

The Magazine For Pump Users Worldwide

# PUMPS & SYSTEMS<sup>®</sup>

## What Are the Methods for Successfully Sealing Slurries?

Originally published  
December 2007



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# SEALING SENSE

## What are the methods for successfully sealing slurries?

Our September column focused on considerations for applying mechanical seals in the very high solids content slurries found in the mineral and ore processing (M&OP) industry. In virtually any industry, you can encounter a sealing application that can be classified as slurry service. These applications can challenge mechanical sealing know-how and, if successful, optimize overall plant mean-time between failures (MTBF).

A basic understanding of slurry properties, pump hydraulics, and seal chamber flow regimes is a good start toward maximizing seal performance.

### Failure Modes

The properties of slurries can vary greatly between industries. Slurry content can differ in concentration, particle size, hardness, and the tendency to solidify or “dewater.” Knowing how these properties affect seal performance can provide an insight into the approach that will achieve desirable seal life.

The particle size making up the slurry dictates how a single seal will perform. Hard slurry particles enter the seal faces (primary seal) because of either their submicron size or undesirable pumping system hydraulics such as cavitation, nonhomogeneity, or solids aggregation. A carbon-graphite face is prone to scoring because the material is much softer than the slurry particles. For this reason, “hard seal face” combinations, such as silicon carbide on silicon carbide, are recommended in slurry service.

There are a number of considerations why one hard face combination would be used over another. The choice may be based on chemical resistance, heat generation considerations or, in some cases, market availability.

Once a primary seal is compromised through face scoring, the solids migrate and deposit across the seal faces into the atmospheric cavity of the seal. Once they enter the atmospheric cavity, another mode of failure starts to occur, clogging the springs. Though the springs are not contacting the process, they are indirectly affected once the primary seal is compromised.

In addition to spring clogging, the chemical constituents in the slurry can cause spring “stress crack corrosion.” Seal manufacturers take different design approaches to prevent this type of spring failure, one of which is shown in Figure 1.

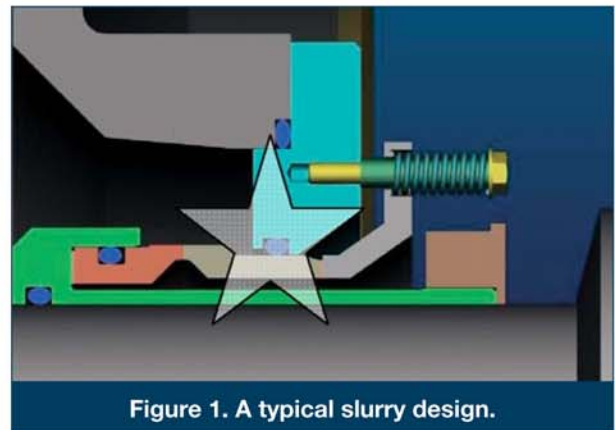


Figure 1. A typical slurry design.

On the process (wetted) side, the dynamic O-ring (highlighted in Figure 1) can become clogged or compression set. In this area, flow is low or stagnant and heat generation is the highest. Increased clearances around the dynamic O-ring area minimize clogging and increase cooling. The use of oversized seal chambers is recommended. Oversized chambers are available for slurry services from most pump manufacturers. One word of caution: Do not use a conventional tapered bore seal chamber. Studies show that the taper directs solids toward the primary seal.

Dewatering occurs most often when the slurry has a density lower than that of water. A wood pulp slurry in a paper pulping application is a perfect example of such a condition. The slurry will collect at low laminar flow areas closest to the seal gland and dewater. This dewatering insulates the seal faces from the fluid in the seal chamber, thus supporting a dry run condition and generating excess heat. These conditions produce a failure mode in the form of dynamic O-ring compression set, excess seal face wear and heat checking.

### Seal Environment

One approach to avoiding the above problems is to control the seal environment and prevent entry of the slurry particles. Industries have varying degrees of acceptance toward this type of seal augmentation. API Flush Plan 32 is one of the easiest ways to augment single seal installation, but the user may not want to intentionally dilute their process, which can add unwanted removal costs in the form of evaporation and reheat costs.

Due to geographic location, a clean flush source may not even be available. Silt laden lakes or rivers will not provide a clean flush source. In the chemical processing industries a carrier solvent, e.g. toluene or methyl-ethyl-ketone, may be used to flush seals. These solvent flushes are usually clean and work well.

The seal chamber fluid flow patterns have been well defined through flow analysis. The heavier solids are thrown to the bore of the seal chamber by the centrifugal force imparted by the rotating shaft. An optimized API Plan 32 includes the use of a close clearance throat bushing at the bottom of the seal chamber. This bushing is meant to minimize product dilution and keep solids from entering the seal chamber.

