SEMI SPLIT MECHANICAL SEALS FOR VERTICAL PUMPS IN DESALINATION PLANTS

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Abstract

In desalination plants, the pumps for the transfer of liquids are fundamental for the efficiency and reliability of the plant.
On the pumps the mechanical seal is one of the most critical components, necessary in order to avoid the leak of the process liquid between the rotating shaft and the stuffing-box.
Fluiten Italia Spa has been producing mechanical seals and lubricating systems since year 1962. The development of new technologies and materials has allowed us to get commercial advantages in comparison to other seal systems such as packing, which is sometimes used on big vertical machines. The standard regulation in compliance with American Petroleum Institute has defined the configurations and applicable plans for process pumps as axially split or multi-stages pumps.

Our attention is now focussed on the "semi-split" seals solution, which allows insignificant leakages and very reduced power consumption compared to packing. Energy saving is only one of the interesting issues of such a solution for big vertical axial pumps. Fluiten semi-split mechanical seals have the big advantage to enable the machine maintenance without disassembling the shaft, thus reducing the plant shutdown and maintenance costs.

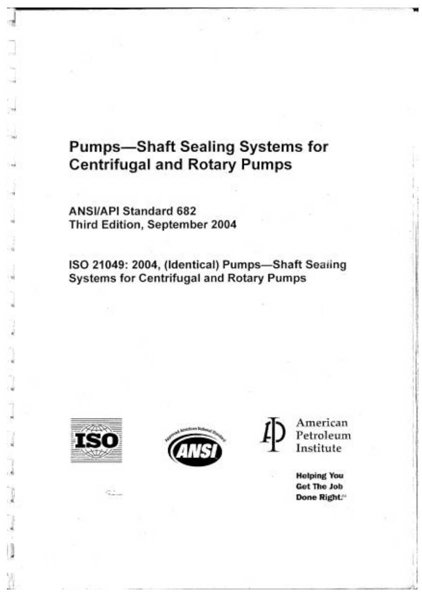
I. INTRODUCTION

The rotating interfacial axial mechanical seals are surely the "sealing" system used universally for rotary shafts on centrifugal pumps, to prevent the fluid's leakage to the atmosphere or air infiltration into the process. Actually this is the standard device chosen by all majors pump manufacturers, and the American Petroleum Institute recognizes it as mandatory sealing system for Centrifugal and Rotary Pumps.

The development of mechanical seals started around 1930's, with the application on the tracked wheels of tanks and saw major development with applications mainly in the Oil & Gas, Chemical and Pharmaceutical industries.

The mechanical seals became the seal device instead of packed stuffing box seals, which is still fitted for low duty applications and some niche markets.

The reason of this evolution is justified by the advantages that the mechanical seals offers in comparison of packing seals.


Pumps—Shaft Sealing Systems for Centrifugal and Rotary Pumps

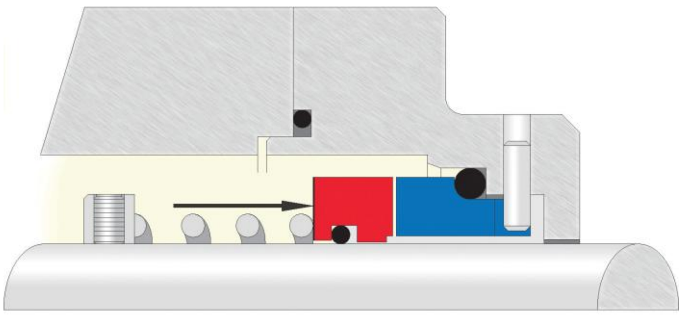
ANSI/API Standard 682
Third Edition, September 2004

ISO 21049: 2004, (Identical) Pumps—Shaft Sealing Systems for Centrifugal and Rotary Pumps

Front page of Standard API 682

1.1 Functioning of Mechanical Seal

A seal consists of two sealing rings, either of which rotates relative to the other. One of the rings is mounted rigidly and the other is arranged so that it can move freely and align radially, axially, and angularly with the rigidly mounted ring. A dynamic seal is achieved where the two rings contact perpendicularly to the pump shaft. These rings are called seal faces, one the rotating face and the other the stationary face. The faces are lapped flat, which results in very low levels of leakage, while at the same time providing long life on the basis of normal wear. Besides the two faces, the mechanical seal contains a set of secondary sealing elements and several metal parts. These serve the function of sealing dynamically and statically, loading the faces, and transmitting rotation. The secondary seals provide sealing between the seal faces and the metal parts, such as mating ring housing, sleeve, and gland. The metal parts transmit the torque and provide an axial mechanical force by means of a spring element to load the lapped faces.

