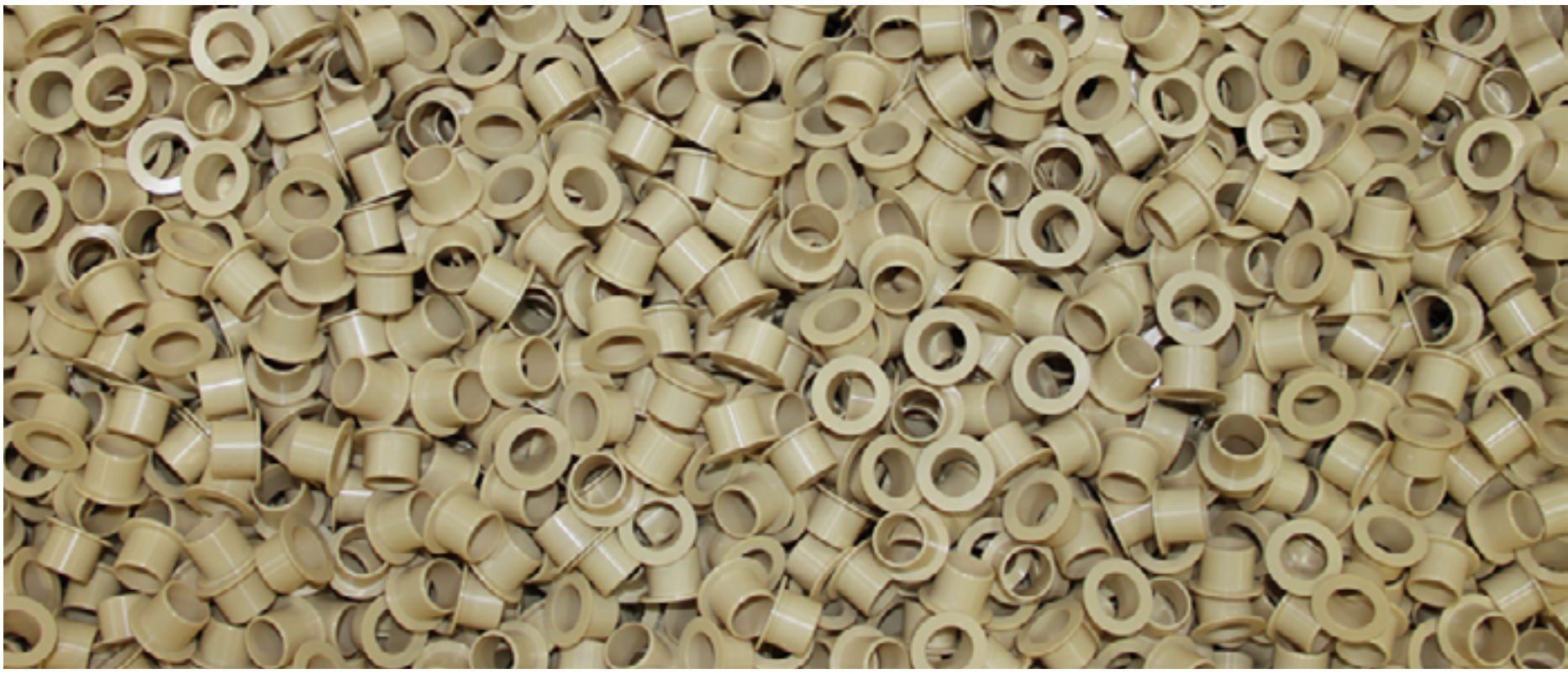
Plastic bearings have staying power

by Nicole Lang
igus® Product Manager

During the past three decades there has been an evolution in the advancement and use of highly engineered plastics in bearing applications. Plastic bearings are no longer designed like their dime-a-dozen, injection-molded nylon ancestors. Today, plastic bearings cost and weigh less than their metal counterparts, but what many design engineers still do not realize, is that they also often last longer in unforgiving environments.

