



White paper

Bearing points without lubrication? Guide, expert tips and practical examples

igus®

Issue**Schematic overview**

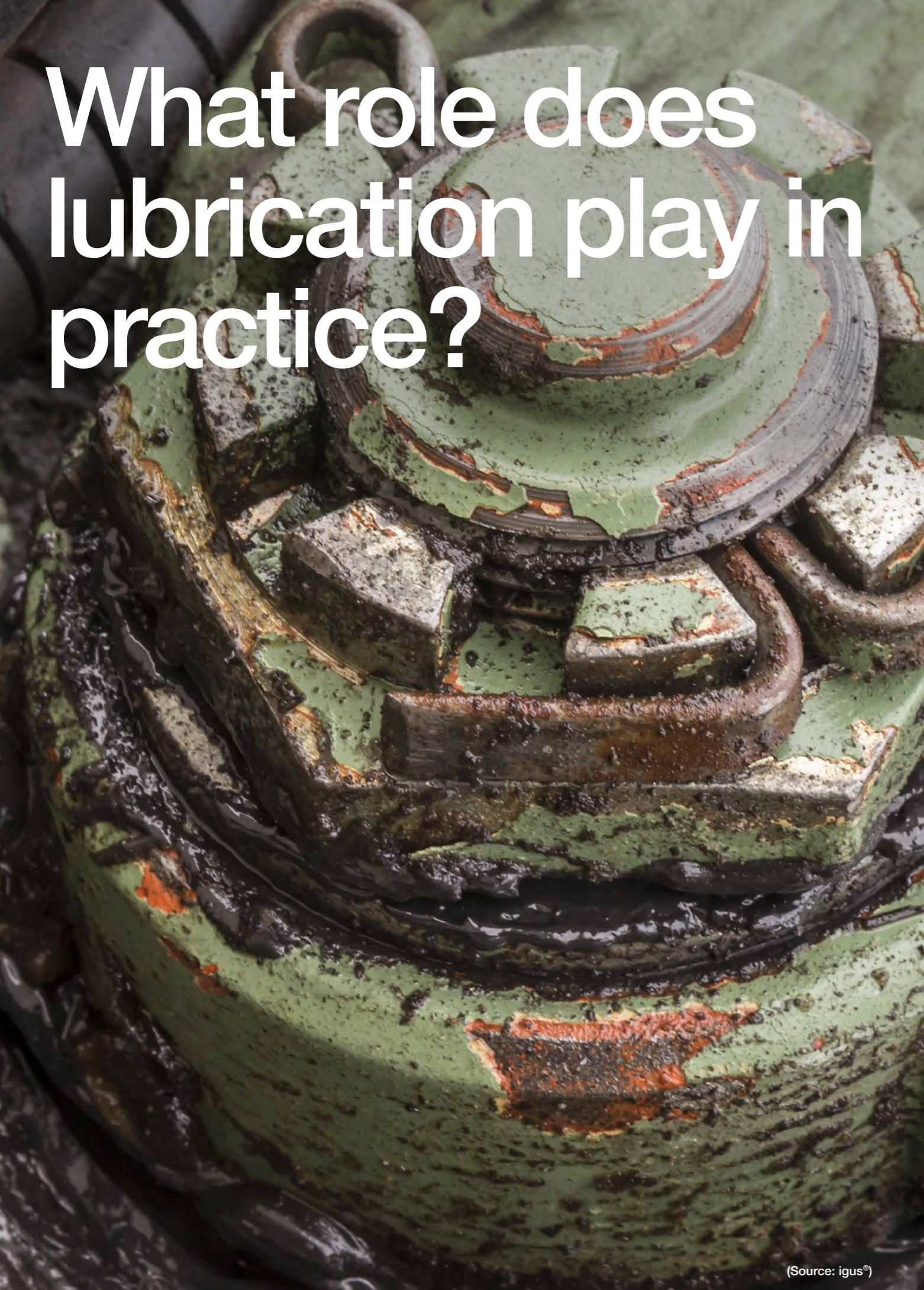
Introduction.....	3
Functions of lubrication in bearing positions.....	5
Cost of lubrication on the environment.....	7
Requirements for the use of lubrication-free plain bearings	8
Reports and figures from the field.....	10
Lubrication costs	11
How do lubrication-free plain bearings work?	13
Operating conditions of lubrication-free plain bearings.....	14
What is iglidur®?	16
What is igutex®?	17
Examples from practice:	
Lemken - 22 lubrication points saved per cultivator.....	19
Bottle filling.....	20
Chains for escalators	21
Agricultural engineering	22
Excavators	23
The story behind igus®	25
Solution.....	26
Frequently asked questions	27

Bearing points without lubrication?**Introduction**

"That works like a well-oiled machine" - Lubrication is so self-evident and important for moving parts that the lubrication condition has even become an established saying. Wherever parts move against each other, lubrication is necessary. It improves the coefficient of friction and protects not only against wear, but also against corrosion and dirt. But it also has its price. In technical applications, it is important to keep the right amount of the right lubricant in the right place. This system is not only prone to errors and often causes expensive damage when mistakes are made, it also potentially poses a problem for human health and the environment.

It has long been possible to implement lubrication-free bearing points - i.e. without grease or oil-based lubrication. In this white paper, you can find out how best to proceed, available expert tips and how manufacturers and users benefit from this technology.

What role does lubrication play in practice?



What role does lubrication play in practice?

Functions of lubrication in bearing positions



Reduction of friction and wear



Protection from moisture and corrosion



Protection from dirt and dust

The use of lubricants is essential for most metallic bearings in order to minimise friction in the bearing position. The oil or grease decouples the sliding surfaces of the friction partners and thus protects them from friction and wear.

Grease and oil displace water and thus moisture in bearing points. Combined with seals that keep the lubricants in place, the metallic components such as the shaft or mount are protected against corrosion.

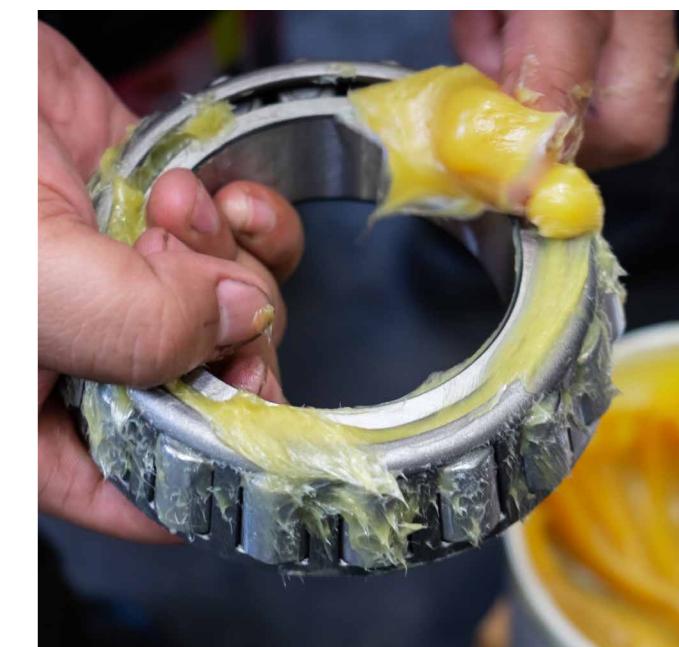
In grease-lubricated bearing arrangements in dirty or dusty environments, the grease pressing outwards from the bearing point provides good protection against the ingress of foreign bodies that would otherwise damage the bearing point.

