



## MECH-303: Gaskets, Packing and Mechanical Seal Failures Analysis

### Abstract

The early detection and prevention of catastrophic bearing and seal failures alone has justified the existence of predictive maintenance departments within companies. Preventing unexpected failures and unplanned outages saves hundreds of thousands of dollars throughout industry on a daily basis.

But how far have we really come from the mechanic with a good ear and a broomstick or screwdriver? In truth, a vigilant operator or mechanic can catch a large percentage of problems without ever touching instrumentation designed for vibration, oil analysis, enveloping, shock pulse measurement, etc. The real power of today's technology lies not in the detection of problems at an early stage, though that does have great value. More important is the ability to pinpoint the *root cause of failure* and prevent it from happening again.

Preventing unexpected failures and unplanned outages saves hundreds of thousands of dollars throughout industry on a daily basis. Much too often, finding and correcting the root cause of premature failure is not even an issue; the failed mechanical seal or bearing is simply replaced. Even with the best technology available, root causes of failures still elude us. Throughout industry, extending mechanical seal life continues to be a challenge. Successful programs include not only looking at the physical symptoms of a failed seal, but also looking at it from an entire seal system approach. Bearing life calculations prove that bearings designed for critical equipment should last from 11.4 to 22.8 years. Yet, less than 10% of rolling element bearings reach their design life. Why?

First, to accurately troubleshoot bearing and mechanical seal failures, you must understand the component itself. A working knowledge of rolling element bearing types, including their purpose, load and speed capabilities, component parts is essential. You must also understand how to properly install a bearing or mechanical seal...sounds simple, yet there remains much room for improvement, especially when it comes to such subjects as properly checking fits, setting radial internal clearance, careful handling, etc. Next, you must understand the fundamentals of bearing and seal lubrication and the effects of adverse operational and environmental conditions.

A final step in effectively resolving premature failures is to develop the necessary knowledge and skills to accurately identify and evaluate the physical symptoms of bearing and mechanical seal failures and operating environments that result from inadequate design/application, improper installation and assembly, adverse operating conditions/process problems, and adverse environmental conditions.



## **Seminar Duration**

The standard duration of this seminar is 40 hours. Seminar can be customized to meet specific client needs.

## **Who should attend?**

This seminar is designed for maintenance, operations, engineering, technical support and management personnel whose job functions involve rotating machinery. The scope of content is appropriate for technicians who change bearings and mechanical seals, those who detect, investigate and resolve premature machinery failure problems, as well as those who direct activities relative to machine reliability.



## Associated Task(s)

1. When given sufficient machine history and a failed bearing or mechanical seal, identify and evaluate specific symptoms of the failure, list probable causes of failure and generate potential solutions for preventing recurrence of the failure.
2. Identify and resolve premature bearing failures that result from the following four (4) general categories:
  - A. Improper installation and fit
  - B. Inadequate lubrication
  - C. Operating/mechanical conditions adverse to the bearing
  - D. Adverse environmental conditions
3. Identify and resolve premature Mechanical seal failures that result from the following four (4) general categories:
  - A. Design/Application
  - B. Assembly Errors
  - C. Operating Conditions/Process Problems
  - D. Adverse environmental conditions

## Seminar Objectives

Upon successful completion of the seminar, the student will be able to:

1. Explain the benefits of precision maintenance.
2. Explain the purpose of bearings.
3. Discuss bearing life expectancy, including the effects of the following:
  - A. Bearing Load
  - B. Type of Machine Service
  - C. Shaft Rotating Speed
  - D. Static and Dynamic Loads
4. Define terms associated with bearing designation, bearing installation, bearing lubrication and bearing failure analysis as listed in the glossary.
5. When given the following types of bearings, explain the bearing construction, general applications, types of loads supported and general limitations:
  - A. Plain Bearings
  - B. Conrad (deep groove) Ball Bearing
  - C. Maximum Capacity Ball Bearing
  - D. Double Row Ball Bearing
  - E. Double Row Self-aligning Ball Bearing
  - F. Angular Contact Ball Bearing
  - G. Spherical Roller Bearing



- H. Cylindrical Roller Bearing
  - I. Needle Roller Bearing
  - J. Tapered Roller Bearing
6. Explain how each of the following is used to describe a specific bearing and how these terms impact bearing performance:
    - A. Grade of Precision
    - B. Series Designation
    - C. Bore Size
    - D. Type of Fit
    - E. Radial Internal Clearance
    - F. Preload
    - G. End Play
    - H. Contact Angle
    - I. Type of Cage
  7. When given the following types of mounted bearings, identify the type of mounting and describe its general uses and limitations:
    - A. Pillow Block Bearing
    - B. Flange Mountings
    - C. Take Up Units
  8. Explain how the following methods are used to detect impending bearing failures, including, the advantages and disadvantages of each:
    - A. Listen, Feel, Look
    - B. Vibration Monitoring, Analysis, and Diagnostics
    - C. Enveloping
    - D. Oil Analysis
  9. Explain bearing root cause failure analysis and prevention procedures, including:
    - A. Failure Investigation
    - B. Root Cause Analysis
    - C. Strategy and Corrective Action Determination
    - D. Success Evaluation
  10. When given a failed bearing and sufficient machine history:
    - A. Identify, describe, and document the major physical symptoms of failure.
    - B. Explain and document potential causes of failure.
    - C. Evaluate symptoms and potential causes to determine corrective actions.
  11. Explain the purposes of mechanical seals.
  12. Discuss mechanical seal life expectancy.
  13. Describe how a mechanical seal functions to seal a rotary shaft joint.
  14. Identify the major component parts of a mechanical seal and the function of each.