High-performance plastic bearings are working to shed their negative image and continue to forge a path into almost every industry; from packaging machines and medical devices, to automotive, farming equipment, textile machinery, and many more. Plastic plain bearings are an economical replacement for needle, ball, and plain metal bearings. However, they are often not considered a viable choice in the engineering community due to the common misconception that plastic is inferior or weaker compared metal.

The truth is that composite plastic bearings can outperform their metal counterparts in countless rotary, oscillating, and linear-motion applications. In addition, plastic bearings are readily available in many different styles, sizes, materials, and colors to meet the demands of almost any application.

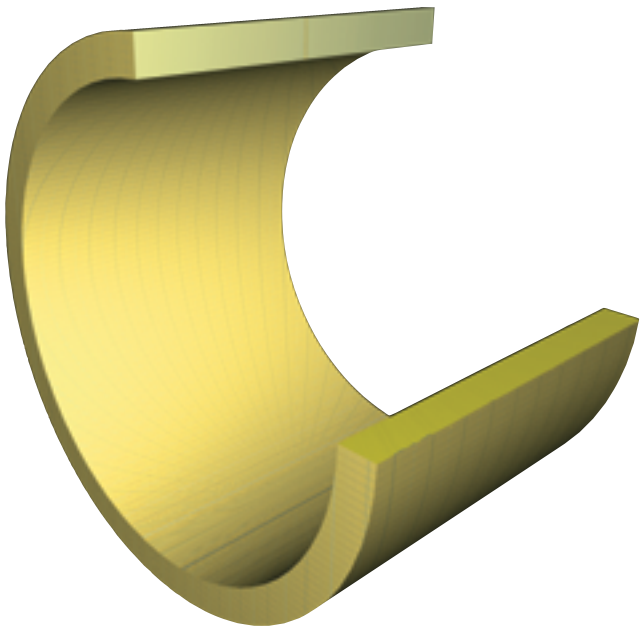


The Argument for Plastic

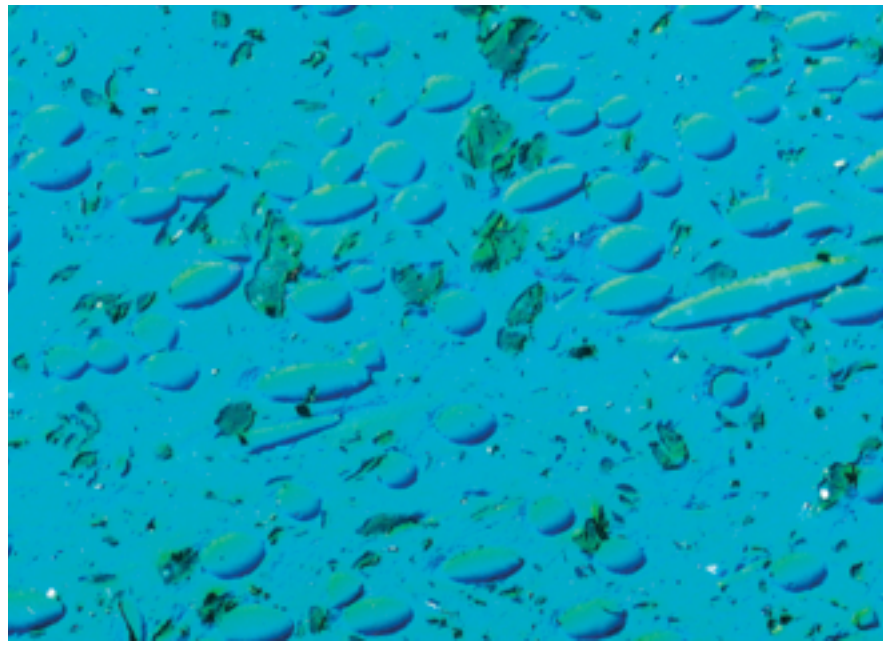
igus® designs and develops its high-performance, cost-effective plastic bearings for almost any application. The company's plastic bearings are an off-the-shelf solution, and are available in more than 120 different plastic compounds. Each is comprised of three parts:

- Base polymers, which are responsible for the resistance to friction and wear;
- Reinforcing fibers and filaments, which make the bearings ideal for high forces and edge loads;
- Solid lubricants, which are blended into each material and eliminate the need for any external oils or grease.

