Tech Talk

Flushless Mechanical Seals For Paper Stock Applications

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Introduction

Shaft sealing of centrifugal paper stock pumps is an important consideration for pulp and paper mills. Studies show shaft sealing components such as packing and mechanical seals are the primary cause of maintenance and downtime of paper stock pumps.

Traditionally, paper stock pumps have been sealed with packing (Fig.1). Packing is an effective and forgiving sealing method. However, it requires the constant attention of maintenance personnel. It must be frequently adjusted or packed to maintain the proper leakage rate that is necessary for cooling. Packing also requires a constant supply of flush water that needs to be collected and treated. This adds additional cost and environmental considerations.

Mechanical Seals

Mechanical seals have become much more common and accepted in pulp and paper mills (Fig. 2). While mechanical seals also require flush water, maintenance is much less frequent. The downside is that when a mechanical seal fails, pump disassembly is required to replace it. To minimize unnecessary mill outages, pulp and paper mills are intent on maximizing mechanical seal life. To accomplish this, it is necessary to focus on the primary cause of mechanical seal failures, which is the seal environment. Paper stock applications are flushed with mill water and one may assume that this would lead to very reliable seal operation. However, the reliability and quality of flush water itself often leads to mechanical seal failures. Flush water is the life blood of pulp and paper mechanical seals. If seals could be operated with an uncontaminated and an uninterrupted stream of flush water, the vast majority of seal failures would be eliminated.

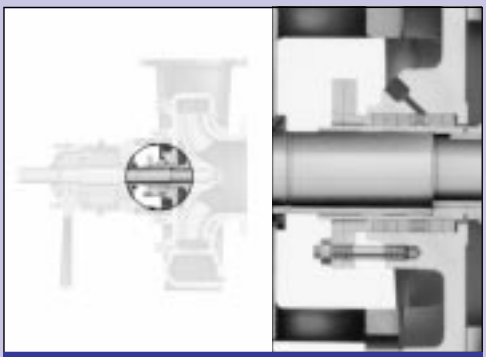


***Figure 1** – Packing can be used to seal paper stock pumps. However, this method requires the constant attention of mill personnel and a constant supply of flush water.*

With existing mechanical seals and seal chambers this is wishful thinking as particulate matter often present in the flush water can accelerate seal face wear. Secondly, air bubbles in the flush water will gravitate to the seal faces and will cause dry running. Lastly, interruption of the seal flush water will allow the paper stock to enter the seal chamber, pack around the seal and cause an imminent failure. Seal water interruption is caused by the inadvertent closing of a valve or plugging of a flush-line. Plugging often occurs after an outage when the paper stock is allowed to flow back into the seal chamber and flush-line. At start-up the flush-line valve may be turned on, but plugging impedes the flow of flush water into the seal chamber resulting in a seal failure.

Mechanical seals are housed in a pump seal chamber which provides the environment for the seal. Prior to discussion on paper stock pump sealing it is important to understand the evolution of seal chambers over the last 15 years.

Seal Chamber Evolution

Since vapor and solids are unavoidable with most liquids being pumped and with flush water, pump designers set out to design seal chambers that would be more forgiving to these environmental certainties. Their mission was to find a way to use the product being pumped to lubricate the mechanical seal, but, keep harmful solids and vapor away from the seal faces.

For this reason Taper Bore seal chambers were developed in the mid 1980s (Fig.3). With the taper bore design it was anticipated that solids and vapor would be centrifuged to the bore and then axially move towards the impeller where they would exit the seal