15. Describe the possible paths of leakage in a mechanical seal.
16. Discuss the common mechanical seal face materials used in your facility and the advantages and limitations of each.
17. Discuss the types of seal chambers and the advantages and limitations of each.
18. Describe the various classifications of Mechanical seals (Design/Arrangement).
19. Describe the requirements for seal face lubrication and cooling and how this is accomplished.
20. Describe the various piping plans used at your facility and function of each.
21. Discuss the various pieces of auxiliary equipment used in conjunction with mechanical seals and the functions they serve.
22. Describe and/or demonstrate how to properly install a component type seal.
23. Describe and/or demonstrate how to install a cartridge type seal.
24. Discuss the requirements for startup of components equipped with mechanical seals.
25. Discuss the requirements for operation and shutdown of components equipped with mechanical seals.
26. Describe the basic steps involved in troubleshooting mechanical seal failures.
27. When given a failed mechanical seal or symptoms of the failed seal, determine the cause of failure and the potential corrective action.
28. Describe the basic operation of a centrifugal pump including identifying its basic component parts and the function of each.
29. Describe the effects of the following on Seal Operation:
  - A. Cavitation
  - B. Recirculation
  - C. Operating Pump at shutoff conditions
  - D. Standby equipment
30. Describe the fundamental components of a basic centrifugal pump performance curve.



31. Discuss the implications of running a pump off the Best Efficiency Point (BEP).
32. State the relative percentages of mechanical seal failure causes in the industry and at your facility.
33. Define terms associated with mechanical seal designation, mechanical seal installation, mechanical seal flushing and mechanical seal failure analysis.
34. When given various types of mechanical seals, explain the mechanical seal construction and general applications.
35. Explain Mechanical seal root cause failure analysis and prevention procedures, including:
  - A. Failure Investigation
  - B. Root Cause Analysis
  - C. Strategy and Corrective Action Determination
  - D. Success Evaluation
36. When given a failed Mechanical seal and sufficient machine history:
  - A. Identify, describe, and document the major physical symptoms of failure.
  - B. Explain and document potential causes of failure.
  - C. Evaluate symptoms and potential causes to determine corrective actions.



## Seminar Outline

### 1.0 Introduction

- 1.1 Making Precision Maintenance Happen
- 1.2 Seminar Overview, Objectives, and Schedule

### 2.0 Bearing Fundamentals

- 2.1 Purposes of Bearings
- 2.2 Bearing Life and Effects of Load, Speed, Etc.
- 2.3 Bearing Terminology
- 2.4 Functions and Characteristics of Different Bearing Types
- 2.5 Bearing Manufacturer Designations and their Meanings
- 2.6 Bearing Tolerances, Grades of Precision, Series, and Bore Size
- 2.7 Bearing Clearance and Preload
- 2.8 Bearing Fundamentals Activities!

### 3.0 Methods of Detecting Impending Bearing Failures

- 3.1 Listen, Feel, Look
- 3.2 Vibration Monitoring, Analysis, and Diagnostics
- 3.3 Enveloping
- 3.4 Oil Analysis
- 3.5 Bearing Detection Activities!

### 4.0 Rolling Element Bearing Failures, Causes, and Solutions

- 4.1 Root Cause Failure Analysis Processes
- 4.2 Normal vs. Abnormal Wear
- 4.3 Bearing Failure Terminology
- 4.4 Proper Bearing Removal/Disassembly
- 4.5 Installation and Fit Problems: Symptoms, Causes, and Solutions
- 4.6 Lubrication Failures: Symptoms, Causes, and Solutions
- 4.7 Operational Problems: Symptoms, Causes, and Solutions
- 4.8 Environmental Problems: Symptoms, Causes, and Solutions
- 4.9 Bearing Failures and Root Cause Analysis Activities!

### 5.0 Bearing Failure Troubleshooting and Diagnostics

- 5.1 Hands-on Bearing Root Cause Failure Analysis Activities!

### 6.0 Mechanical Seal Fundamentals

- 6.1 Purposes of Mechanical seals
- 6.2 Mechanical seal Life Expectations
- 6.3 Common Causes of Premature Seal Failure
- 6.4 Major Components and Functions



## **7.0 Mechanical seal Failures, Causes, and Solutions**

- 7.1 Root Cause Failure Analysis Processes
- 7.2 Normal vs. Abnormal Wear
- 7.3 Mechanical seal Failure Terminology
- 7.4 Proper Mechanical seal Removal/Disassembly
- 7.5 Design/Application Problems: Symptoms, Causes, and Solutions
- 7.6 Assembly: Symptoms, Causes, and Solutions
- 7.7 Operational Problems: Symptoms, Causes, and Solutions
- 7.8 Environmental Problems: Symptoms, Causes, and Solutions
- 7.9 Mechanical seal Failures and Root Cause Analysis Activities!

## **8.0 Mechanical seal Failure Troubleshooting and Diagnostics**

- 8.1 Hands-on Mechanical seal Root Cause Failure Analysis Activities!

## **9.0 Conclusions**

**NOTE:** *This 2-tier condensed outline highlights the major subjects and general sequence of the seminar. More detailed and day-to-day outlines are available upon request.*

