FMC Fluid Control Division
TA908-1
Technical Alert

Rotational Torque In Swivel Joints

Swivel joints are metal pipe fittings that permit the rotation and movement of lines while maintaining the strength and integrity of the steel. There are two principle designs of swivel joints on the market: Chiksan ball bearing swivels and journal bearing swivels (sometimes referred to as thrust, sleeve, or bushing swivels).

To perform as intended, a swivel joint must rotate while under pressure in many applications. If a swivel joint fails to rotate when pressurized, loads and vibrations will be transmitted to other parts of the piping system. If the torque required for rotation exceeds the torque needed to loosen the end connections, a catastrophic failure can result.

The facts about rotational

CAUTION: TESTS CONDUCTED BY FMC SHOW THAT THE TORQUE REQUIRED TO ROTATE LONG RADIUS JOURNAL BEARING SWIVELS AT NORMAL OPERATING PRESSURES CAN EXCEED THE TORQUE NECESSARY TO LOOSEN THE END CONNECTIONS IN MANY INSTANCES.

This bulletin examines and explains the reasons for the tremendous differences in rotational torque between Chiksan ball bearing swivels and journal bearing swivels.

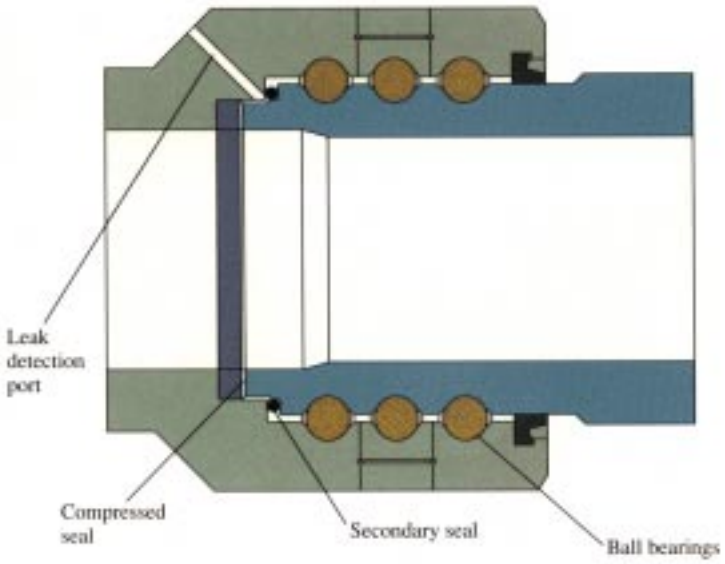

FIGURE 1
CHIKSAN BALL BEARING SWIVEL

Bearing Design Comparison

Chiksan ball bearing swivels achieve rotation through the rolling action of ball bearings in precision machined and heat treated ball races (Figure 1). Journal bearing swivels achieve rotation through sliding friction. The torsional resistance produced by metal sliding against metal increases with internal pressure and continued rotation causing the rotational torque to increase exponentially. Rolling friction produces far less torque than sliding friction and is minimally effected by applied loads as opposed to sliding friction. At 15,000 psi, a typical 2-inch Chiksan Longsweep ball bearing swivel joint requires from 220 to 400 foot pounds of torque for rotation. The 2-inch long radius journal bearing swivels tested by FMC required from 1,300 to 2,400 foot pounds of torque to initiate rotation at the same pressure rating. This is more torque than it takes to loosen a Figure 1502 wing union end connection (Figure 3). A conventional line pipe threaded connection can be backed off with about 1,200 foot pounds of torque.

When pressurized, journal bearing swivels produce extreme high rotational torques as a result of sliding friction between the journal bearings, split steel collet, and male piece (Figure 2). The higher the pressure, the higher the rotational torque.

Upon disassembly of the journal bearing swivels tested by FMC, it was discovered that the split steel collet often engaged with journal bearing "A" due to the compounded sliding friction caused by the split surface rotating against the aluminum bronze surface (Figure 2). In these instances, rotation occurred between the split collet and its groove in the male piece (Figure 2). Galling of the collet and groove was so severe that it prevented the journal bearing from being removed. Compressive deformation of the journal bearing was also observed. Based on these observations, additional deformation of the journal bearing can be expected with continued rotation resulting in even higher operating torque requirements over the service life of the swivel.