While most plastic bearings, like the ones from igus, can endure extreme temperatures, heavy loads and high speeds, it is still important to understand both the advantages and disadvantages of the different options available.



Injection molded iglide® plain bearings are homogeneously structured. Base polymer, bonding materials and solid lubricants mutually complement each other.



Base polymers with fibers and solid lubricants, magnified 200 times dyed.

iglide® plastic bearings vs. Bronze Bearings

Maintenance-free plastic bearings regularly deliver a longer service life and a cost savings of up to 40 percent when compared to oil-impregnated sintered bronze bearings. Plastic bearings not only outlast their metal counterparts, but prove more economical because no grease or oil lubricants are required, eliminating the need for routine maintenance.

With sintered-bronze bearings, oil is drawn from the bearing as it rotates on the shaft (minimum speed of 200 feet per minute). The oil creates a thin film that then separates the bearing and shaft, preventing wear and shaft damage. At high speeds, a low COF is achieved. Shaft oscillation, slow speeds, irregular use or uneven loads can impede film lubrication from being maintained. As a result, the COF and wear rates increase. In addition, if movement stops completely, the oil on the bearing surface dries up and cause higher friction and squeaking. High temperatures can also break down the oil. In addition, oil film on the shaft can act like a magnet for dust, dirt and airborne debris, which can seize up the bearing or contaminate a product or process, especially in food or medical applications.

Learn more about iglide® plastic bearings
www.igus.com/iglide

Common misconceptions

Despite the performance advantages, several misconceptions may make engineers reluctant to take full advantage of the benefits of thin-walled plastic bearings:

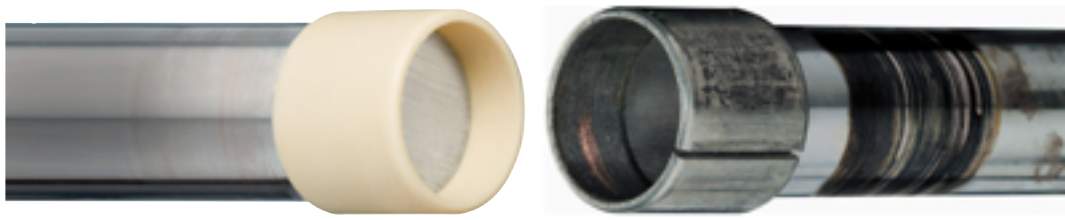
1. The wall thickness of either bearing does not directly correlate to its strength. Other factors that are more important and should be taken into consideration include the weight, coefficient of friction and wear capabilities of the bearing.

   In addition to the material, a basic difference between thin-walled plastic bearings and thick-walled bronze bearings is thickness. Thick-walled bronze bearings feature a standard wall thickness between 0.0625 and 0.156 inches. In comparison, the wall thickness of a plastic bearing is much less, typically between 0.0468 and 0.0625 inches. Due to their thin walls, plastic bearingss not only offer a number of benefits, but also perform equally as well, if not better than a thick-walled bearing.

2. Due to its thin wall, the surface pressure of a press-fit plastic bearing will be negatively affected. Another mistake is to assume the thin wall of press-fit plastic bearings will affect the surface pressure. Actually, the surface pressure of a press-fit bearing, typically rated in pounds per square inch (psi), is determined by the load divided by the surface area it acts on: Ps = L/(D × l) where Ps = surface pressure, psi; L = load, lb; D = inside diameter, in.; and l = bearing length, in. Whether one is using a thin-walled plastic bearing or a thick-walled bronze bearing, wall thickness has no effect on surface pressure.

