

Rolling, Sliding, Lubricating

An overview of bearing technology in the agricultural sector

Jan Hinrich Löken (state-certified engineer)
J.Loeken@industriehof.com



Discs, trailers, packer rings, rotors and augers: all of these parts have one thing in common, they need bearing technology to function correctly. No matter how different or complex they may be, they simply cannot function without bearings. Whether large and robust, or small and delicate, bearings come in all shapes and sizes.

1. Types of bearings

There are two main types of bearing: plain bearings and roller bearings.

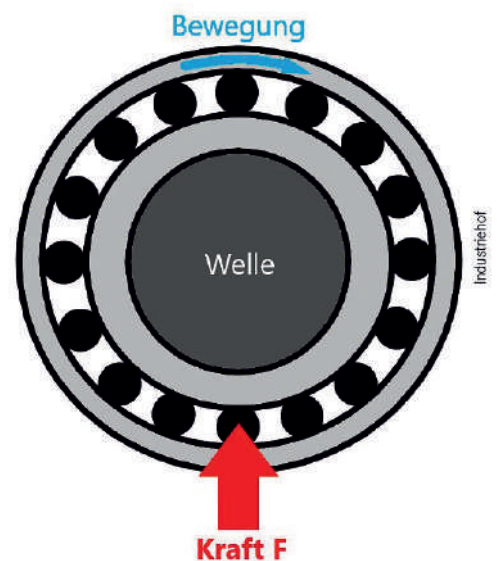
1.1 Plain bearings

A plain bearing usually consists of a housing and a sliding bushing which is located inside the housing. The housing can be made of one or two parts. With two-part housings, the bushing is usually held in place with two half-shells. With one-part housings, the bushing is often pressed in to fix it into position within the bearing housing. The bushing guides the shaft and acts as a wearing part at the same time. This means that only the bushing needs to be replaced and not the entire bearing if the part starts to wear. Sliding bushings are usually made from a soft material such as brass or bronze. These metals are also sometimes used as sintering materials. Here, the material has the porous nature of a sponge. This means that it soaks up the lubricant and then gradually releases it. Thanks to this, the service life of a plain bearing bushing can be significantly extended.

Plain bearings can be used for a wide variety of applications. They run smoothly and guide shafts very precisely. In addition, they are nowhere near as complicated to install and remove as roller bearings. However, plain bearings are more suited for use at constant and lower speeds. There are special types of plain bearings that have been designed for use at higher speeds and with intermittent loads: hydrodynamic and hydrostatic bearings. With these bearings, the shaft moves inside a space filled with oil. These types of bearings are usually used in industrial machinery and systems. They are not suited for use in the agricultural sector. Nevertheless, there are a few applications where plain bearings are still used. As the installation of plain bearings simply consists of sliding the shaft into the bushing or sliding the bushing into the housing, I will not talk about this in more detail.

1.2 Roller bearings

Roller bearings are usually built according to a certain principle. The bearing consists of an outer and an inner ring. The rolling elements, which is where the roller bearing gets its name from, usually roll around between the rings a so-called ball cage. There are some exceptions to this, such as with needle roller bearings where the shaft also acts as the inner ring. The exact name of the roller bearing depends on the form of the rolling elements. There are ball bearings, cylindrical ball bearings, tapered roller bearings, barrel roller bearings and needle roller bearings. There are also further subdivisions within these groups. I will talk about some of these in more detail later. Many of the types of roller bearings used in the agricultural sector today are “maintenance free”. This means that the bearings do not need to be relubricated during their whole service life. Some bearings need to be lubricated from time to time in order to keep them clean and keep them moving. Not doing this regularly can significantly reduce the service life of the bearing. Bearings that need to be relubricated have a grease nipple somewhere on the housing through which the lubricating grease can be pressed in with a press. To be on the safe side, you should do this every day before starting your work. If the manufacturer has not provided any information about the quantity of lubricating grease needed (usually applied in “strokes” with the grease gun), the lubricating grease should be pressed down until it comes out of one of the sealing gaps. This pushes the older lubricant, and with it any contaminants or impurities, out of the bearing.

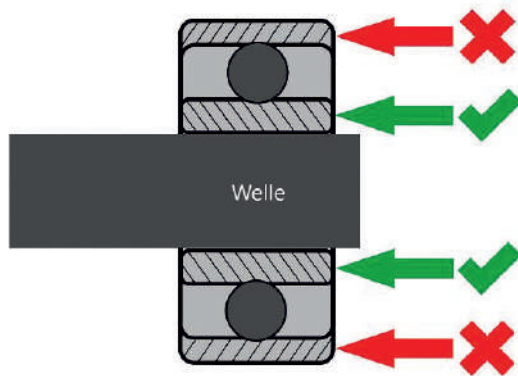


Side view of a ball bearing. The inner ring bears the point load and the outer ring the circumferential load.