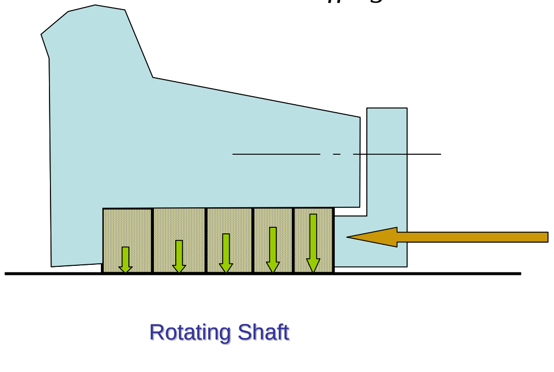


Basic mechanical seal design.

1.2 Functioning of Packed Stuffing Box.

The Packed Stuffing Box controls the leakage of the product around rotating shaft restricting the clearance between the shaft and the pump casing by packing a soft, resilient material around the shaft within pump back head called Packing.

Basic Packed Stuffing Box



2. MECHANICAL SEAL COMPARED TO THE PACKING SEAL

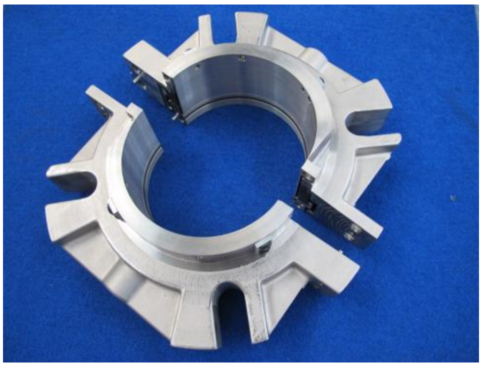
2.1 Comparison table

	Packing Seal	Mechanical Seal
Leakage	Yes	Irrelevant
Wear of pumps' parts	Yes	No
Frequent adjustments needs	Yes	No
Power consumption		About 65% less than the packing seal

2.2 Analysis

Termomeccanica CEXD vertical pumps for desalination plant.

One of the applications in which the packing seal is still used instead of mechanical seal is on the big size equipments.
The packing on vertical pumps can be replaced without removing the coupling between the motor and the shaft

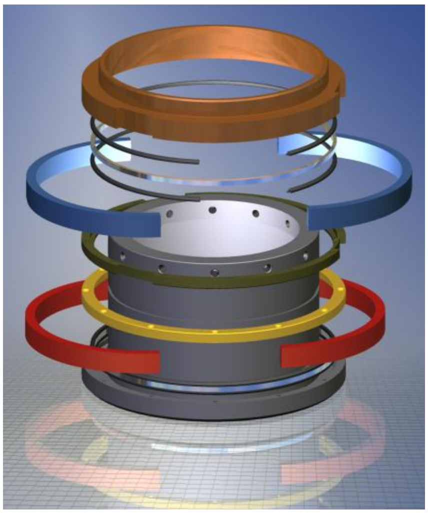


Fully split seal

2.3 Fully split seals

As regard mechanical seals, to simplify the disassembling, it has been designed a version of mechanical seal split in two halves, called "Split seal".
All the components are cut in two halves to permit easy mounting avoiding long time maintenance due to the disassembling of the rotating shaft from the coupling.
The disadvantages of this solution are mainly two: the first is the very expensive cost due to the complicated production to guarantee a perfect match between the two halves. The other one is the arduous fitting in case of big size and weight of the two halves; in this case it's easy to mistake.