Seal Design Comparison

The seal is the main source of torsional resistance in Chiksan ball bearing swivels. This is due to the fact that the seal is compressed during assembly to prevent low pressure

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torque.

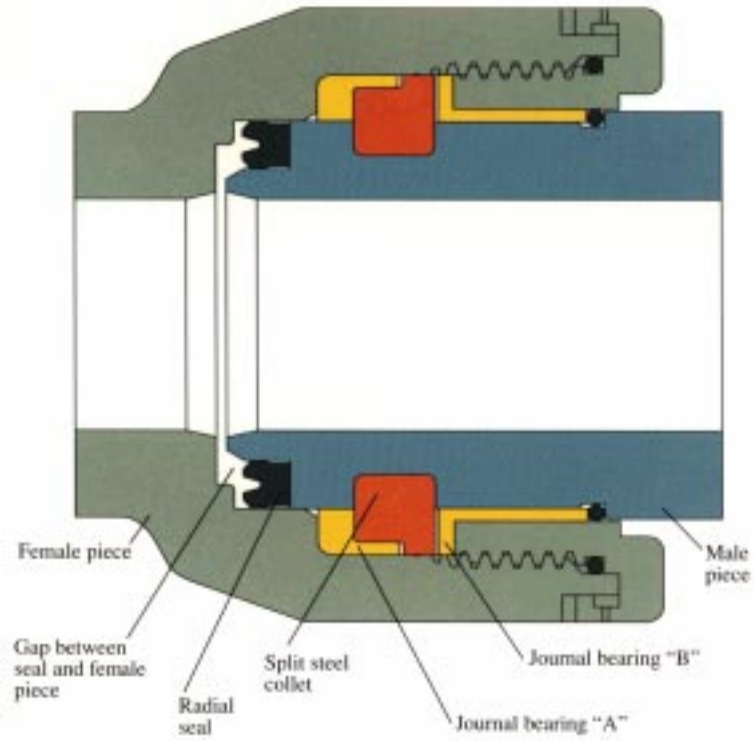

FIGURE 2
JOURNAL BEARING SWIVEL

torque, leakage. Torsional resistance between the seal and the seal chamber increases slightly with working pressure and rotation. However, even at full working pressure, Chiksan ball bearing swivels rotate much easier than journal bearings swivels.

By contrast, the radial seals used in most journal bearing swivels must be pressure energized before a seal is accomplished. As a result, journal bearing swivels can leak when subjected to alternating low pressure/vacuum cycling.

CAUTION: AN OFFSHORE OPERATOR REPORTED FACING A POTENTIAL SAFETY HAZARD WHEN A JOURNAL BEARING SWIVEL IN A TEMPORARY FLARE LINE LEAKED DURING ALTERNATING LOW PRESSURE/ VACUUM CYCLING.

NOTE: IN TESTS WITNESSED BY LLOYDS, A CHIKSAN BALL BEARING SWIVEL PROVIDED BUBBLE-TIGHT SERVICE THROUGH SIX DAYS OF LOW PRESSURE/ VACUUM CYCLING THAT INCLUDED ROTATION OF THE SWIVEL.

The radial seal design used in journal bearing swivels also leaves a gap between the seal and the seal chamber (Figure 2) creating a trap for sand, cement, acid, and other foreign material. This can result in leakage and permanent damage of the sealing interfaces. Because the two surfaces must be maintained circular and concentric, only a minimal amount of buffing can be tolerated. Chiksan ball bearing swivels provide a smooth, uninterrupted flow path. There are no recesses or traps to collect foreign particles. Flat metal packing faces afford easier refinishing than cylindrical surfaces, and more metal can be removed during refurbishment without effecting the integrity of the seal.

