

THE SMAC-SERIES SWIVEL JOINT DESIGN

This article is written to describe the FULL-CIRCLE swivel joint design concept.

The main purpose of a swivel joint used to transfer liquefied gases is to allow 360° rotation while being able to seal product under high pressures. The SMAC series swivel can be used in a variety of applications, which include hose reels on bobtail delivery trucks, bulkhead applications, loading arms, and hose-end use.

While temperatures tend to vary from state to state and country to country, the SMAC swivel must be able to seal under extreme weather conditions as the pressure of stored liquefied gases vary with temperature. For example, the tank pressure of propane on a cold winter day in Alaska at -25° F is only around 8 psi. However, on a hot summer day at 100° F in Arizona, the tank pressure would be around 170 psi! Also, when a swivel is installed on the discharge side of a pumping system, the seal in the swivel will be exposed to even greater pressures as the pump develops the pressure necessary to overcome friction associated with line loss. This can be as much as 125 psi or more over tank pressure, which can result in the swivel being exposed to 300 psi or more. Not only must the swivel be able to seal liquid under a broad pressure range, it must also be able to seal vapor as well, since many liquefied gases such as propane, butane, and mixtures tend to be stored at their boiling points.

Since the swivel must be able to rotate freely through the above mentioned temperature/pressure range, it must contain some sort of bearing arrangement that allows 360° rotation. As the rotating portion of the swivel utilizes the ball bearing to rotate freely, it seals against the seal package to prevent leakage. The bearing arrangement is crucial because if it cannot compensate for eccentric rotational movement such as misalignment in a rigid piping system, the swivel seal will generally leak because the rotating portion of the swivel is moving in a nonconcentric fashion.

This misalignment can cause the leakage of product with swivel designs other than the SMAC. Other swivels that contain a seal that rubs on the face of the rotating component will generally have a difficult time sealing product because as the face rotates in an eccentric, wobbling manner, the rubber seal will tend to lift periodically, causing product leakage. Other seal/bearing designs incorporate a seal that must be sandwiched very tightly between the rotating portion of the swivel and the swivel housing itself, causing the swivel to be difficult to rotate. This is due to the friction between the seal and the face of the rotating swivel. To overcome this friction, grease is used to not only lubricate the ball bearing, but the seal as well.

This must be handled with extreme caution because too much or too little grease could be used. By overgreasing, the seal may lift off the rotating member of the face, causing leakage. Also, the seal may be subjected to any particle contamination that may degrade off the bearing itself and there is no compensation once the seal begins to wear.

HOW DOES THE SMAC-SERIES SWIVEL DESIGN OVERCOME THE ABOVE MENTIONED PROBLEMS?

Let's begin with the ball bearing arrangement. As shown in Figure 1 below, note the relatively large ball bearing manufactured to exact tolerances used in the SMAC-series swivel. The ball bearing used in this swivel is sealed on both sides to prevent unwanted contamination problems and is manufactured to International Ball Bearing Standards. These standards give us the ability to specify a certain type of ball bearing for the design it is intended for. In other words, if we wanted to use ball bearings for high speed shaft rotation, we may opt to specify a low percentage grease pack ball bearing with greater clearances. In the case of the 1-1/2" and 2" swivel sizes, we specify a very tight clearance ball bearing, with a relatively high grease pack. This accomplishes two things. The tight clearance minimizes eccentric type movement where misalignment is present, allowing the bearing to overcome unwanted stress while still sealing against the seal package. Also, the slow swivel speed allows for a higher percentage grease pack. Keep in mind this grease pack never contacts the seal package in the swivel, thus eliminating a potential contamination source.

As already mentioned, the SMAC-112 and SMAC-200 series swivels utilize a sealed ball bearing. The bearing is specified with the tightest clearances to International Standards. This minimizes the amount of sideways movement of the rotating female portion of the swivel. Other swivels which use lightweight ball bearings and bearing balls "poured" into raceways will allow for a considerable amount of sideways movement of the female rotating portion of the swivel, thus increasing chances of product leakage and bearing wear.

However, even with SMAC-series swivels, there will be some movement of the rotating portion of the swivel due to eccentric rotation (misalignment) as in a hose reel application or for loading arms where heavy counterbalances are used. When this occurs, the seal package in the SMAC swivels will move accordingly to correct and align itself with the rotating portion of the swivel. The seal package can move **axially** (along the centerline of the rotating swivel), **radially** (clockwise or counterclockwise), and **perpendicular** to the centerline of the rotating portion of the swivel. All three types of movement can occur individually or all simultaneously.