3. A thin-walled plastic bearing has a shorter life than its thick-walled bronze counterpart. It is reasonable to assume that since a plastic bearing has less material (a thinner wall), it will not last as long as a thick-walled bronze bearing. This is incorrect because the thin wall of a plastic bearing helps to dissipate any heat buildup, which actually prevents wear. In high-rotation applications, continually re-lubricating the bronze bearing will help prevent wear. However, if a bronze bearing is being used to facilitate other types of motion; excessive wear can lead to added clearance between the shaft and the bearing. If this happens, a number of problems will arise. It is important to remember that wear is dependent on the makeup of the bearing material and not on the wall thickness (refer to misconception one). For this very reason, igus is constantly developing new plastic materials, which minimize wear and provide a long-lasting, maintenance-free solution for a variety of applications.

iglide® self-lubricating plastic bushings are proven to deliver a longer service life than oil-impregnated sintered bronze bearings.



Reasons to replace PTFE-lined bushings

Plastic bushings are now designed to handle high speeds, loads, temperatures, caustic chemicals and a wide array of other application factors. Here are the top four reasons for replacing PTFE-lined bushings with plastic bushings, which offer more design flexibility.

Thinner wear surface
A PTFE-lined bushing is comprised of a metal shell and a very thin polymer coating (PTFE) applied to the inside. These types of bushings typically have a maximum wear surface of 0.06 millimeters (0.002 inches), but as the PTFE coating is stripped off during operation, the metal shell becomes exposed. This creates a metal-on-metal effect between the bushing and the shaft and can cause serious damage. This problem is common when high edge loads or oscillating movements are present.

In comparison, plastic bushings are comprised of advanced compounds, which contain solid lubricants embedded in millions of tiny chambers throughout the material. During operation, lubricant is transferred onto the shaft to help lower the coefficient of friction and wear, and unlike PTFE-lined bushings, plastic bushings eliminate the danger of metal-on-metal contact. This is huge benefit since the acceptable amount of wear can be determined by the type of application (unlike the PTFE-lined bushing, which will fail if the wear rate surpasses 0.06 millimeters).

For example, igus®' lifetime calculator uses a preset wear rate of 0.25 millimeters (0.01 inches), but the user can easily increase or decrease this number to meet the wear limit acceptable for the particular application. Unlike PTFE-lined bushings, plastic bushings eliminate the danger of metal-on-metal contact. Almost any of igus®' iglide® plastic bushings can replace a PTFE-lined bushing. One of the most popular is iglide® G300.

iglide® G300 is ideal for demanding applications with medium to high loads, average surface speeds, and moderate temperatures. It is available as a sleeve bushing, flange bushing or thrust washer.

Increased weight
PTFE-lined bushings weigh more than plastic bushings. When using a heavier bushing, no matter what material it is comprised of, more energy is required for the bushing to operate. This can be troublesome, especially in automotive, aerospace, recreational vehicle, and bicycle applications.

In contrast, plastic bushings are lightweight, which helps decrease fuel consumption and carbon dioxide output. The reduced weight can also help reduce carbon dioxide output, lower masses and subsequently, lower energy consumption.

In a weight comparison, an iglide® plastic bushing weighs approximately 80 percent less than a PTFE-lined bushing.

- iglide® G300 plastic bushing = 0.0144 pounds per piece
- PTFE-lined bushing = 0.0750 pounds per piece

No corrosion or chemical resistance
The metal shell of a PTFE-lined bushing is not ideal for applications where water or caustic chemicals are present. In these types of applications, PTFE-lined bushings can rust, corrode, contaminate sensitive areas, and ultimately fail. Since plastic bushings are made solely of high-performance polymers, they offer both corrosion- and chemical-resistance and operate unaffected in those types of environments.