ENGINEERING SUMMARY AND CONCLUSIONS

Chiksan ball bearing swivel joints have provided long service in a variety of applications requiring rotation under pressure for over 60 years. Chiksan ball bearing swivels provide low rotational torque throughout the rated pressure range preventing the end connections from backing off and minimizing structural loads on other parts of the piping system. Chiksan ball bearing swivels provide bubble-tight sealing at all rated pressures, including alternating lowpressure/ vacuum services. Chiksan ball bearing swivels have

demonstrated long fatigue life. Maintenance and field repair are simple. Testing and engineering support are unsurpassed worldwide.

In comparison, journal bearing swivels have limited usage in oilfield applications which require rotation under pressure. The torque required to rotate a journal bearing swivel at normal operating pressures can exceed the torque necessary to loosen the end connections. FMC's test data indicates that rotational torque will increase over the life of the journal bearing swivel. If a journal bearing swivel fails to rotate when pressurized, loads and vibrations will be transmitted to other parts of the piping system producing high stress values and short fatigue life. The design of journal bearing swivels exposes the seal to debris which can lead to leakage and permanent damage of the sealing surfaces. Because journal bearing swivels must be pressure energized before a seal can be accomplished, they can leak when subjected to alternating low-pressure/vacuum cycling.

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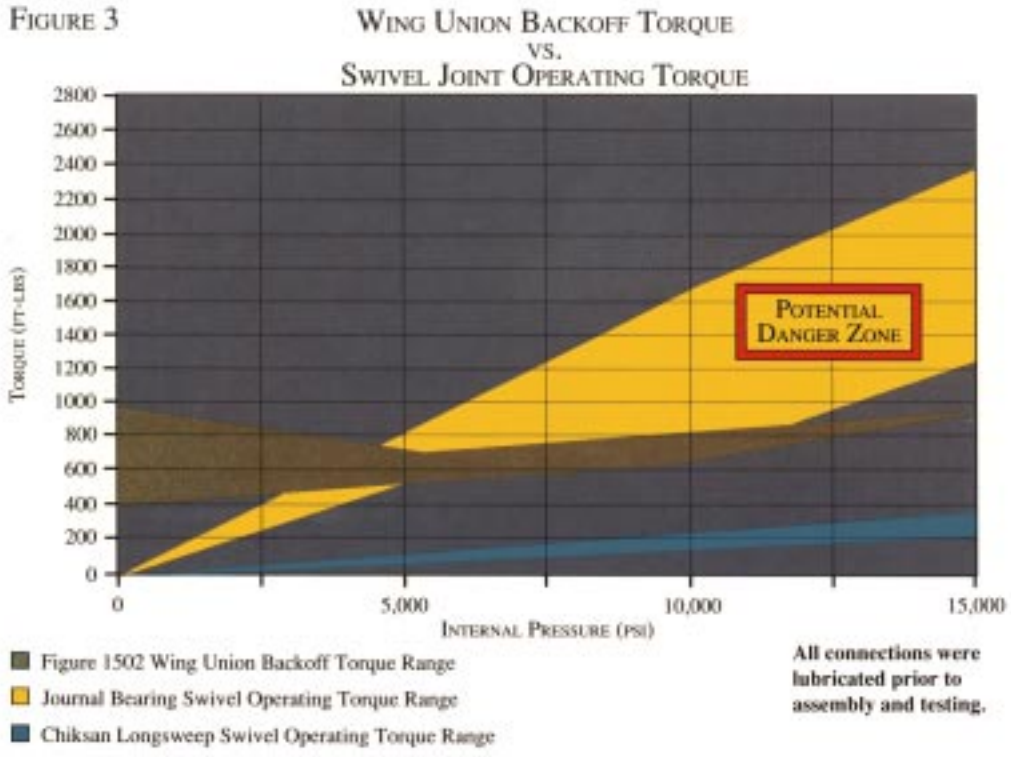
IMPORTANT: FMC RECOMMENDS THAT YOU KNOW THE ROTATIONAL TORQUE AND SEALING REQUIREMENTS OF THE SWIVEL JOINTS YOU USE TO AVOID POTENTIAL DANGER TO PERSONNEL AND EQUIPMENT.

CALL FMC FOR MORE DETAILS

If you have any questions about swivel joints, please call or write FMC Fluid Control Division.

FIGURE 3



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