Should you lubricate with grease or oil? Different concepts for different challenges

A basic distinction is made between two types of lubrication, which have different advantages with regard to the above-mentioned areas of application, but also have specific design requirements and are therefore not suitable for every application. With oil lubrication, a lubricating film is maintained with specifically adjusted pressures. In grease lubrication, a highly viscous lubricant is applied in the form of an ointment or introduced under high pressure.



Oil lubrication (Source: igus®)



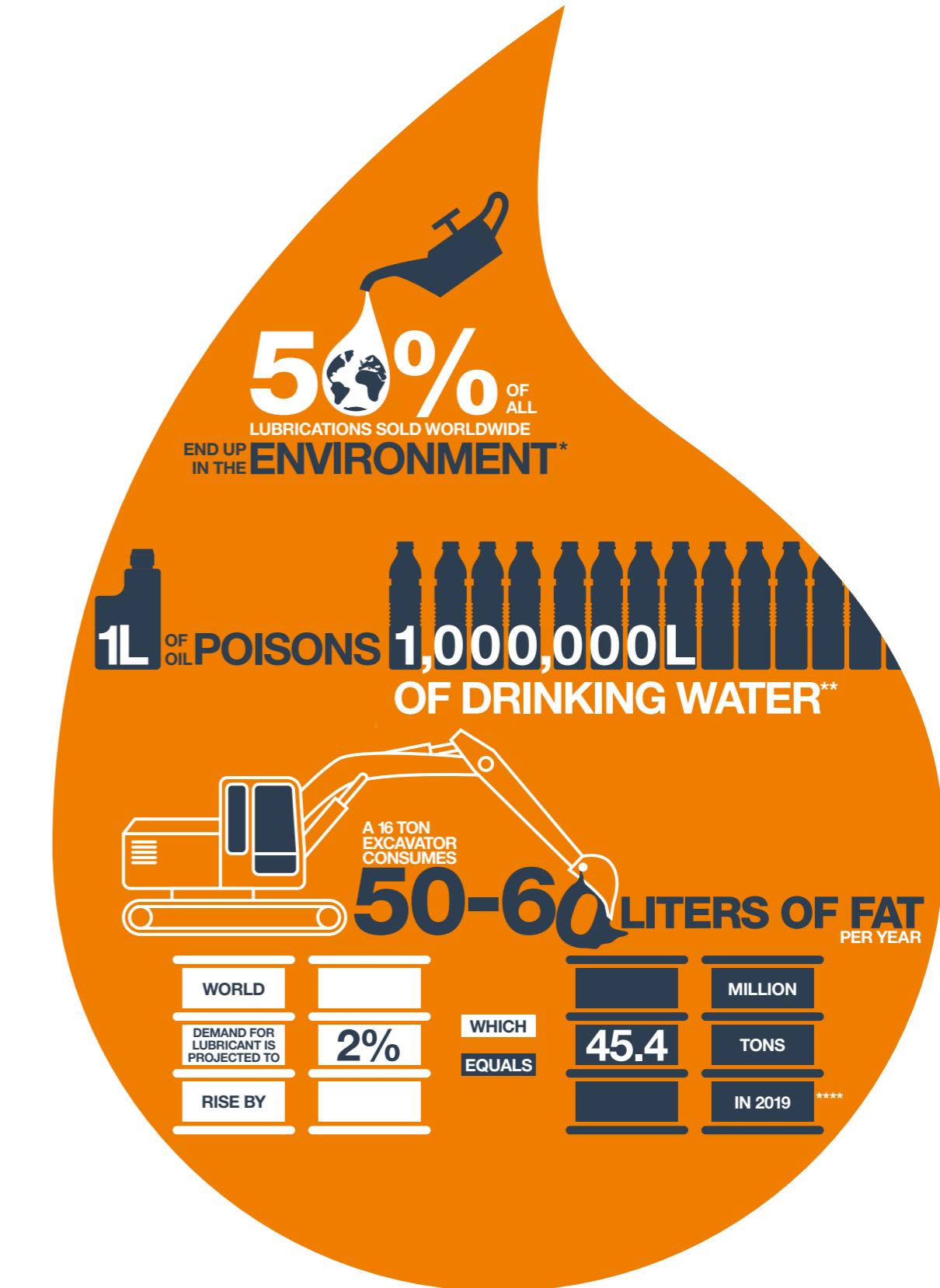
Grease lubrication (Source: igus®)

What does lubrication cost?

(Source: igus)

What does lubrication cost?

Cost of lubrication on the environment



Tribo-plastic bearings do not require lubrication

* M. P. Schneider, 2006; ** Saskatchewan Association for Resource Recovery Corp., 2008; *** K. Holmberg, P. Andersson, A. Erdemir, 2012; **** The Freedonia Group, 2015

(Source: igus®)

What does lubrication cost?

Requirements for the use of lubrication-free plain bearings



Study results: Ecological assessment of the use of plastic plain bearings



Project completion | Cologne, October 16, 2023

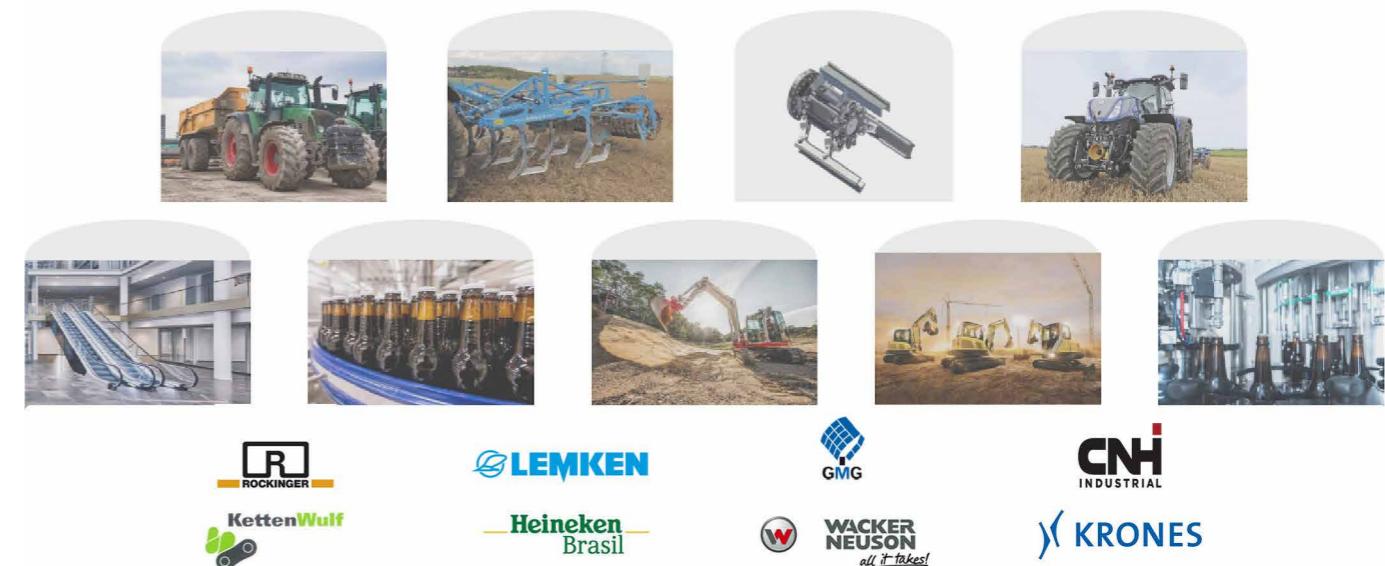
(Source: RWTH Aachen University)