Flow analysis shows that some slurry solids are trapped behind the standard throat bushing outer diameter, even with a Plan 32 installed. This condition continues to build the volume of solids every time the pump stops and starts, so the arrangement won't keep all solids from the seal. Depending on the type of slurry, this can actually promote clogging of the seal chamber, subsequently clogging the seal.

Solids can be managed or controlled when an internal

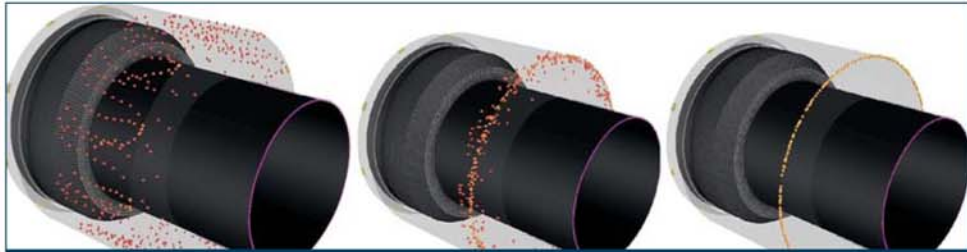


Figure 2. Time progression showing solids concentrating at bore.

environmental controller is utilized. Unlike the standard bushing installation, this environmental controller is designed to take advantage of the centrifugal force imparted by the rotating shaft. The device uses spiral grooves in the reverse direction to impart flow and continuously evacuate solids from the seal chamber. This evacuation is instantaneous at pump start-up. Clogging of the seal chamber is virtually eliminated.

## Dual Seals

Dual pressurized seals are often used to increase seal life cycles in slurry applications. Transitioning from a single to a dual seal can improve life only if the failure mode has been identified as a typical single seal failure. These failures begin with scoring from solids that migrate across the seal faces, subsequently clogging the springs.

## Fluid Sealing Association

*Sealing Sense* is produced by the **Fluid Sealing Association** as part of our commitment to industry consensus technical education for pump users, contractors, distributors, OEMs, and reps. *This month's Sealing Sense was prepared by FSA Member Chris Little.* As a source of technical information on sealing systems and devices, and in cooperation with the **European Sealing Association**, the FSA also supports development of harmonized standards in all areas of fluid sealing technology. The education is provided in the public interest to enable a balanced assessment of the most effective solutions to pump technology issues on rational Total Life Cycle Cost (LCC) principles.

The **Mechanical Seal Division** of the FSA is one of five with a specific product technology focus. As part of their mission they develop publications such as the *Mechanical Seal Handbook*, a primer intended to complement the more detailed manufacturer's documents produced by the member companies. This handbook served as the basis for joint development of the more comprehensive **Hydraulic Institute** publication: *Mechanical Seals for Pumps: Application Guidelines*. Joint FSA/ESA publications such as the *Seal Forum*, a series of case studies in pump performance, are another example as is the *Life Cycle Cost Estimator*, a web-based software tool for determination of pump seal total Life Cycle Costs. The *Sealing Systems Matter* initiative also was launched to support the case for choosing mechanical

seals that optimize life cycle cost, safety, and environmental compliance.

The following members of the **Mechanical Seal Division** sponsor this *Sealing Sense* series:

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Dual seals offer the ability to pressurize a clean barrier fluid between two sets of seal faces. API Plans 53A, B, and C as well as Plan 54 provide such an arrangement. Plans 53A, B, and C use a seal support tank to supply barrier fluid to the seal, while the fluid for Plan 54 is supplied from an outside source (pressurized header) and termed a *flow through arrangement*. On all, the pressure is set to a minimum of 15-psig (1-bar g) above the seal chamber pressure.

This sealing approach ensures that a clean fluid is forced between the inboard set of seal faces, which would otherwise contact slurry in a single seal installation. In this dual arrangement, the outboard set of faces also runs on this clean barrier fluid and provides a backup seal. The backup seal allows for planned maintenance or seal repair.

### Summary

Many factors must be considered when selecting a sealing system for the various types of slurry services. Most important are the properties of the slurry itself and how those properties may change in service and affect seal performance. While this article addresses some of these key issues, the challenge of



**Figure 3. Time progression showing dispersion of solids by spiral grooves.**

achieving optimum seal MTBF can be best addressed in collaboration with your mechanical seal supplier. Additionally, the standard *Rotodynamic (Centrifugal) Slurry Pumps (ANSI/HI 12.1-12.6)* provides guidance for this type of service.

**Editor's Note:** For more information on API Plan 32, API Plan 53A, B, C, and API Plan 54, please see "Circulation Systems for Single and Multiple Seal Arrangement" in the May, June and July 2007 issues of *Pumps & Systems*, or go to [www.pump-zone.com](http://www.pump-zone.com).

**Next Month:** *Was it really the gasket?*

We invite your questions on sealing issues and will provide best efforts answers based on FSA publications. Please direct your questions to: [sealingquestions@fluidsealing.com](mailto:sealingquestions@fluidsealing.com).

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