No resistance to biofuels
The trend towards the increasing use of biofuels and biodiesels creates problems when using PTFE-lined bushings; after limited exposure to moisture, parts of the bushing's metal shell can begin to peel off. However, these types of applications open new doors for plastic bushings. Since they are corrosion-resistant, plastic bushings remain unaffected despite the fact that biodiesel has the tendency to absorb a great deal of water. iglide® T500 plastic bushings can be used in applications with biofuels and biodiesels.

Learn more about iglide® plastic bearings
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Reasons to use iglide® plastic bearings

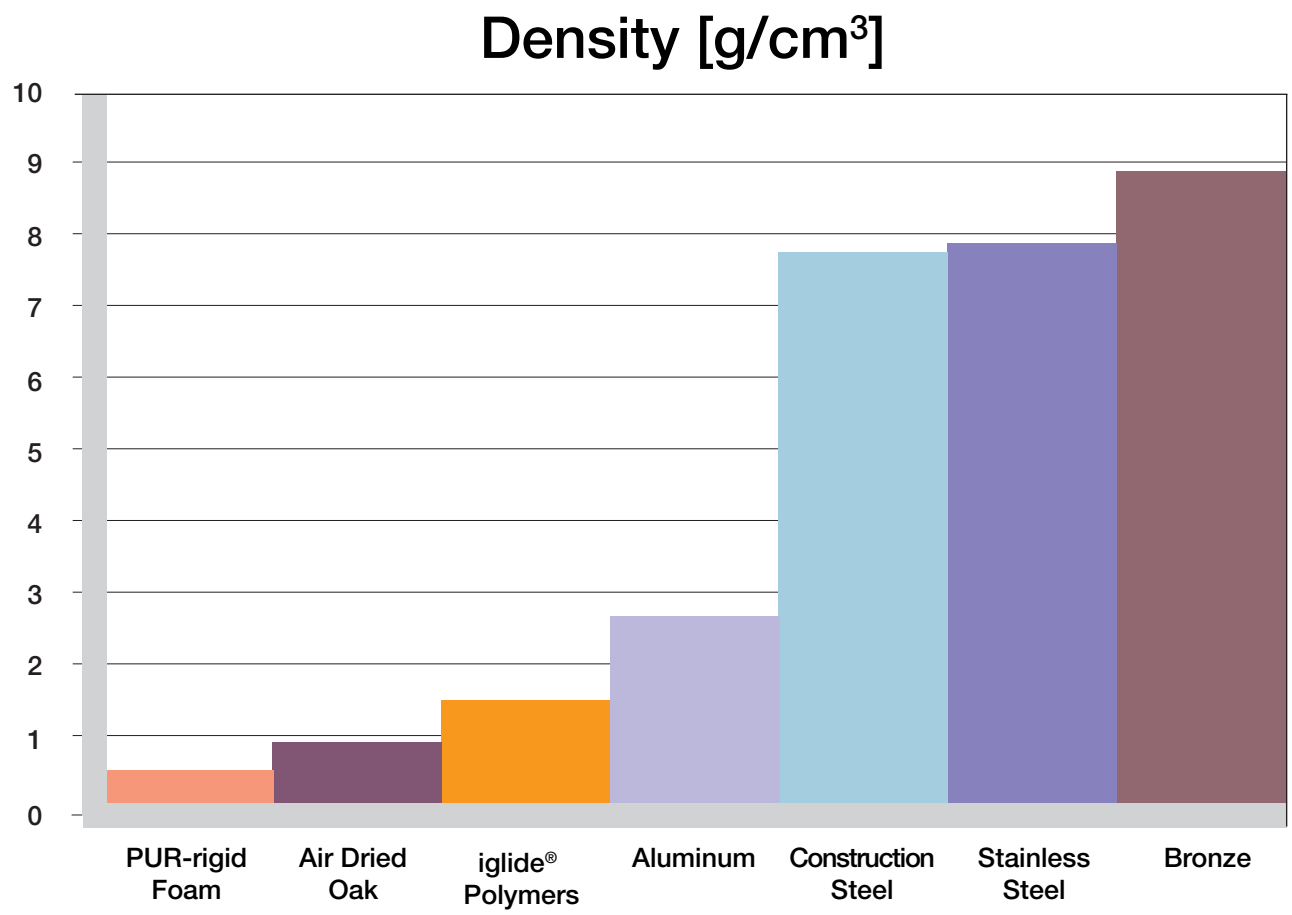
All iglide® bearings contain — the thermoplastic, fibers and or filaments, and lubricants — have excellent antifriction and low-wear characteristics that produce a self-lubricating effect. This is especially important during the start-up phase of an application - with metal bearings, the lubricant film has not yet formed and the bearing begins operating dry, which can accelerate wear. In comparison, iglide® plastic bearings are homogeneously impregnated with solid lubricant, and run “lubricated” from the start. During operation, plastic bearings transfer lubricant onto the shaft to help lower the COF. This also minimizes slip-stick conditions and wear, as well as increases operating life, unlike with plain metal, ball, and needle bearings. Dimensional changes to the bearing are essentially non-measurable, and abrasion decreases rapidly following startup and becomes negligible in continuous operation. In addition, the fiber-reinforced materials maintain the bearing’s strength and resistance to high forces and edge loads. Plastic bearings can also be used on many different shaft types.