Study: How big are the savings potential really?

How high the specific savings in machines and systems can actually be through the use of lubrication-free plain bearings can only be precisely determined in the context of the respective applications. In order to quantify and extrapolate these savings using examples, the Manufacturing Technology Institute MTI at RWTH Aachen University is conducting a study on behalf of igus® SE & Co. KG.

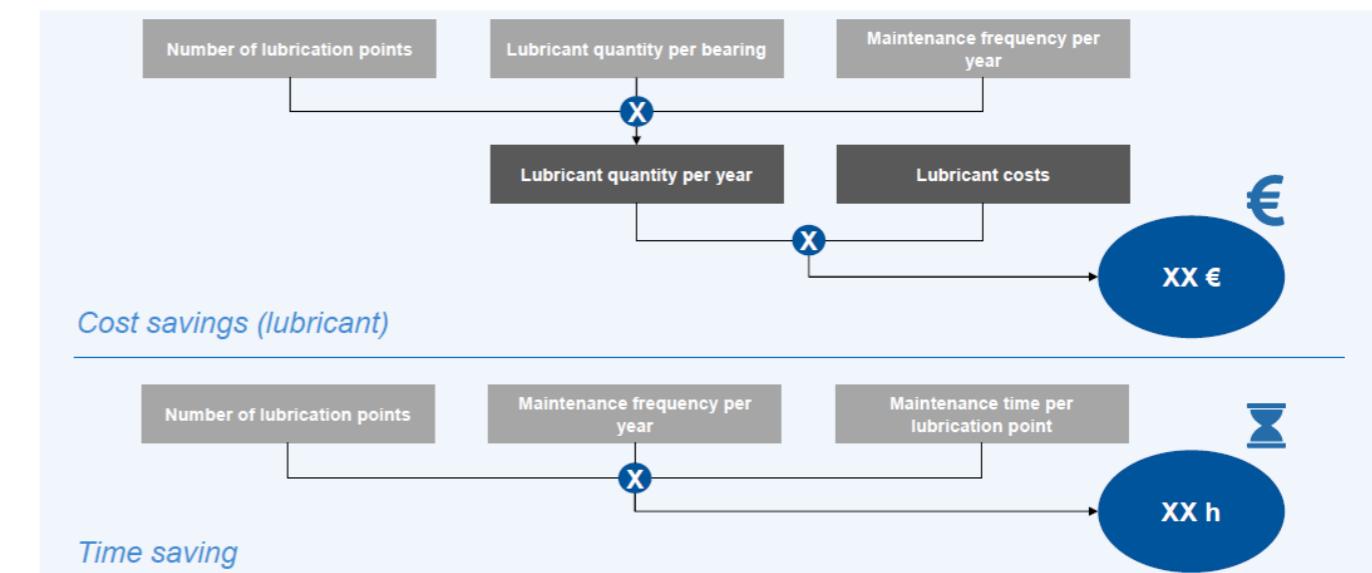
The actual savings in operating resources and working time, but also in terms of indirect consequences such as complaints due to incorrect or insufficient lubrication, depend on many factors. Bearing points must be lubricated to varying degrees. The time required to carry out the work varies with the complexity of the devices and systems. Some systems have centralised lubrication units. On others, all lubrication points must be lubricated separately. In order to analyse these specific characteristics, the MTI surveyed nine companies from a wide range of industrial sectors. With the information thus obtained about the type and condition of the bearing point, the necessary lubrication and maintenance intervals, as well as the consequences of inadequate lubrication, MTI then calculated the impact on the environment and the resulting costs. These figures were then extrapolated to industry sectors using other methods.

Study: Ecological assessment of the use of plastic plain bearings Study participants



(Source: RWTH Aachen University)

Company profiles Annual savings calculation logic

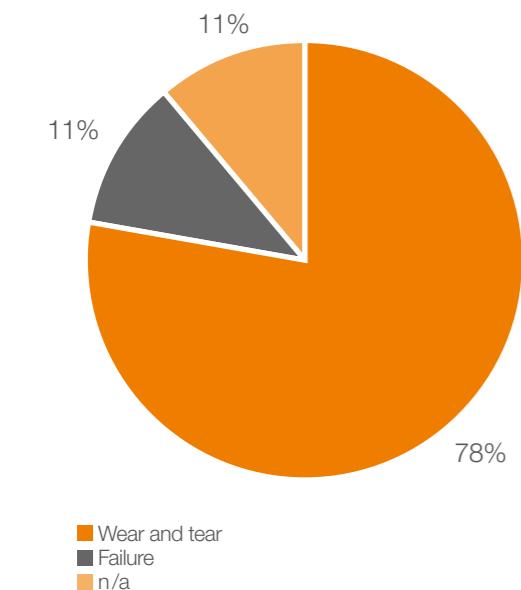


(Source: RWTH Aachen University)

What does lubrication cost?

