

PSC Tech Topics

Coupling Design and Impact on Bearing And Seal Life



Why Choose PSC Disc Couplings?

- Longer equipment life with industry leading high torque density and low restoring forces
- Quick and easy installation with self piloting, fully assembled, and collapsible disc pack cartridges
- Better balance with precisely manufactured components and piloting features



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Function of a Coupling

Any coupling that connects rotating equipment generally serves two main purposes: transmitting torque and taking up misalignment. While in principle this can be fairly straightforward, there are many ways this has been accomplished. The primary design challenge has always been getting a coupling to transmit as much torque as possible, yet require as little force as necessary to be bent out of alignment.

Economics is generally the driving force behind a great percentage of products. A very torque-dense coupling can be economical to produce because of its smaller overall diameter. Having a lower torque-dense coupling that can be easily misaligned protects and extends the bearing and seal life of connected equipment.

Restoring Forces

The forces required to misalign a coupling are called coupling restoring forces. Restoring forces of a coupling can be an important consideration when developing a drive train system. High restoring forces can result in higher vibratory loads on bearings and seals, which can lead to premature bearing and seal failure.

Different styles of couplings have different restoring forces, but couplings of the same style generally have similar restoring forces. This characteristic is generally a function of the design of a specific coupling.

In order to arrive at a restoring force value (F_r), take the coupling angular spring rate and multiply it by the anticipated running misalignment.

$$F_r = K_{t_{ang}} \times \text{Deg}_{\text{misalignment}}$$

Where:

F_r = restoring moment (in-lbs)

$K_{t_{ang}}$ = angular spring rate (in-lbs/degrees)

$\text{Deg}_{\text{misalignment}}$ = coupling misalignment (degrees)

Coupling Comparison

Some low-cost couplings like jaw style or elastomer donut-type couplings can generate high restoring forces because they have high misalignment ratings. Even though the coupling can take the misalignment, bearings and seals could have significantly shortened life.

Gear couplings, on the other hand, have a varying level of restoring forces based on the amount of torque they are transmitting. This is because the gear teeth are transmitting torque through the same plane that needs to slip when being misaligned. The higher the transmitted torque, the higher the force required to misalign the coupling because the teeth do not want to slide due to friction. This can worsen significantly if lubrication is neglected. Gear couplings are very torque dense, which makes them economical, but they can have some of the highest restoring forces in the industry.

The following table shows some basic comparisons between different styles of coupling and their respective restoring forces. Selection of a style of coupling depends on the application requirements.



	Diaphragm	Disc	Gear	Elastomeric	Jaw-In-Shear	Jaw
Restoring Forces	Very Low	Low	Very High	Moderate	High	Very High
Torque & Misalignment	Independent	Independent	Dependent	Independent	Dependent	Dependent
Misalignment Capability	Low	Low	Moderate	High	Moderate	Moderate
Up Front Cost	Very High	High	Moderate	Moderate	Low	Very Low

The end user may not share the same motivation as the original equipment manufacturer (OEM). The OEM may be more concerned with price and delivery, while the end user may want higher levels of performance and longer life. No matter the selection criteria, whenever torque and misalignment occur in the same plane, they have a dependent relationship. This issue can generate high restoring forces.

Disc Coupling Design

When designing a coupling, a manufacturer takes into account many variables. In some cases, restoring forces are byproducts of the type of coupling being designed as well as other factors such as cost control, torsional stiffness requirements and torque-carrying performance.

This is no different when designing disc couplings. A disc coupling transmits torque through a stack of steel laminates. These laminates act as rigid discs in the torque transmission plane but flex like a deck of cards in the misalignment plane. The ideal disc coupling would be torsionally stiff and torque-dense in the torque plane, yet require a proportionally small force to bend it out of alignment in the misalignment plane.

Disc couplings are the preferred choice for any application that demands a long life and low-maintenance coupling. Here are some competing factors in designing a disc coupling and how manufacturers can address those challenges.

1. Total disc stack thickness

In order to make a disc coupling with a low restoring force, ideally the disc laminate stack should be very thin. However, in order to transmit torque and have a stable bolted joint, the disc laminate stack needs to be fairly thick. It is possible to get the best of both by imbedding threaded bushings into the disc pack and using ultra-high-strength stainless steel to help reduce thickness and increase strain properties. This means the manufacturer has tried to get the disc stack as thin as possible without compromising coupling torque or joint stability.

2. Disc material type

Most manufacturers are stuck using a disproportionately thicker disc pack in order to achieve proper bolted joint mechanics, and as a result they only need low-strength material to handle the torque. An alternative is a high-performance disc pack that uses ultra-high-strength stainless steel, which allows for a thinner over all laminate stack translating into lower restoring forces. This ultra-high-strength stainless steel also extends the life of the discs as they are repeatedly bent because of misalignment.

3. Disc laminate thickness

Using thinner discs allows them to flex out of alignment easier—lowering restoring forces. However, thinner discs require a manufacturer to use more of them to achieve the overall pack thickness required, and this means increased costs. Using the ultra-high-strength stainless steel can result in very thin discs in order to further reduce restoring forces.

When selecting a coupling for an application, end users should make sure they check out the restoring forces of the coupling. Their bearings and seals will appreciate it.