In extremely dirty conditions, particles simply embed into the wall of a plastic bearing with little effect on performance. Plastic bearings offer other advantages as well, including the ability to withstand chemicals and certain types of corrosives such as hydrocarbons, alcohols and alkaline solutions. igus also offers FDA-approved plastic bearings that permit contact with food and pharmaceuticals.

Many engineers are also surprised to learn that plastic bearings can be used in high temperature applications. For example, certain igus bearings can operate continuously at temperatures approaching 500 degrees Fahrenheit, as well as withstand peaks to 600 degrees Fahrenheit and lows of –148 degrees Fahrenheit.

Plastic bearings also run quietly and absorb mechanical vibrations. The so-called mechanical loss factor, an indicator of vibration-damping capability, is up to 250 times higher than that of plain-metal bearings.

For applications where weight and fuel economy are an issue, for example in racing bikes, snowmobiles, automobiles, and motorcycles, a thin-walled plastic bearing is ideal. The image below compares the weights of different bearing materials.



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Successful applications

Plastic bearings have already replaced plain metallic bearings in thousands of applications from a wide range of different industries, including agricultural machinery, medical equipment, fitness equipment, packaging machinery and more. Engineers are increasingly turning to plastic bearings in a wide range of challenging applications.

In the medical industry, iglide plastic plain bearings from igus are helping to improve the way prostate cancer is detected and treated. A team of researchers from the Worcester Polytechnic Institute (WPI) in Massachusetts have developed a specialized magnetic resonance imaging (MRI) compatible piezoelectric actuated robot. To facilitate different types of motion, the robot uses iglide plastic self-lubricating bearings and DryLin linear guide systems to facilitate translational motion of the positioning module, which provides gross positioning for the robot's needle driver. The needle driver is a vital part of the system, as it enables the rotation and translational movement of the needle cannula: a flexible tube inserted into the patient's body cavity for MRI-guided diagnosis and therapy. The needle driver has a needle guide sleeve, a collet locking mechanism and passive optical tracking fiducial frame. Two plastic plain bearings are used in the front and rear of the driver to constrain the needle guide. The bearings enable the robot's motor to rotate the needle using the collet mechanism by way of a timing belt. This rotating needle would reduce tissue damage while enhance targeting accuracy. Another 10 plain bearings were used to create a revolute joint, also known as a "pin joint" or "hinge joint", to provide single-axis rotation. The plastic bearings and linear guides operate without messy lubrication, which is important in a sterile medical environment. The plastic bearings also ideal because they are comprised of FDA-compliant polymers specifically designed for applications with contact to food or drugs.