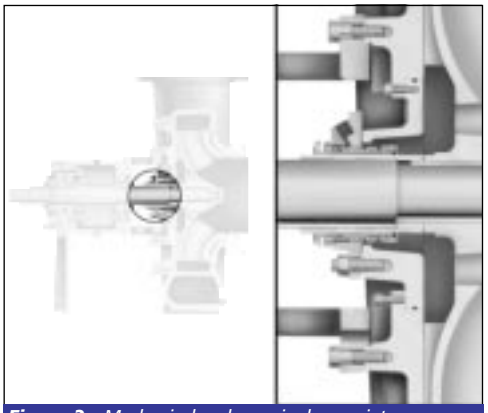
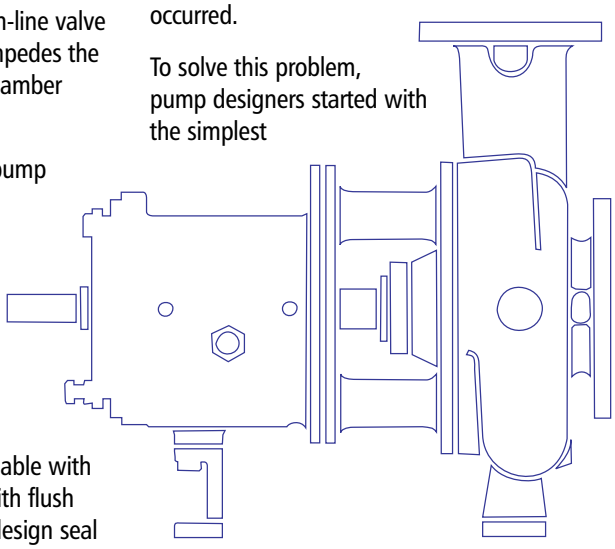


***Figure 2** – Mechanical seals require less maintenance, but, also requires a constant supply of flush water. Reliability and quality problems with flush water are the primary causes of mechanical seal failures.*

chamber. However, once the solids made it into the box they could not escape. High pressure at the impeller vane tips and low pressure at the shaft made the flow of solids and vapor out of the box impossible. Accumulation of solids resulted in severe erosion of seal and pump parts. In addition, dry running mechanical seal failures caused be vapors trapped in the seal chamber also occurred.

To solve this problem, pump designers started with the simplest



approach which was to add axial ribs to the bore to disrupt the existing flow profiles. This design does dramatically change the flow profile and is effective at removing solids from the seal chamber. Unfortunately, the new flow profile that allows the solids to escape also deflects solids towards the seal faces which can cause failures. It is a good solution for vapor removal but has a solids handling limitation of approximately 1%.

The ultimate solution to this problem involved creating a flow profile that removes solids

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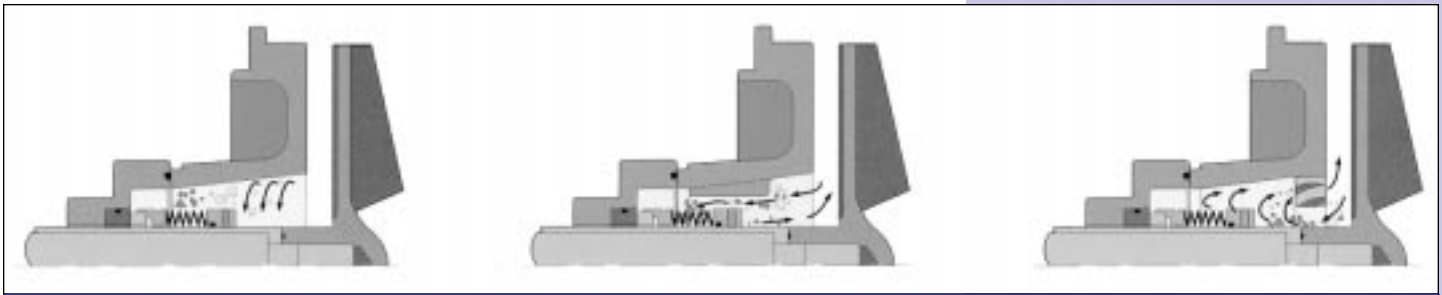

Figure 3 – *The bore of the seal chamber has had many changes since the mid-1980s. On the left, the first tapered-seal chamber failed to adequately handle liquids with solids or entrained vapors. Shown in the center, a tapered bore with axial ribs was able to deal with up to 1% solids content in liquids. The seal chamber on the right uses a vane particle ejector to handle up to 10% solids content.*

without deflecting them at the mechanical seal. Recently, a seal chamber design that meets this objective was introduced. This design uses a "vane particle ejector" or VPE at the seal chamber entrance. A low pressure zone created by the VPE creates a unique flow path that directs solids and vapor away from the mechanical seal. Testing has also confirmed that the back pump out impeller vanes, in conjunction with the VPE, create a turbulent zone which helps to minimize the amounts of solids entering the seal chamber bore. This VPE design extends the solids handling limit to 10% by ensuring that the seal faces are continuously flushed with clean liquid.

