CENTRIFUGAL PUMP AND SEAL
(API Std. 610 and 682)

Presented By
Prakash Kumar
ME(NSPL)
CONTENTS OF PRESENTATION

- BRIEF ABOUT CENTRIFUGAL PUMPS AS PER Std .API 610.
- MECHANICAL SEAL DESIGN AS PER Std .API 682.
- CASE STUDY ON MECHANICAL SEAL DURING COMMISSIONING OF NSPL PUMP AFTER MOH.
API-610 TYPE CLASSIFICATION of CENTRIFUGAL PUMPS

API - 610 TYPES

CENTRIFUGAL PUMP

Overhung
- Flexibly Coupled
  - Horizontal
  - In-Line Bearing Frame
  - Foot Mtd
  - C'line Mtd
- Rigidly Coupled
  - Vertical
  - In-Line
  - High Speed Integral Gear

Between Bearings
- 1 & 2 Stage
  - Axially Split
  - Radially Split
  - Double Casing
- Multistage
  - Axially Split
  - Radially Split
  - Double Casing

Vertical Suspended
- Single Casing
  - Disch Thru Column
  - Diffuser
- Double Casing
  - Separate Discharge (Sump)
  - Volute
  - Canti-lever
  - Line Shaft
  - Axial Flow
  - Volute
  - Diffuser
MECHANICAL SHAFT SEAL

- A mechanical shaft seal consists of two main components: a rotating part and a stationary part. The rotating part is axially pressed against the stationary part.

- The mechanical shaft seal is essentially a throttle arranged around the shaft. It reduces leakage between the pump and the surroundings to an absolute minimum.

- The clearance between the stationary and rotating part of the seal must be small in order to reduce leakage.
A LIQUID IS SUPPLIED TO THE PUMP “SUCTION”

CENTRIFUGAL FORCE EXPELS THE LIQUID OUT FROM THE IMPELLER

AS THE PUMP SHAFT ROTATES
WHY MECHANICAL SEAL ????

ROPE PACKING
WHY LEAKAGE ???
STILL LEAKAGE ????
LEAKAGE RATE IS HIGH !!!!
INTRODUCTION OF MECHANICAL SEAL

- leakage could be controlled to a much greater degree.
It is a fact, all mechanical seals leak.

But, leakage is so minute that actual droplets of liquid are not detected. Instead, the lubricating liquid will vaporize as it crosses the seal faces and the leakage is a gas or vapor.

Sealing points of a typical mechanical seal.
Sealing on the shaft

The seal gland to the stuffing box

O.D. of the stationary

And finally, the seal faces
PRESSURE DROP & VAPORIZATION

Liquid

Liquid + Vapor

Vapor + Liquid

Vapor

0 psi

25 psi

50 psi

100 psi
Based on API 682, all mechanical seal shall be cartridge design.

- A completely self-contained unit (including seal faces, flexible elements, seal gland plate, sleeve, and mating ring) which is pre-assembled and preset before installation.

- It covers seals for shaft diameters from 20 mm to 110 mm.

Seal categories:
- Category 1 seals
- Category 2 seals
- Category 3 seals

- Shaft-to-sleeve diametrical clearance shall be 0.020 mm to 0.093 mm (ISO 286-2).
### COMPARISON

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>CATEGORY 1</th>
<th>CATEGORY 2</th>
<th>CATEGORY 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seal chamber size</td>
<td>ASME B73.1 and B73.2 (Chemical duty pumps)</td>
<td>API-610, ISO 13709</td>
<td>API-610, ISO 13709</td>
</tr>
<tr>
<td>Temperature range</td>
<td>-40ºC to 260ºC</td>
<td>-40ºC to 400ºC</td>
<td>-40ºC to 400ºC</td>
</tr>
<tr>
<td>Pressure range, absolute</td>
<td>20 bar</td>
<td>40 bar</td>
<td>40 bar</td>
</tr>
<tr>
<td>Face material</td>
<td>Carbon v/s self sintered SiC</td>
<td>Carbon v/s reaction bonded SiC</td>
<td>Carbon v/s reaction bonded SiC</td>
</tr>
<tr>
<td>Throttle bushing requirements for single Seals</td>
<td>Fixed carbon bushing required.</td>
<td>Floating carbon bushing optional.</td>
<td>Floating carbon bushing required</td>
</tr>
<tr>
<td>Documentation requirements</td>
<td>Minimal</td>
<td>Minimal</td>
<td>Rigorous</td>
</tr>
</tbody>
</table>
The same four sealing points exist here.

- Seal Gland Gasket
- Stationary O-ring
- Shaft/Sleeve O-ring
- Seal Faces

One additional sealing point exists in this particular cartridge Assembly.
API PIPING PLAN

- Since the rotating seal will create heat from friction, this heat will need to be removed from the seal chamber or else the seal will overheat and fail.

- A seal piping plan is designed to improve the environment around the mechanical seal and therefore increase the performance and reliability of the seal.

- Plan 11 is the default seal flush plan for all single seals.

- In Plan 11, product is routed from the pump discharge to the seal chamber to provide cooling for the seal and to vent air or vapors from the seal chamber. Fluid then flows from the seal cavity back into the process stream. It is the most commonly used flush plan for clean general service equipment.

- Calculations are required to determine the proper orifice and throat bushing dimensions to assure adequate seal flush flow.
**API PLAN 11**

**What**
Seal flush from pump discharge through orifice.
Default single seal flush plan.

**Why**
Seal chamber heat removal.
Seal chamber venting on horizontal pumps.
Increase seal chamber pressure and fluid vapor margin.

**Where**
Flush should be directed over seal faces with piping at 12 O’clock position.
SHARING OF EXPERIENCE

CASE STUDY

HEATING OF MECHANICAL SEAL DURING COMMISSIONING OF NSPL MAIN LINE PUMP
POSITION OF MECHANICAL SEAL

STUFFING BOX
DE SEAL
JOURNAL BEARING
BEARING GUARD
BEARING HOUSING
PUMP SHAFT
DISMANTLING OF NSPL PUMP SEAL

- Flush in port
- Seal face
- Shaft sleeve
- O-ring
- Seal housing
- Leakage drain port
- Throttle ring
- Sleeve lock nut
- Shrink disc
- Bearing housing side
- Stuffing box side
SEAL PARTS

- Shaft Sleeve
- Throttle Ring
- Seal Housing
- Shrink Disc
- Lock Nut
CASE STUDY OVERVIEW

BALANCING LINE

PLAN 11 FLUSH LINE

NDE SIDE

DE SIDE
PROBABLE REASONS ???

1st trial run of pump on 30.12.2013

- Temp rise of DE side seal (68-70°C)
- Dismantling of seal done
- Throttle ring in wear condition
- Clearance checked with sleeve, found within limit (0.21 mm)

Note: As per API 682, maximum diametrical clearance of floating throttle ring is 0.28 mm for shaft ID 81 to 120 mm.
• Technical guidance from OEM (Eagleburgmann) of seal
MECHANICAL SEAL HEATING

Press= 5 Kg/Cm²

Stagnant of process fluid
SEAL QUENCHING

- Quenching is the introduction of a medium, usually water, nitrogen, or steam, on the atmospheric side of a mechanical seal assembly.

- The gland plate is equipped with a throttle bushing to prevent moisture or steam leakage from a quenched seal from entering the bearing housing and contaminating the lubricating oil, and to maximize containment of the quench fluid.

- The quench may be required to prevent solids from accumulating on the atmospheric side of the seal. Typically used with a close-clearance throttle bushing.
API PLAN 62

Prevent solids buildup on atmospheric side of seal. Prevent icing.
THANK YOU