In another case, an OEM turned to plastic bearings for equipment that packages flour, sugar, and various types of pet food. The machines operate around the clock and are expected to last 20 to 30 years. To meet the demanding durability requirements, the company's engineers specified plastic linear bearings on guide rods in the machine's trimming and pressing stations. The linear bearings' aluminum adapter fits over a plastic liner. The beefed-up construction lets them carry up to thirty 50-lb bags/min on each machine, 43,200 times per day. The dry-running bearings are unaffected by flour or sugar dust that gets stirred up during packaging, and will not contaminate food products, unlike bearings that require external lubrication. Plastics bearings have excellent strength, good thermal properties, and need no external lubrication. And the low-cost, lightweight bearings deliver long life despite exposure to harsh chemicals, dust, dirt, and other contaminants. With advances in polymer engineering, plastic bearings now outperform metal in many applications.

iglide® plastic bearing applications

Surgical Light
The motor-powered swiveling LED wings are adjusted with the aid of iglide® JVFM bearings. Self-lubricating and maintenance-free. (Trumpf iLED Medical Systems Inc.)

Washing Chain Bearings
Reduction of the drive power for bottle washing machines by using iglide® under the most difficult conditions in a 2–3 % caustic soda and temperature of +176 °F. (Krones AG)

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A third application is a pasta manufacturer that recently replaced V-grooved, track-guided rollers on its cartoning machines with plastic plain bearings. The machines, which operate 24/7, use a shuttle bucket to carry and unload one-pound portions of pasta. The bucket travels 18 inches, 240 times a minute, to keep up with the machine's load station. Despite the rapid cycling and extreme acceleration, the plastic bearings last more than three times longer than the previous roller bearings and have reduced annual repair costs by $7,800. And the lubrication-free bearings cannot contaminate the pasta or packaging. Replacement, if necessary, takes less than two hours — in contrast to the full day of downtime it takes to rebuild just one set of rollers. And, as an added benefit, the company reports vibration issues have been eliminated and the machines run much quieter. The plastic bearings are also corrosion-resistant and maintenance-free, making them cost-effective replacements for most ball bearings. Their oil-free operation is also a huge advantage, as FDA regulations prohibit most lubricants for sanitary reasons, and even approved lubricants attract dust and dirt, which can eventually cause bearings to seize.

More iglide® plastic bearing applications

Spreaders
Main reasons for iglide® bearings: The special design to complement the centrifugal arm results in a significant reduction of manufacturing costs. It is also maintenance-free and has high wear resistance.
(Fella Werke GmbH & Co. KG)

Tool changer chain
Main reasons for iglide® bearings: Enormous cost advantages in comparison to standard metallic rolled bearings as well as low coefficient of friction and with soft shaft materials.
(Deckel Maho Seebach GmbH)

Axle box arrangement
The edge load is usually a deciding factor for or against the use of bearings. iglide® G bearings solve this, also giving high wear resistance, low costs, resistance to corrosion and dirt.
(Zunhammer GmbH Gülletechnik)

Tubular bag machines
The continuous operating temperature in the bonding arms frequently reach +320 °F and higher. These requirments are met by iglide® Z bearings which also offer particularly high resistance to wear.
(Affeldt Verpackungsmaschinen GmbH)