Reports and figures from the field

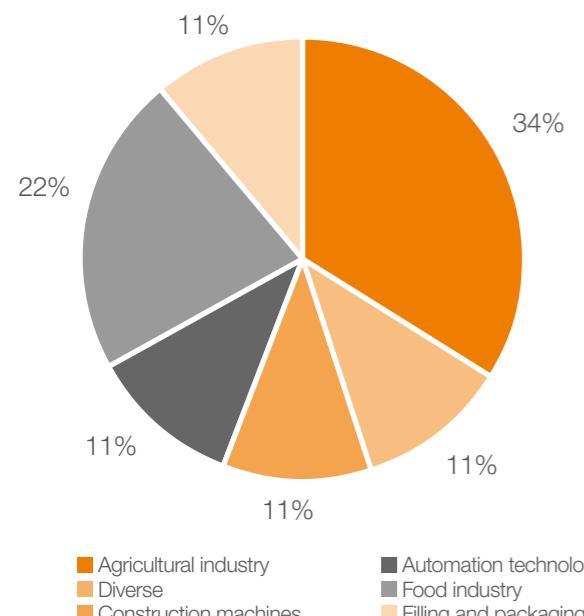
Consequences of incorrect lubrication



(Source: RWTH Aachen University)

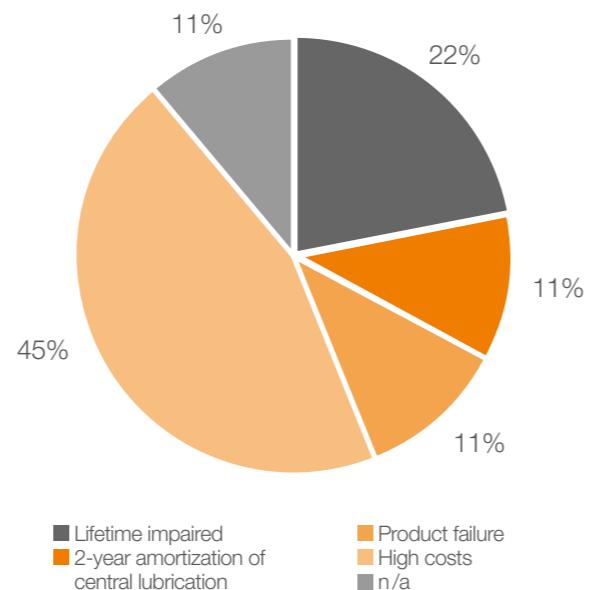
The companies surveyed in the agricultural and food industry, the packaging and bottling industry as well as manufacturers of construction machinery and automation technology provided different information on the consequences of incorrect and insufficient lubrication. These range from reduced service life to the amortisation of expensive central lubrication systems after a short time.

Sector distribution



(Source: RWTH Aachen University)

Lack of lubrication costs



(Source: RWTH Aachen University)

What does lubrication cost?

Lubrication costs

Many bearing points are protected against environmental influences and wear by so-called loss lubrication. Grease is permanently pressed out from the inside of the machine. The lubricants enter the environment unhindered. As a result, **27 million tons of lubricating grease are released into the environment worldwide every year**, which is why environmental protection regulations are becoming stricter. One possible solution is more environmentally friendly oils and greases, but these are very cost-intensive.

In order to reduce the costs of these fats and oils on the one hand, but also to reduce the impact on the environment on the other, increasingly more manufacturers are looking for alternatives.



Lubricating grease gets directly into the ground in many applications.
(Source: igus®)



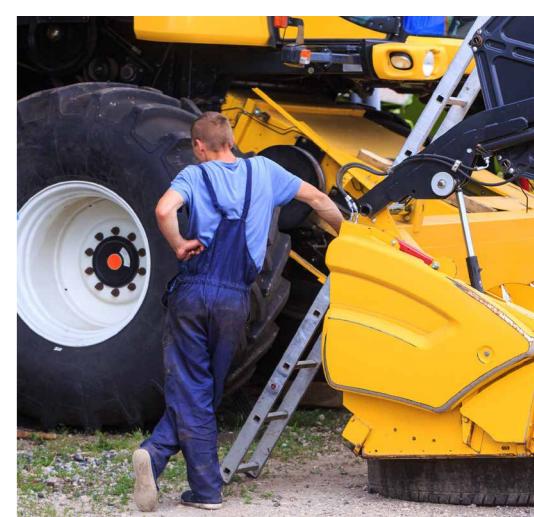
Trained personnel are required for proper maintenance. (Source: igus®)

Lubrication is cost-intensive. Qualified personnel are required for proper maintenance in accordance with regulations. In addition to the pure costs of lubrication itself, as well as the expenditure for the structural measures that enable and ensure lubrication, the personnel costs must also be counted.

During the time in which the lubrication and maintenance work is carried out, the devices are not available, which also incurs additional costs.

In order to counter both the increasing shortage of skilled labour and the increased demands on the productivity and profitability of machines, manufacturers are trying to reduce maintenance costs.

According to industry surveys, 35-50% of all bearing damage occur due to improper lubrication. This damage is often reported to the manufacturer in the form of complaints. While users are faced with unplanned machine downtimes, equipment manufacturers are confronted with **complaints that are difficult to resolve and often not only cause financial costs, but can also damage their image**. More and more manufacturers are therefore endeavouring to reduce maintenance costs in order to offer a better user experience and avoid complaints.



Downtimes cause high costs for users and manufacturers. (Source: igus®)

Lubrication-free plain bearings as an alternative?



(Source: igus®)

Lubrication-free plain bearings as an alternative?

How do lubrication-free plain bearings work?

In **solid plastic plain bearings**, the homogeneous, continuous structure ensures almost constant wear rates and coefficient of friction over the entire product life cycle. Solid lubricants and reinforcing materials are uniformly distributed in the plain bearing over the entire cross section. No additional lubricant is necessary. Among the solid plastic bearings are iglidur® plain bearings.



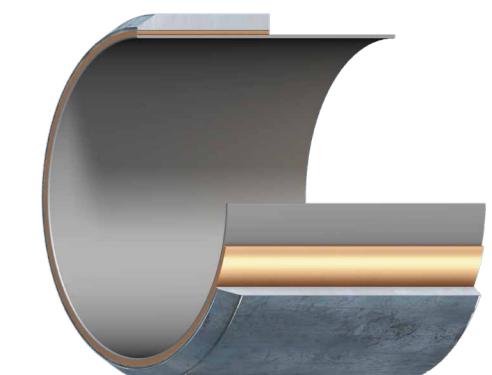
Plastic bearings with embedded solid lubricants (Source: igus®)

Where the specifications of solid plastic plain bearings reach their limits due to extremely high mechanical loads, wound **fibre composite bearings** display their strengths. The specially interwoven filament used ensures maximum resistance. At the same time, the incorporated solid lubricants mean that no additional lubricants are required. Various types of fibres are used, which are permeated with synthetic resins and cured under high pressure. This manufacturing process allows a wide range of material combinations to be used. Fibre composite plain bearings include igutex® plain bearings.



Fibre composite plain bearing made from wound filament (Source: igus®)

Rolled metal bearings slide on a thin layer, often made of PTFE or other plastics with excellent sliding properties, but which are relatively soft. In order to protect this plastic layer from mechanical stress and to achieve a more precise fit, this gliding layer is encased in a metallic base body. This is rolled onto metal sheets in a technically sophisticated process, which are then rolled into shape.



Rolled metal plain bearing with gliding layer (Source: igus®)

Lubrication-free plain bearings as an alternative?

Operating conditions of lubrication-free plain bearings



Damage due to permanent overload
(Source: igus®)

White papers and factsheets on the topic:



igus.eu/knowledge

Those who know plastic, will take steel. This old design maxim has long been considered outdated in most areas. Technical plastics have become an indispensable part of everyday life.