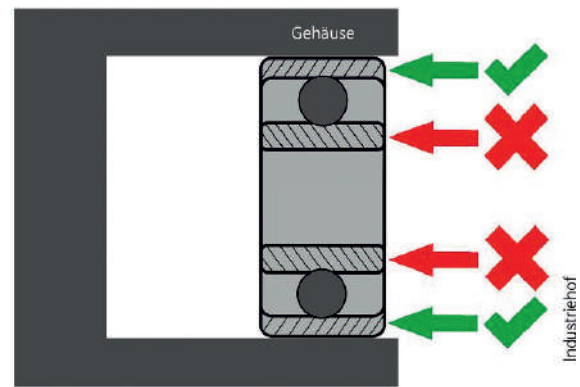
2. Bearing installation

You do not usually require a lot of technical knowledge or skill to install plain bearings as the components often only need to be inserted into each other. Sometimes you may need a hammer to help. The installation of roller bearings, however, should not be done by an amateur. Unfortunately, you cannot always find a qualified expert to help you and as such sometimes do have to do it yourself. Some of you may be reading this, smiling to yourself and saying that you do not need an expert to help you, but installing a roller bearing is not as simple as it may seem at first glance. While the quality and design of the bearing is incredibly important when it comes to the bearing's performance and period of use, the right installation can also have a significant impact on its service life. There are certain points that must be kept in mind when installing roller bearings. The most important point is that fact that the roller bearing's rings should either be tight or loose depending on the load. This information is often not known, but is frequently also simply ignored. If the ring (either the inner or the outer ring) bears a point load, where the force always acts on just one point on the ring, the ring can sit loosely. This is often referred to as the ring having a “clearance fit”. If the ring bears a circumferential load, where the force gradually acts on all parts of the ring due to the rotation, the ring must sit tightly. This is referred to as a “press” or “interference fit”. This should stop the ring from “wandering” up and down the shaft. In a worst case scenario, this movement can cause wear on the shaft. In most cases the rule of thumb is: the ring that moves during the work bears the circumferential load and must have a tight fit.





Mount the bearing on a shaft. The force should only be acting on the inner ring!



Press the bearing into a housing. The force should only be acting on the outer ring!

A certain amount of know-how is needed for the actual assembly. The force required to drive a ring with an interference fit onto a shaft or into a housing, for example, should only act on the ring being moved. Often, the entire bearing, so both the inner and outer ring, is subjected to pressure at the same time during this process. When this happens, the rolling elements are pressed into the running flanks of the rings, damaging them in the process. This causes the running surface to become uneven, resulting in resistance and vibrations during the rolling movement. As a result, the bearing can no longer run smoothly and its performance is drastically affected. In the worst case, the bearing may need to be changed after being used for only a short period of time. The vibrations in the bearing also always generate heat. A damaged roller bearing can become very hot because of the increased friction coefficient. This heating also causes an uneven larger expansion of different components which can result in damage to the rings and, under some circumstances, to the bearing housing too. Theoretically, the same principle applies when removing a roller bearing but only if the bearing is going to be used further. This may be the case if the bearing hinders the removal of another element and as such must be removed before the end of its service life. As a general rule, roller bearings should not be reused after having been removed. Professionals often use a so-called inductive heating device when mounting a bearing on a shaft. The bearing is heated in a targeted way by means of induction so that it only expands to a certain extent. When it has widened, the bearing with an interference fit can be pushed onto the shaft without a significant amount of effort. It is important that this is done very quickly after the heating, as the bearing quickly contracts again once it comes into contact with the cold air and shaft. With very tight fits, it may be necessary to cool the shaft even further so that it contracts a little. This installation technique can actually be done with common household objects if the size of the components allows for this. For example, you can easily heat the bearing in an oven. But you must make sure that the bearing does not heat up over 110°C, otherwise it may be damaged! The shaft can be cooled to below 0° C in a fridge or freezer. However, with difficult fits you should work with a specialist workshop, or at least trained specialists.



3. Types of bearings used in the agricultural sector

Now that we've spoken about the most important aspects of installing bearings, we are going to take a closer look at the different types of bearings used in the agricultural sector. Roller bearings are used in most applications today. Nevertheless, plain bearings are still used in some areas. You often find exotic-looking bearings in older packer rings and trailers with sliding bushings made from hardwood or even plastic, for example. Plain bearings are still often used in agitators and mixers as all the advantages of this technology come into play here.

