



Helical Planetary Gearboxes: Understanding The Tradeoffs

The choice between helical and spur gears in planetary gearboxes may seem straightforward. Go with helical gears if you want the gearbox to run as smoothly and quietly as possible. Choose spur gears when you need to maximize the gearbox's torque density or working life under higher loads.

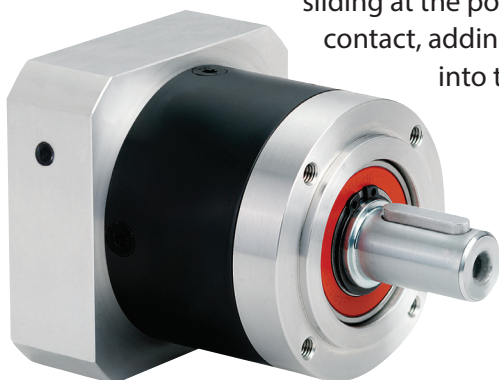
These rules of thumb capture most of what you need to know when specifying traditional fixed axis gearboxes. Just size the gearbox properly, and the choice between helical and spur gears will often be obvious for a given set of application requirements. With planetary gearboxes, however, the choice between helical and spur requires some additional thought.

Here's what you need to know to make the right choice:

Helical gears create axial forces.

As you might expect from their different mesh geometries, spur and helical have very different loading characteristics. With their zero helix angle, spur gears lack an axial load component. And they suffer from very little sliding tooth contact.

Helical gears, by contrast, generate significant axial forces in the gear mesh. They also exhibit more sliding at the point of tooth contact, adding friction forces into the mix.



Helix angles in gearboxes usually fall in a range between 15 and 30 degrees. As that angle increases, both the axial forces and sliding contact increase.

Helical gears place greater demand on bearings.

Since they don't need to withstand any axial forces, spur gear bearings play just a supporting role in the functioning of the gearbox. The bearings simply need to support the rotating gear shafts, but they do not play an active role in torque transfer.

The presence of axial forces makes things very different for the bearings that support helical gears. But it's important here to make a distinction between fixed-axis and planetary gearboxes. In fixed-axis gearboxes, the additional axial forces amount to little more than an inconvenience. Gearbox designers will often upsize the bearings to accommodate the additional forces.

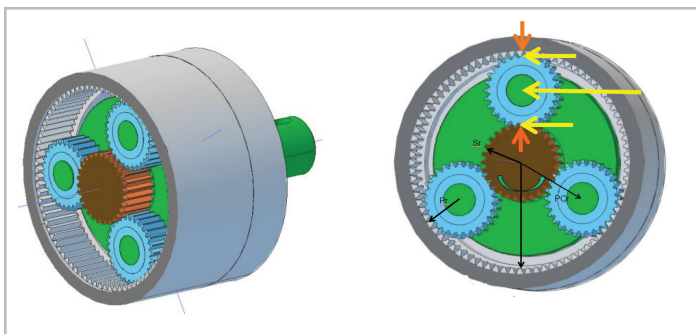
Gearing Arrangements



Fixed Axis



Planetary



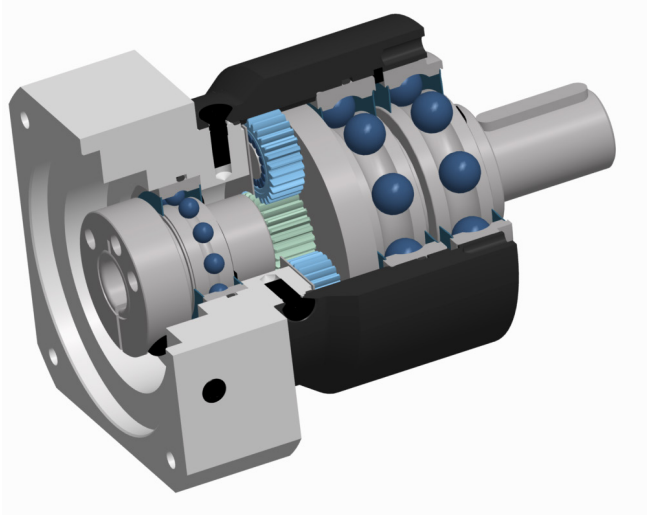
Or in extreme cases, they may select angular contact or tapered roller bearings, both of which are designed to withstand axial loads.

In planetary gearboxes, however, it's much more difficult to design around these axial forces for two related reasons. First, there is typically very little room in a planetary gearbox to incorporate the kind of bulky bearings that can tolerate high axial forces.

Second, the planet gear bearings need to play an active role in torque transfer. Planetary systems split the torque input from the sun gear amongst the planet gears, which in turn transfer torque to a planet carrier connected to the gearbox output. The bearings that support the planets on the carrier have to bear the full brunt of that torque transfer.

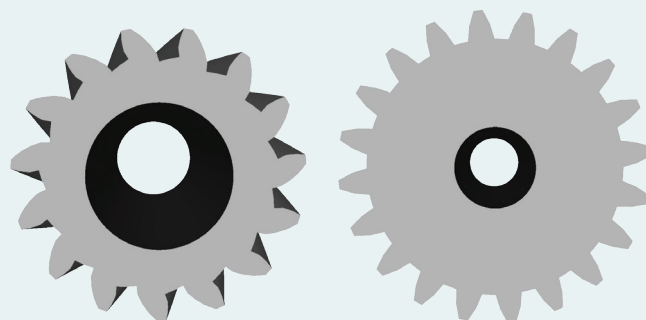
And here's the difficulty.