But the reputation is not without basis for applications with extreme loads. For bearing points that have to withstand moving loads in excess of 100MPa, there are few solutions other than solid steel or bronze bearings. The loads that affect the materials are too great - the compressive strength and hardness of plastic compounds are too low. Although there are high fibre-reinforced thermoplastics whose compressive strength exceeds 100 or even 150MPa, it often turns out in practice that compressive strength alone does not adequately describe their suitability for heavy-duty applications.

In practice, alternating or unevenly distributed loads occur, affecting the material matrix in different ways. For example, forces can act in several directions at the same time or cause fatigue and stresses in the material when they frequently change intensity and direction. It is not just a matter of simple material compressive strength. Shear strength, toughness and creep resistance also play a role in withstanding the different loads.

The analysis of damage patterns from real applications with signs of fatigue, literally shattered surfaces and general deformation shows that even metal bearings advertised as highly pressure-resistant often reach their limits. Then there are the design and application requirements that these bushings make necessary. Lubrication must be maintained continuously to protect against external influences such as dirt and moisture and to reduce friction; this is a major cost item and also often pollutes the environment.

The material developers at igus® have been working for decades to push the boundaries of plastics technology with regard to the requirements of high-load applications. This is achieved on the one hand by refining material formulations and the flexibility of processing methods in injection moulding, and on the other hand by using other technologies such as fibre composite technology. With the experience gained from over 40 years of plain bearing development, new possibilities and alternatives to metallic plain bearings and conventional fibre composite materials can be created.



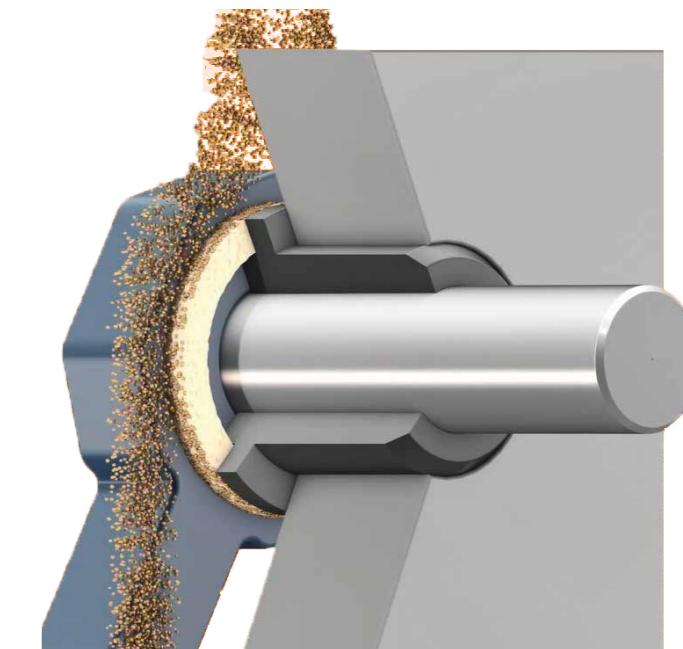
(Source: igus®)

You should bear this in mind before switching to lubrication-free bearing systems:

Due to the many reasons for the use of lubrication in bearing positions, it is necessary to check these reasons in the respective application before switching to lubrication-free plain bearings. What exactly are the operating conditions? If corrosion protection is still important because, for example, the bearing bolt or the mount are susceptible to corrosion, corrosion protection must be ensured by other means - e.g. by anti-corrosion coating - e.g. by protective wax applied during assembly. The ingress of dirt can also be problematic if protection against dirt cannot be guaranteed by saving on lubrication. Felt seals can help here.



Anti-corrosion wax (Source: igus®)



Felt seal against dirt ingress (Source: igus®)

What is iglidur®?

iglidur® are materials developed by igus® from high-performance polymers that are characterised by their exceptional specifications: their special composition makes them extremely wear-resistant, resilient and self-lubricating. Their service life can be precisely determined. In addition, every iglidur® material has individual specifications and strengths that characterise its suitability for special applications.

All iglidur® materials consist of three components: base polymers, fibres and fillers, solid lubricants. As it is not possible for one universal material to fulfil all tasks equally well, there are different iglidur® materials. Each has a different proportion of the three components and a different application area.

How does the self-lubrication effect work?

The solid lubricants are embedded in millions of tiny chambers of the material. From these chambers, the material releases tiny amounts of solid lubricants during movement. This is adequate to sufficiently lubricate the immediate surrounding area. These help reduce the iglidur® material's coefficient of friction. They are not indispensable for the bearing's function, but have a supporting effect. Since they are embedded in the tiny chambers, they cannot be forced out.

Self-lubrication reduces iglidur® materials maintenance to a minimum. No regular relubrication is necessary, and no dirt or dust can settle in the bearing.



Base polymers

The base polymers are decisive for the iglidur® materials' wear resistance. They ensure that the solid lubricants are not subjected to excessive surface pressure.