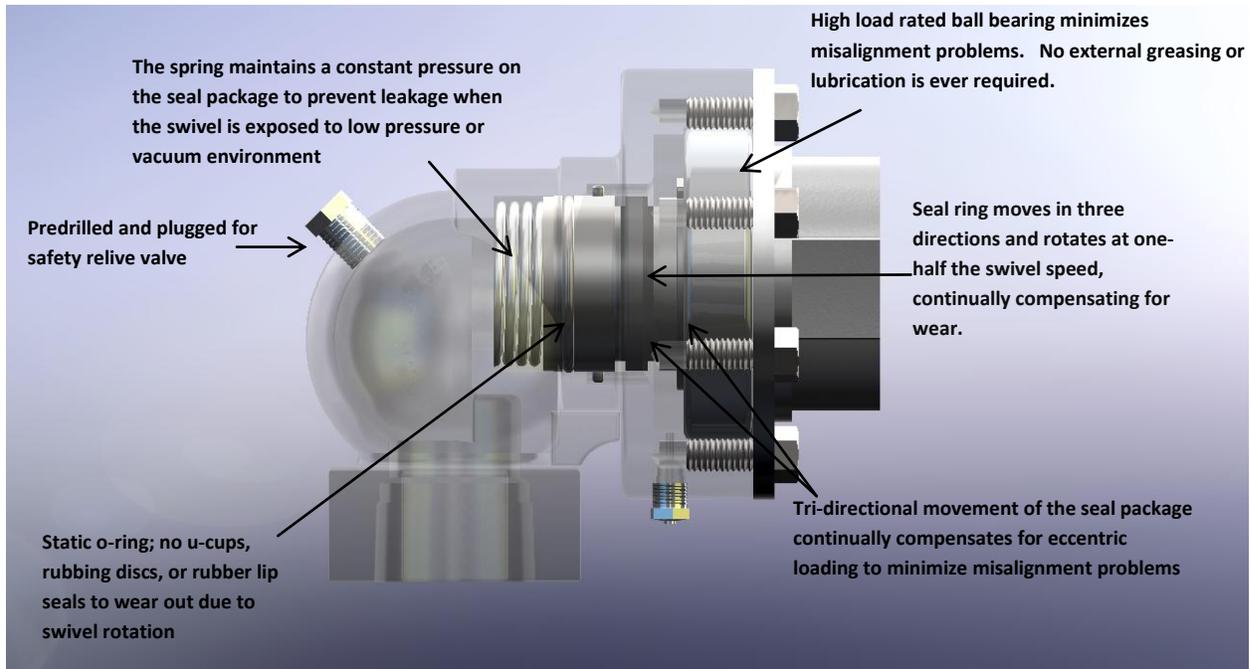


Figure 1. SMAC-200LN; 2" FNPT 90° swivel

It is important to understand the seal package in the SMAC-series swivels is held together by system pressure. In other designs, the force that holds the seal package together is the initial jamming of the seal held tightly against the rotating part of the swivel. Over time, the seal will begin to diminish and the force holding the seal together will dissipate. This will eventually lead to leakage. With the SMAC swivels, no diminishing force action exists because the package is held together by system pressure with no rubber seals exposed to rotational movement. As the seal ring wears, the seal ring as well as the stationary small seal continue to move axially, constantly sealing. The spring constantly applies tension to the seal package, which is used to hold the seal package together during shipping or in a low pressure application, since high pressure is already producing a sealing action when in use.

The seal package used in the SMAC-series swivels is a three piece seal. The advantages are as follows:

- 1.) There are no rubber seals used that either rotate or are rotated against.
- 2.) No ball bearing grease contacts the seal package or is ever required.
- 3.) A spring is utilized to hold the seal package together, not the force of the rotating portion of the swivel against a sandwiched rubber seal.
- 4.) Once installed in a pressurized system, the pressure itself holds the seal components together.
- 5.) The three piece seal package can move in three directions. This is very important in cases where misalignment occurs, allowing simultaneous movement if required. This eliminates "lifting up" of the seal which would otherwise cause a leak.
- 6.) The seal ring rotates at $\frac{1}{2}$ the RPM of the rotating portion of the swivel. With other swivels that contain a two piece seal, the static seal is subjected to full rotational speed, thus causing more wear.
- 7.) The materials that make up the SMAC swivels are highly engineered.
- 8.) No periodic greasing or lubrication is ever required

Operating parameters for the SMAC-series swivels include the following:

1. Approvals: U.L. Listed for LP-GAS, Anhydrous Ammonia, Natural Gas, and Refined Fuels in accordance with U.L. 567 Standard. Most swivel models comply with the following European Directives: Pressure Equipment, Machinery, and ATEX. EC Declarations of Conformity and/or Declaration are available upon request.
2. Temperature Range: -40°F to +250°F
3. Maximum working pressure: 400 psi per U.L.
4. Hydrostatic test pressure: 2000 psi per U.L.
5. Available in $\frac{3}{4}$ ", 1", 1- $\frac{1}{4}$ ", 1- $\frac{1}{2}$ ", 2" and combination thread sizes.
6. Full-Circle is certified to the ISO 9001:2008 Quality Management System standard.