3 FLUITEN SEMI SPLIT SEAL

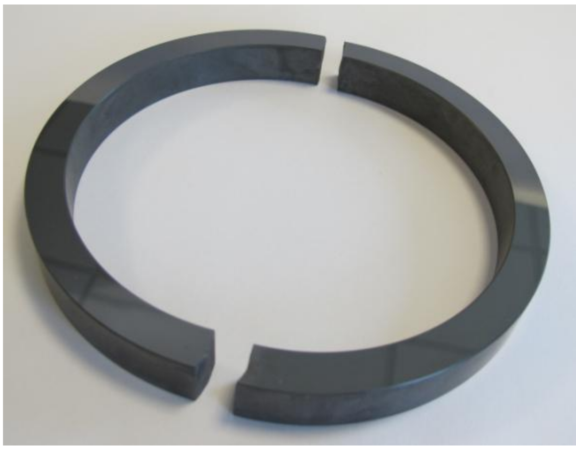


To overcome this problem Fluiten developed a new solution called "semi-split" in which only the rotary and stationary rings are split in two halves; those lightweight items, together with the O-rings are the wear parts of the seals.
The first time this seal must be fitted as a traditional mounting, inserting it on the shaft, then in case of maintenance, it is possible to replace the rings, with the new split ones.
The O-rings also can be easily replaced, cutting the old one with the new "Flui-clip" o-ring "suitable to guarantee a perfect seal.

3.1 Split ring technology

Thanks to the innovative fracture system of the rings made in carbon and silicon carbide, the semi-split execution is feasible.

This working process has been rationalised for high performance engines where the connecting roads are initially produced as single part precision forged parts. The connecting rod bearing is then broken apart at a predefined point by fracture splitting, so-called cracking.



The entire cracking process only takes milliseconds and the quality of the fracture process can be determined from the force/time curve.

Prior to this innovation the manufacturing process of the connecting road required complicated and expensive working cycles, during which the risk of mistakes and production reject occurred.

3.2 Conclusions

We summarize the benefits of the rotating interfacial axial mechanical seals in semi-split execution compared with a packing seal; in particular related to a desalination plant for big vertical pumps.

O-ring with Flui-clip technology

We can say that mechanical seals guarantee better seal performances avoiding environment contamination, moreover avoiding air infiltration in the process..

Mechanical seals don’t require any periodical maintenance and don’t wear any part of the machine.

It is very important to point up the energy saving advantages by installing a mechanical seal, because the value of power absorption is around 1/3 of a packing seal.

FRICTION TORQUE

Required input:

Di : inside face diameter (mm)
De : outside face diameter (mm)
Db : effective balance diameter (mm)
Dp : pressure across the seal face (N/mmq)
f : friction coefficient – assume f=0,05 - **Carbon against Silicon Carbide**
K : pressure drop coefficient – assume k=0,5
Fm : springs force (N)
N : running speed (RPM)

$$Af = \frac{\pi \cdot (De^2 - Di^2)}{4} \quad [mm^2] \quad \text{face area}$$

$$B = \frac{(Db^2 - Di^2)}{(De^2 - Di^2)} \quad \text{balance ratio}$$

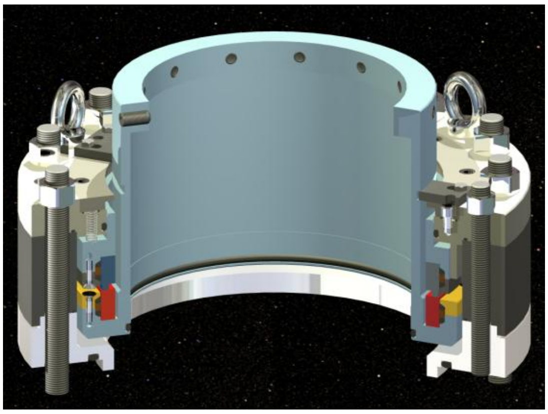
$$Pm = \frac{Fm}{Af} \quad \left[\frac{N}{mm^2}\right] \quad \text{spring pressure}$$

$$Pc = Dp \cdot (B - K) + pm \quad \left[\frac{N}{mm^2}\right] \quad \text{total face pressure}$$

$$Dm = \frac{(De + Di)}{2} \quad [mm] \quad \text{mean face diameter}$$

RUNNING FRICTION TORQUE $Cf = \frac{Pc \cdot Af \cdot f \cdot Dm}{2000}$ $[N \cdot m]$

RUNNING FRICTION POWER $Pf = \frac{Cf \cdot N \cdot 6,28}{60}$ $[W]$



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