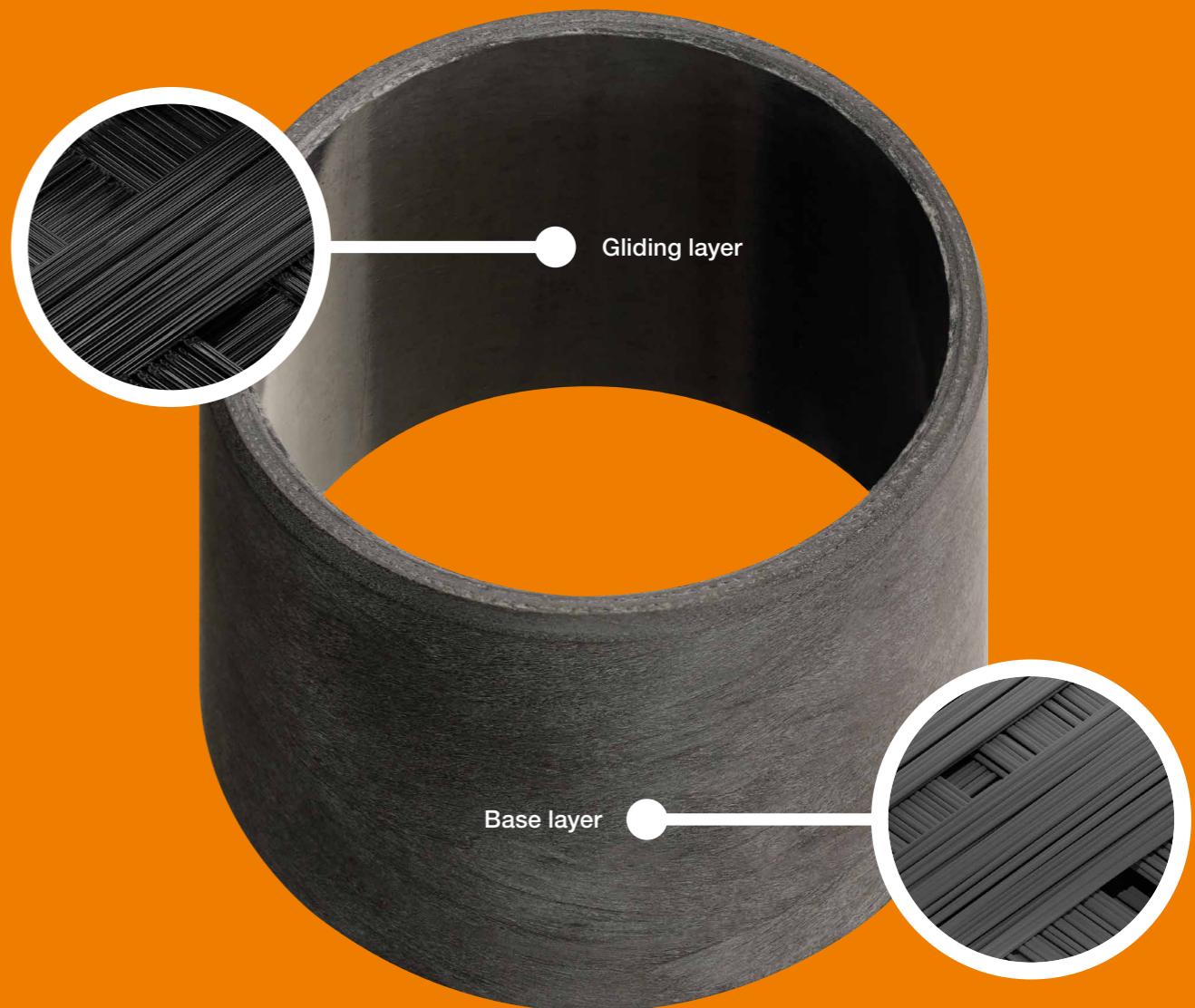
Fibres and fillers

These components strengthen the materials so that they withstand high forces or edge loads and can be used continuously.

Solid lubricants

They lubricate components made of iglidur® materials independently, preventing friction. They are distributed throughout the material in the form of microscopic particles.

What is igutex®?



igutex® plain bearings consist of fibre composite materials, which is the name of a fabric made of high-strength fibre filaments connected by means of a matrix - usually synthetic resin. The processing or weaving methods depend on the area of application and the shape to be produced.

The use of high-tensile fibres in combination with special resins enables the production of particularly robust plain bearings, which are characterised above all by their high compressive strength and rigidity. This technology can be used to create both bearings made from wound tubes and plates.

Gliding layer

The sliding layer also consists of a filament fabric, but it uses a tribologically optimised fibre strand with a tailored matrix.

Base layer

The outer layer of igutex® plain bearings is made from very durable filament wound material. This hard shell protects the inner layer, which has been optimised for particularly low friction.

How do we support you



Practical examples:

Lemken - 22 lubrication points saved per cultivator

"The working time alone which users save due to the maintenance-free plain bearings, is a very strong argument in favour of plastic bearings for us today. We will continue to rely on plain bearings from igus® in the future. Because, what is proven will be retained by us, that's for sure." Lars Heier, Head of Marketing Lemken

Lemken GmbH & Co. KG is a family-run company that specialises in the production of agricultural machinery for tillage, sowing and plant protection. One of the manufacturer's product areas is stubble cultivation equipment, so-called cultivators and short disc harrows. Today, these are mainly used for conservation tillage and stubble cultivation. With the "Karat 9", Lemken offers an intensive cultivator that penetrates between five and 30 centimetres deep into the soil and thus optimally incorporates organic matter. During use, it is possible that large stones can be in the path of the tractor and its tillage equipment. For this reason, the Karat 9 has overload elements, whereby the tines, which work on the ground in normal operation, automatically dodge backwards and upwards and then automatically return to the working position. The metal bearing solution used to move the tines had to be lubricated for up to an hour a day, depending on the size of the cultivator, so that the bearings could do their job properly. If the numerous lubrication points, depending on the working width, were not sufficiently lubricated, the resulting lack of lubrication led to considerable problems with corrosion and greatly increased wear of the bearing point, which ultimately resulted in damage to shafts and housing holes.

Thanks to the use of lubrication-free igus® plastic plain bearings, the overload element is now maintenance-free. With the iglidur® high-performance materials, subsequent lubrication can be completely dispensed with, as the bearings contain self-lubricating solid lubricants. This saves valuable time for the farmer. Unlike metal bearings, where the lubricants cannot be distributed evenly and only the same points on the bearing are always subjected to stress, plastic plain bearings can utilise their advantages here. The pivoting movements cannot affect them as much and no lubricant can be displaced. Another advantage is the dry operation of the bearings, as no dirt can adhere to them. Together with the high strength of the plain bearings, which can easily withstand the high forces in the overload element of the cultivator. This increases reliability significantly. Lemken also saved costs thanks to the more favourable procurement costs and the increased service life of the plain bearings.

€88
14.7hrs
6.35kg

Annual savings in costs
(lubrication and personnel) Time
and CO₂ equivalent
per cultivator



(Source: igus®)

Practical examples:

Bottle filling - 600 lubrication points saved



(Source: igus®)

€2,815
1,560hrs
180kg

Annual savings in costs and time for
lubricant and personnel per line

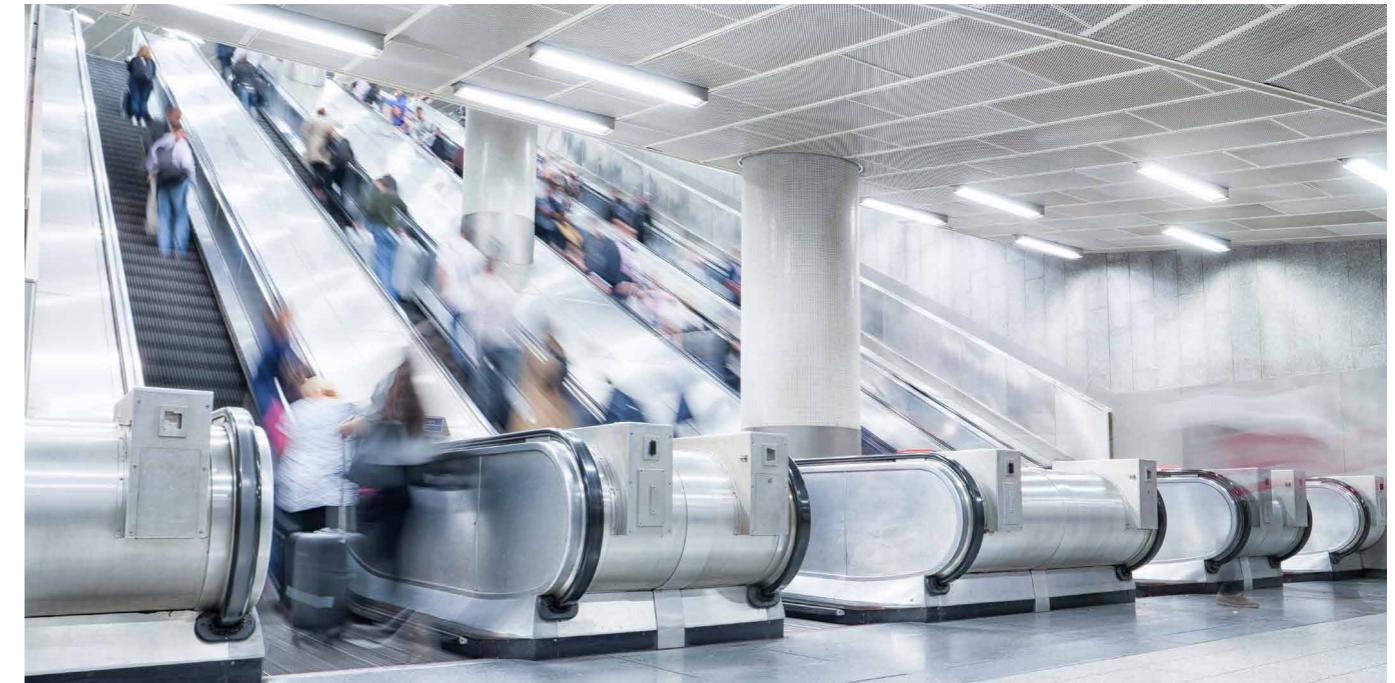
Modern bottling plants for major beverage brands fill over 70,000 bottles with different beverages in a single hour. The highly automated processes necessary for this require a large number of moving parts in highly complex systems.