3.1 Agri-Hubs

As discs are being increasingly installed with individual suspension, Agri Hubs have become an essential component used in modern agriculture. They consist of a housing which merges into a flange with drilled holes on one side and a shaft extension protruding from the other side. The shaft usually has a special attachment point with a width flat. This should stop the shaft from spinning in the suspension mounting. The shaft has a thread behind the attachment so that it can be fixed into place behind the mounting. Either angular contact ball bearings or tapered roller bearings are used in the Agri Hubs. Due to their design, they can absorb forces in both an axial and a coaxial direction. The Agri Hubs are robust and mostly maintenance free. They are more or less well sealed depending on the manufacturer. When buying, the user should think about the environment in which the Agri Hub will be used. If it is going to be used with liquid manure, an Agri Hub with a sealing designed for use with these types of mediums should be selected. The manufacturer's standard sealings are often not suitable for use with aggressive mediums and as such, the bearing may stop working correctly after a shorter period of time. But this technology is not only used in disc harrows. Cutting discs, coulter discs, cover discs and other discs positioned in the same way (at an angle to the direction of travel) can use these types of bearings. As there is a wide selection of discs available on the market, all with different bolt circles and drilled holes, it can sometimes be tricky to find the right Agri Hub for your machine. There are spare part providers which offer customers a drill service for Agri Hubs which allows them to adapt the Agri Hubs to meet their requirements and equip them with the correct bolt circle. This method is often the simplest and most cost-effective as fit accuracy is guaranteed and the bearings used are usually very high-quality.



Agri Hubs without drilled holes for customer configuration



3.2 Flange bearing/Tensioning bearing

Flange or tensioning bearings can often be found in the suspension of packer rollers on cultivators or ploughs. The bearing housing is usually square or oval-shaped and has 2 or 4 drilled holes, depending on the design, drilled in the axial direction. The outer ring of the roller bearing is usually convex. This prevents slipping. As a general rule, the roller bearing is tilted to the axis of rotation by 90° and is pushed into the housing. Once inside the concave housing wall, it is tilted back in the axial direction and can then no longer slip out of place. The whole installation process is really simple. In this case, the roller bearings are usually sealed on both sides to prevent any dirt from getting into the space between the rolling elements. The most popular form here is the deep groove ball bearing.



Tensioning/Flange bearing with four drilled holes and a sealed deep groove ball bearing.

3.3 Pillow block bearing

Pillow block bearings are constructed in a similar way to flange bearings. The big difference is the configuration of the bearing. There are only two drilled holes and the bearing is coaxially aligned with the screw connection. This bearing technology is used in trailers and also in potato harvesters to accommodate the belt drives and guider rollers. Here - like with flange bearings - care must be taken to ensure that the inner ring always has an interference fit, as it is the rotating element.



Pillow block bearing with a sealed deep groove ball bearing. The tight fit of the shaft is ensured by grub screws.



3.4 The 4-sided shaft bearing

This type of bearing consists of a housing that is open on both sides in which two tapered rollers bearings sit opposite each other on a hollow shaft. There is a shoulder in the middle of the housing which determines the position of the bearings in the housing. The sides of the housing are closed with covers from which the hollow shaft protrudes. During the assembly, flanges can be placed on both sides of the hollow shaft to act as the connection point for the work tools. These bearings are then clamped together with the work tools on a shaft with a square cross-section. The interesting thing here is that the shaft is only used to brace the parts. For this reason, many of these types of bearings used today have a round inner geometry instead of a square opening. Due to the increased use of compact disc harrows with individual suspension for discs, the 4-sided shaft bearing has been partly pushed out of the market. But they can still be found in use in some applications today. They are still used in rotary spade harrows and many wider trailers, and even in larger or heavier disc harrows.



4-sided shaft bearing without a special connection flange. Often used in rotary spade harrows and very short/small trailers.

4. A final few practical tips

One final thing to bear in mind is that paying a higher price for your bearings does not necessarily mean that you will get better quality products. Of course, there are very high-quality bearing assemblies from well-known manufacturers such as SKF, FAG, INA or Schäffer, but the bearing assembly does not always have to be an expensive “brand model” to fulfil its purpose. In the field of agricultural bearings, there are some serious manufacturers who have established themselves on the market, who are only active in this segment and who design their products specifically for this range of applications. Sometimes bearings from Eastern Europe are just as stable and robust as those from Northern European brands. After all, these bearings are used in harsh conditions in the vast collective farms of Belarus and Ukraine. The only drawback is not always being able to find parts to match the bearing thread. Luckily, the manufacturer almost always provides matching screws and nuts with the bearing so you do not usually run into any problems. Finally, a bit of advice based on my own personal experience: when you get a new machine, make sure to thoroughly lubricate it before using it for the first time as often manufacturers - usually to try and save money - do not fill the bearing housing with enough lubricating grease which means that it wears much more and much quicker if you do not relubricate it before use.