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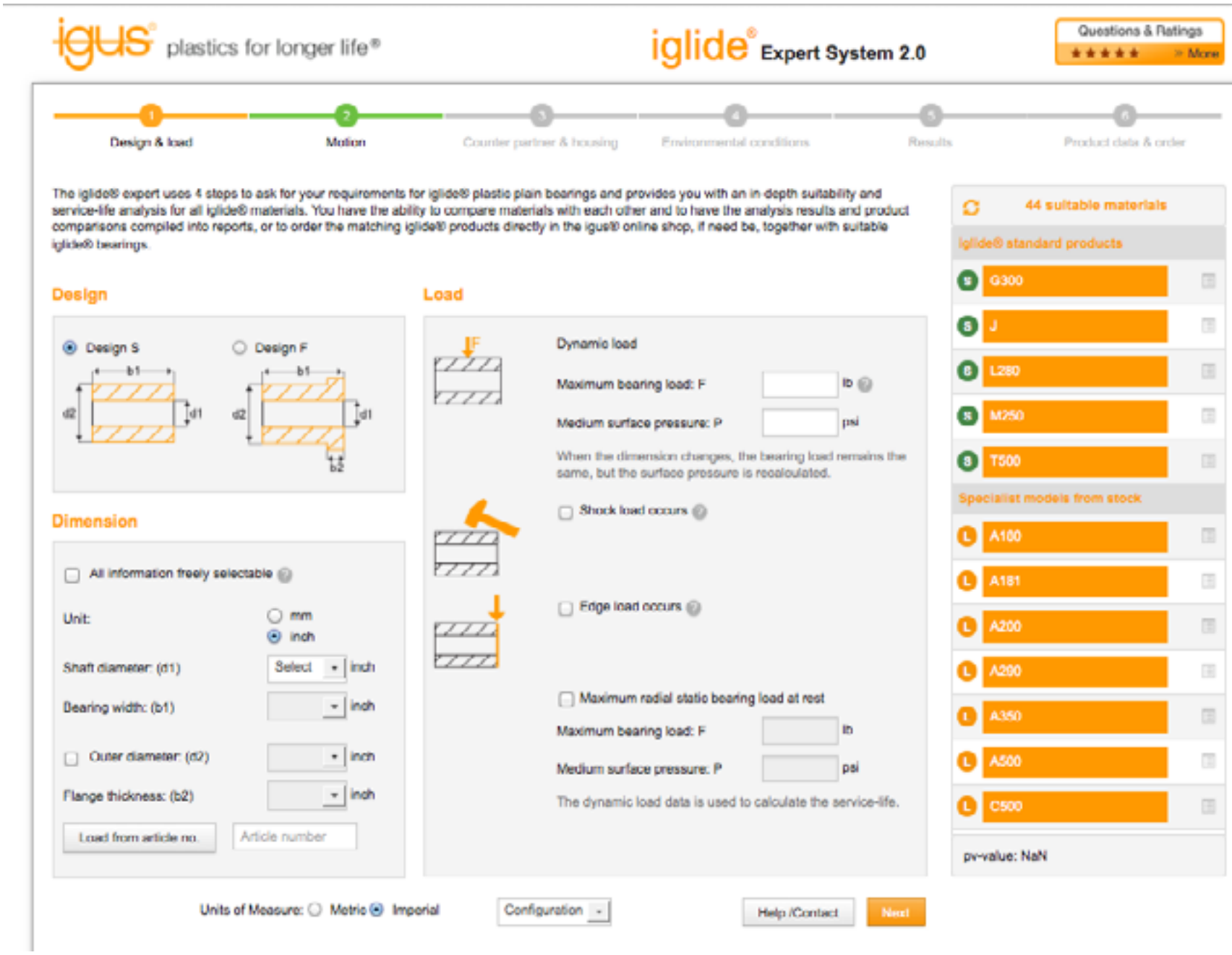

The Ability to Predict Bearing Life

igus® offers a service-life calculator called The Expert System for its lines of iglide® plain bearings and DryLin® linear bearings. These convenient tools are based on an extensive tribological test database and have been verified with thousands of hours of actual testing that make it possible to predict plastic-bearing life under almost any operating condition. Users enter various data — proposed bearing dimensions; maximum loads; whether motion is rotating, linear, pivoting, or a combination of the three; speed; whether the motion it is intermittent or constant; operating temperature range; chemical exposure; mating surface; and acceptable limits on bearing wear — and the system uses these factors to calculate bearing life. The Expert System then calculates and delivers results, including life in hours and travel distance for various suitable products.

The Expert System delivers trusted results, but igus does encourage testing a selected bearing in the proposed application before releasing a machine to the market. igus® supplies free test samples and advice through its expert sales engineers to select the best material and design for a given application.

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www.igus.com/iglide

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