Lubricated bearing points, distributed over the many metres of equipment, cause expensive downtimes due to maintenance work. At the same time, the sheer mass of bearing points requires large quantities of lubricant, which also causes high costs due to special requirements for suitability in contact with food.

By using lubrication-free plain bearings, a well-known brewery with locations all over the world was able to save on grease and maintenance costs.

Practical examples:

Chains for escalators - 375 bearings per staircase



(Source: igus®)

€90,000
48,000hrs
6,490kg

The individual steps of escalators are attached to drive chains whose chain links remain movable with plain bearings. These are permanently exposed to loads during operation. Downtime is not only annoying for users, but also expensive.

A major manufacturer of drive and roller chains relies on lubrication-free plain bearings in chain links. Previously, the bearings had to be permanently lubricated. This required regular maintenance work, during which the escalators had to be stopped, partially dismantled and finally repaired by appropriately secured and trained personnel.

The use of lubrication-free plain bearings has not only reduced maintenance intervals, but also significantly reduced grease and oil consumption.

Annual savings in costs
(lubrication and personnel),
time and CO₂ equivalent for
escalator drive chains manufactured
in Germany

— Heineken —
Brasil

KettenWulf


Practical examples:

Agricultural engineering - maintenance-free couplings



(Source: igus®)

€87.36
13hrs
1kg

Annual savings in costs
and time for lubricant and personnel
per coupling



No more lubrication: for balers, loader wagons, manure spreaders, tippers and field sprayers, Rockinger Agriculture GmbH has developed ball couplings called KS80 with a high-performance plastic of the iglidur® series, which igus® has developed specifically for the company. The coupling consists of a coupling ball and a coupling claw, which are installed in the height adjustment mechanism.

Trailer couplings actually need to be lubricated every time they are used. This leads to high costs and time expenditure. "I know farms where someone has to service and lubricate every single bearing point on all the machines once a week," reports Toni Milhahn, who works in product management and as a sales engineer at Rockinger Agriculture GmbH. It must also be ensured that the correct amount of grease is applied to the coupling. "Excessive quantities can lead to some of the lubricant getting into the soil or onto the crop. Too little of this leads to coupling damage," explains Marcus Reinländer, Head of Plant Production at Agrargenossenschaft e. G. Kirchheiligen.

In a fatigue test, the inserts survived two million load changes – with a support load of 4.5 tons. Rockinger Agriculture GmbH calculates that if a third of the tractors in Germany were equipped with a KS80 and wear insert, around 8,300 couplings would require no lubrication. Eight tons of grease per year could be saved.

Practical examples:

Excavators - One working week per year for lubrication



(Source: igus®)

Compact and mini excavators from Huppenkothen can be found on many construction sites. The connection points between the stick and excavator bucket are exposed to high forces and harsh environmental influences on a daily basis. Therefore, the bearing points had to be lubricated daily. With iglidur® plain bearings, this is now a thing of the past.

As the market leader for construction machinery in the mini and compact class, Huppenkothen relies on lubrication-free plain bearings, e.g. in the connection between the arm and bucket of small excavators. Previously, steel bearings were used here, which had to be lubricated daily to ensure smooth and low-wear operation. By eliminating the need for lubrication, the productive time of the machines can be increased and grease consumption reduced.

€88
36.7hrs
4.4kg

Annual savings in costs
(lubrication and personnel),
time for lubricating four bearing
points of a compact excavator

We support you on site



Facts

The story behind igus®

"Give me your most difficult part and I will give you a solution", said Günter Blase. He had to take a risk in order to win over Pierburg, his very first customer. There were two children at home who needed to be cared for. Money was in short supply. He had just set up igus® with his wife (tax consultant) and the first injection moulding machine still had to be bought. The order from Pierburg was urgently needed.

And Günter Blase received that enquiry from Pierburg. Their complicated problem part was a valve cone for a carburettor. In 1964, no-one would have come

up with the idea of using plastic to make this small metal component and, what's more, to do so with an injection-moulding machine. The manufacturing process was simply too complicated. For Günter Blase, this was no reason to lose heart. He went into his double garage and experimented until the first perfect plastic valve plug emerged from the injection-moulding machine.

The double garage in Cologne-Mülheim soon became too small. As did the new location in Bergisch Gladbach. Today, the headquarters of igus® SE & Co. KG is still located in Cologne - in the district of Lind

- but houses over 800 injection moulding machines on an area of over 200,000m². In addition, igus® has over 30 distribution centres worldwide.

The business areas have expanded, from plastic energy chains and plain bearings to other components for moving applications and complex automation solutions. The core philosophy is still the same as in 1964, improve anything that moves.

"Give us your most difficult part and we give you a solution."



