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Rotational Torque and Mounting Rigidity of Hydraulic Swivels

800-394-9986 • www.uea-inc.com • P.O. Box 817 • Waverly, IA 50677-0817

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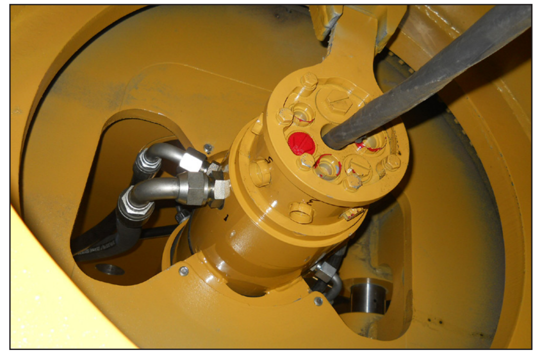
The mounting requirements of a hydraulic swivel are more important than one would ascertain from a brief observation. The purpose of this white paper is to discuss the interactions of two important design considerations of a hydraulic swivel – the mounting rigidity and the swivel torque.

The swivel torque, or rotational torque, of a hydraulic swivel is what is required to overcome the resistance to turning. To judge optimal swivel rotational torque, you need to consider the following:



- **The "breakaway" torque value** when first starting the movement from a static position.
- **The dynamic rotation value.** After the rotation has begun, the dynamic rotation value should be lower.
- **The friction** between the seal and sealing surface, which creates resistance to turning.
- **The seal diameter.** The larger the diameter, the higher the resistance to turning.
- **The number of seals.** The more seals, the higher the resistance to turning.
- **Pounds per square inch (PSI).** The higher the psi within the circuit, the higher the resistance to turning.
- **Seal geometry,** which affects resistance to turning.
- **Seal material,** which affects resistance to turning.
- **Non-pressurized ports,** which create the lowest resistance to turning.
- **Ports.** Every other port pressurized creates the highest resistance to turning. All ports pressurized equally will create similar torque to non-pressurized configuration.
- **Different permutations** of pressured ports will create a wide variety of swivel torques.

Steady state rotational torque is not the only concern when working with mounting requirements of a hydraulic swivel. In addition, the seals within the swivel have both static and dynamic friction. Static friction is higher than dynamic friction. Like pushing a box across the floor, it is harder to start it moving (static) than it is to keep it moving (dynamic). The static resistance to rotation in a hydraulic swivel will be higher than the dynamic resistance to rotation.

The difference between static and dynamic friction is of great importance when discussing mounting rigidity. One example of this importance is the common concern known as torque arm restraint chatter.

Below is a step-by-step description of how this chatter develops within an assembly that contains a hydraulic swivel. Please note that we refer to the torque constraint assembly as the method, typically a weldment, for driving the hydraulic swivel.

1. The rotating member begins to rotate based on operator inputs.
2. Next, the torque constraint assembly engages swivel and begins to put rotational force on swivel.

3. High static friction within the swivel creates large resistance to turning.
4. Torque constraint assembly flexes slightly due to the large resistance to turning that the swivel is creating.
5. As force continues to increase, the swivel transitions from static to dynamic friction and begins to rotate. It actually snaps forward farther ahead due to the torque constraint assembly acting like a slingshot.
6. The swivel farther ahead than the torque constraint assembly, it pauses for a brief moment.
7. Torque constraint catches up and engages the swivel.
8. The cycle begins again at step number two.

This whole process happens many times per second (100Hz potentially), depending on the natural frequency of the torque constraint assembly. The natural frequency of the torque constraint assembly is usually within the audible range of humans, so when it is energized (steps 2-8), it can make a large noise that can be heard as well as felt.

Below are a few points to review that will provide the optimal mounting and torque restraint features, reducing the risk of several potential failure modes:

1. It is not the swivel that is chattering, it is the torque constraint assembly and mounting of the swivel that is the source of any chattering.
2. This is NOT similar to a hydraulic cylinder that chatters in its linear application.
   - When a hydraulic cylinder chatters, it is due to resistance to stroke and a ‘spongy’ fluid power circuit.
3. The best ways to eliminate or prevent hydraulic swivel chatter and other mounting concerns include:
   - Increase robustness into the stationary solid mounting plate and mounting lugs.
   - Increase torque arm constraint assembly rigidity.
   - If a design requires a parallel to the axial centerline of rotation, the length of a torque arm should be as short and robust as possible.
   - Regardless of which end of the swivel faces up or down, choose first to orient your fixed stationary mounting and your rotating element torque arm as close together as possible. Stay as close to the center of the radial plane of the slewing ring as possible.

It would be difficult for UEA to provide design guidelines, as there are many variations of application uses for hydraulic swivels. If you involve UEA designers early in the design process, we can provide additional design analysis and feedback to assist in creating a rigid mounting and torque constraint assembly. Torque constraint assembly flexation and natural frequency analysis can also be provided. Up-front teamwork and analysis will ensure your assembly and our hydraulic swivel will live together for many, many years!