Paper Stock Applications

With the success of this seal chamber design in chemical and mining applications, it was decided to test this design on paper stock applications. A prominent seal manufacturer developed a seal configuration that removed the springs from the chamber which is critical to the operation (Fig.4). Then a 500 hour endurance test was conducted including five 60 hour outages to simulate typical mill outages. After the testing was completed the seal was extensively analyzed and was found to show no abnormal wear.

This was followed up by extensive field testing in mills throughout North America with excellent results. This unique seal chamber received a patent for technological improvement. It has proven that it can be operated on 6% oven dry paper stock applications without the need for external flush water and the problems that it can create. The seal chamber and mechanical seal combination allows the seal to extract uncontaminated water from the paper stock without causing de-watering. This clean extracted water ensures that the mechanical seal will operate in a clean friendly environment. In addition, by eliminating the need for flush water mill operating costs can be substantially reduced.

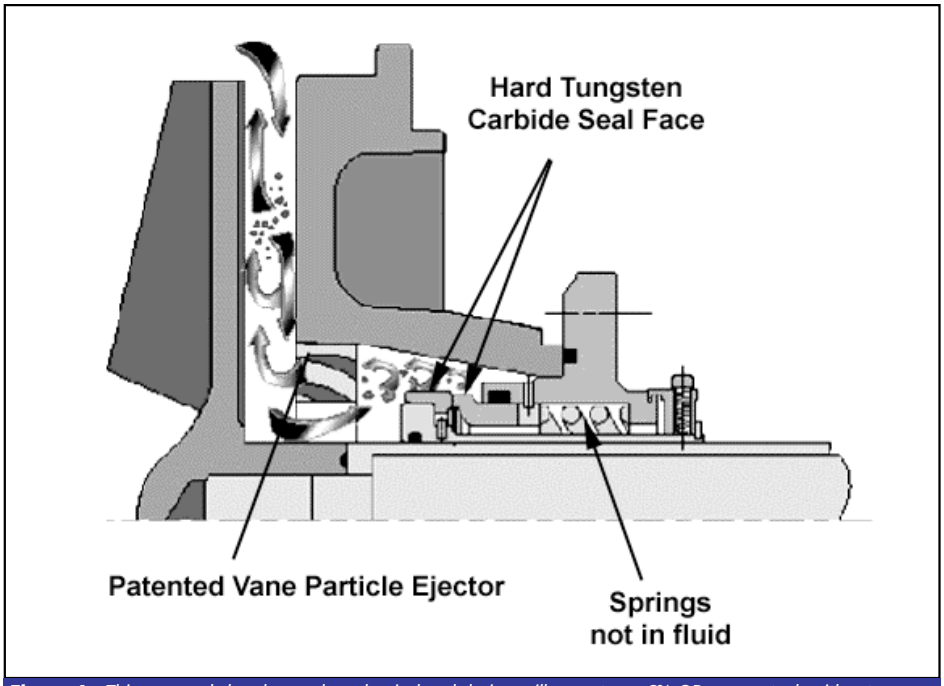

Figure 4 – *This new seal chamber and mechanical seal design will operate on 6% OD paper stock without flush water.*

Summary

The development of this new mechanical seal chamber now enables mills to operate pumps without the need for expensive flush water which provides an environmentally safe shaft sealing solution. In addition, mills should see a dramatic increase in the reliability of mechanical seals that will lead to substantial reductions in maintenance costs of paper stock pumps.