4,600 employees worldwide



€1.115 billion turnover



31 locations and distributors in over 80 countries



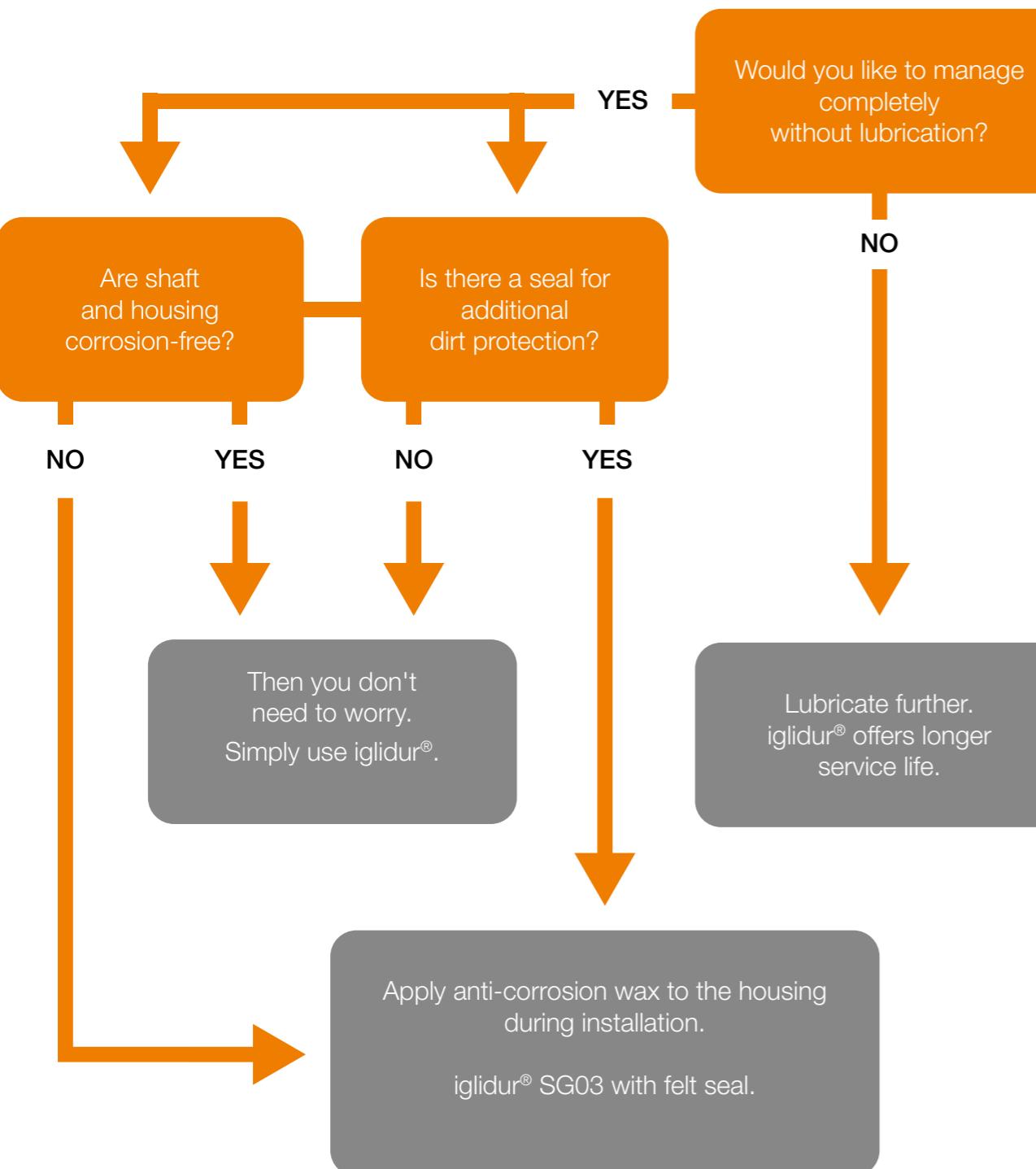
188,000 customers



243,000 parts from stock



800 injection-moulding machines



How do I determine the correct iglidur® or igutex® material for my application?

With the iglidur® expert system, you can determine the material with the best service life in your application in no time at all. Alternatively, our network of experienced application consultants can assist you with the design.

Which shaft material is recommended for iglidur® and igutex® plain bearings?

iglidur® plain bearings exhibit good wear specifications on most shaft materials. The individual performance depends strongly on the respective iglidur® material. In general, surface-hardened shafts deliver better results. For igutex® plain bearings, we recommend the use of gas-nitrided steel shafts.

Which corrosion protection do you recommend if additional protection is required?

We recommend Tectyl™ 120, 210-R, 506 or 300G Clear E as anti-corrosion wax. In laboratory tests, the press-fit and press-out force of the bearings could also be increased by approx. 150% with Tectyl™ 300G Clear E.

How are iglidur® and igutex® plain bearings tolerated?

The plain bearings comply with the current DIN and ISO standards for plain bearings. They are designed for installation in H7-tolerated housing bores and for operation with h9-tolerated shafts. In this installation scenario, the standard tolerance of the inner diameter is E10, F10 or D11, depending on the material.

What loads can iglidur® and igutex® plain bearings carry?

iglidur® plain bearings can absorb up to 80MPa surface pressure depending on the material and movement profile. Plain bearings made from igutex® fibre composites even up to 180MPa.

Can iglidur® and igutex® plain bearings be abraded on the inner diameter?

In principle, reworking is possible without any problems. However, this can affect the coefficient of friction and the running behaviour.

Contact

If you require any further information, please do not hesitate to contact us.

Online contact:

Lars Butenschön

Head of Business Unit iglidur® Plain Bearings

Phone: +49 2203 9649 145

lbutenschoen@igus.net

www.igus.eu

These terms „Apro“, „AutoChain“, „CFRIP“, „chainflex“, „chainge“, „chains for cranes“, „ConProtect“, „cradle-chain“, „CTD“, „drygear“, „drylin“, „dryspin“, „dry-tech“, „dryway“, „easy chain“, „e-chain“, „e-chain systems“, „e-ketten“, „e-kettensysteme“, „e-loop“, „energy chain“, „energy chain systems“, „enjoyneering“, „e-skin“, „e-spool“, „fixflex“, „flizz“, „i.Cee“, „ibow“, „igear“, „iglidur“, „igubal“, „igumid“, „igus“, „igus improves what moves“, „igus:bike“, „igusGO“, „igutex“, „iguverse“, „iguversum“, „kineKIT“, „kopla“, „manus“, „motion plastics“, „motion polymers“, „motionaly“, „plastics for longer life“, „polymore“, „print2mold“, „Rawbot“, „RBTX“, „RCYL“, „readycable“, „readychain“, „ReBeL“, „ReCycyle“, „reguse“, „roboLink“, „Rohbot“, „savfe“, „speedigus“, „superwise“, „take the dryway“, „tribofilament“, „tribotape“, „triflex“, „twisterchain“, „when it moves, igus improves“, „xirodur“, „xiros“ und „yes“ are legally protected trademarks of igus® SE & Co. KG / Cologne in the Federal Republic of Germany and possibly in some foreign countries. This is a non-exhaustive list of trademarks (e.g., pending trademark applications or registered trademarks) of igus® SE & Co. KG or affiliated companies of igus® in Germany, the European Union, the USA and/or other countries or jurisdictions.

igus® SE & Co. KG hereby states that it does not distribute any products from the companies Allen Bradley, B&R, Baumüller, Beckhoff, Lahr, Control Techniques, Danaher Motion, ELAU, FAGOR, FANUC, Festo, Heidenhain, Jetter, Lenze, LinMot, LTi DRiVES, Mitsubishi, NUM, Parker, Bosch Rexroth, SEW, Siemens, Stöber, and all other drive manufacturers mentioned on this website. The products offered by igus® are those of igus® SE & Co. KG.