The limited space within planetary gearboxes means that the bearings used for the planet gears must be chosen more for their size than their tolerance for high axial loads. In general, compact needle roller bearings are the most common choice in these settings.



A Helical Gear Refresher

The main reason for using helical gears is the increased number of teeth in contact at any given time, which is a fundamental requirement for smooth torque transmission. With their increased contact ratio compared to spur gears, helical gears have a lower fluctuation of the gear mesh stiffness.

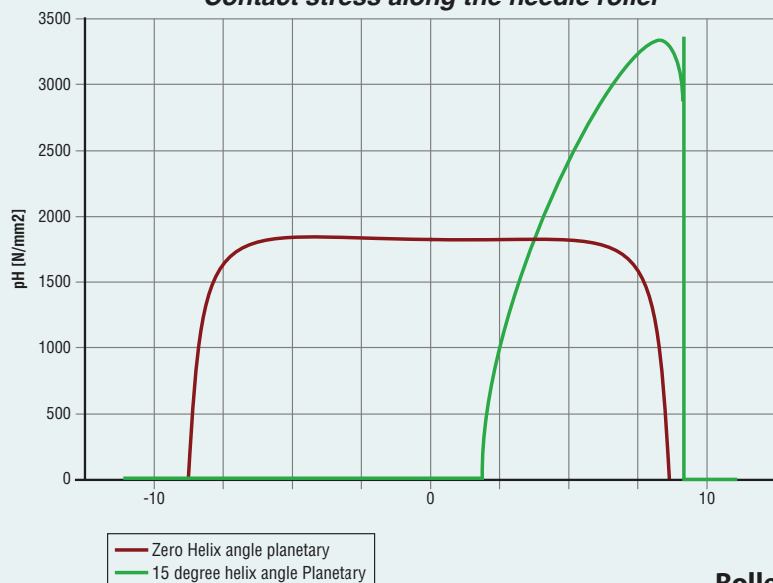


Needle roller bearings do a good job with radial loads that are evenly distributed along the length of the needle. But they don't handle axial loads well.

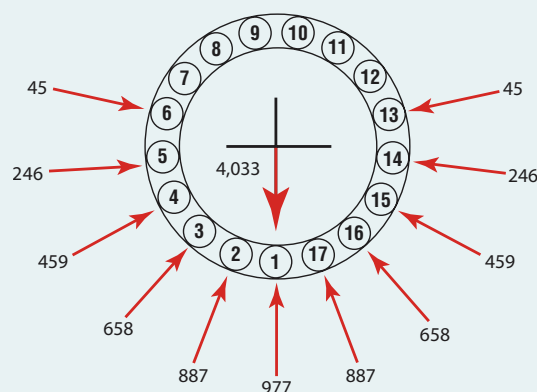
In planetary systems, the direction of the axial force in the sun-planet mesh opposes that of the force in the planet-ring gear mesh. So the planet sees significant tilting moment defined by the axial force times gear pitch diameter. This tilting moment creates an uneven load distribution along the needle rollers, drastically lowering the bearing's load carrying capability and lifecycle.

Gearbox selection advice.

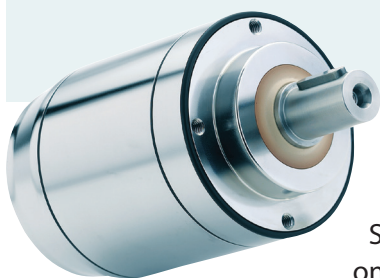
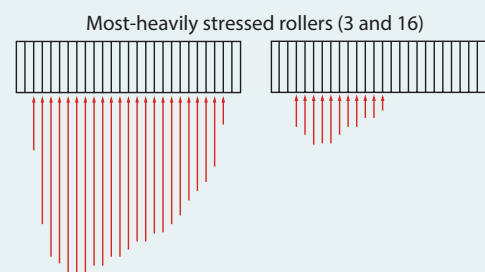
Planetary gearboxes based on spur and helical gears both have their place, which is why we're one of the few manufacturers to offer both kinds. Just be aware that the smooth, quiet nature of helical planetary systems come at the expense of load capacity and torque. We've been able to optimize the design of our needle bearings to some degree, which can help offset some but not all of this load and life penalty.

Contact stress along the needle roller**Roller Position Loads**

4,033-lb LOAD, 860-lb-in. MOMENT



Loads on the rollers will vary, depending on their position around the shaft. Moment is about the Z-axis, and units are in inches and pounds.



So the best advice on gearbox selection is to favor helical planetary in noise-critical applications such as medical equipment, lab automation systems and printing machinery. When low noise is a primary concern, you can often upsize a helical gearbox to reach the desired and torque and lifecycle requirements.

But upsizing the gearbox drives cost. So if noise doesn't matter as much, you'll be better off with a spur gear planetary that will deliver higher load capacity and longer life in a smaller package.

For more information on Neugart gearboxes, visit www.neugartusa.com