

Lubrication and Bearing Failure

Maximize Performance of Your Equipment and Achieve Greatest Cost Savings Using State-of-the-Art Technology for Understanding and Preventing Bearing Failure

JW Marriot Hotel, Kuala Lumpur, Malaysia • 9th – 11th June 2010



Course Facilitator:

Dr Robert H. Badgley
Emcon Systems

Hear What Other People Said About Dr. Badgley's Courses

'Very good, balanced course for petrochem engineers'

~ Texaco Inc.

'Case studies related well to my machinery problems'

~ M.W. Kellogg

'Analysis methods and techniques were helpful in understanding my motor and pump problems'

~ Dow Chemical

'Relevant and useful'

~ Brunei Liquefied Natural Gas

'Excellent experience gained'

~ Brunei Liquefied Natural Gas

'Outstanding instructor skill and knowledge'

~ Brunei Liquefied Natural Gas

Capitalize On Expert Knowledge To Gain Valuable Knowledge On These Vital Issues

- ❖ **GET** a deeper and stronger understanding of how to apply lubrication technology to help avoid bearing failures
- ❖ **BUILD** practical bearing failure problem solving techniques through case studies and best practices illustrations
- ❖ **GARNER** knowledge about advanced practices and relevant knowledge-based approaches to lubricant analysis to determine early warnings of bearing failures
- ❖ **DEVELOP** a systematic thinking process to identify causes of bearing failure, based on measurement and analysis of lubricant properties
- ❖ **APPLY** time-proven techniques for dealing with lubricant degradation leading to bearing failures in your machinery and equipment
- ❖ **EXAMINE** critical elements for effective use of lubricant analysis laboratories

Dr. Badgley's training courses are thoroughly researched and carefully structured to provide practical and exclusive training applicable to your organization.

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Benefits include:

- Thorough and customized programmes to address current market concerns
- Illustrations of real life case studies
- Comprehensive course documentation
- Strictly limited numbers

Official Hotel:

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JW MARRIOTT
KUALA LUMPUR



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Agenda

Workshop Overview

For power generation, petrochemical and other processing industries, high machinery lubrication quality has often been the key to long-life performance of machinery bearings. Requirements for achieving and keeping a quality lubrication program over many years of service have evolved into a quantifiable science. In recent years, newer causes of lubricant-induced bearing failure, such as formation of varnish and sludge by electrostatic discharge, have been identified and research has identified methods of correcting and avoiding the problem.

Through presentations and discussions with our leading expert in lubrication and bearing failure, Dr. Robert Badgley, you will learn how to more effectively evaluate the performance of your machinery bearings and their lubrication systems. This will enable you to quickly determine the onset of machinery bearing distress, accurately identify and correct causes of bearing problems, and move away from costly failure-driven maintenance strategies. This three-day practical course will offer you the opportunity to learn more about various aspects of bearing and lubricant failures in machinery and equipment. During the course, bearing failure diagnostic approaches are presented with practicality in mind. The learning will be accentuated through discussion of case studies and industry best practices.

Facilitated discussion and exercises will allow you to share your challenges and opinions. Delegates can immediately apply the knowledge gained from the workshop to improve and analyze bearing and lubricant health in their machinery and equipment. Following this course, you will depart with a set of more advanced tools to improve your machinery bearing health program and bring lasting changes to your organization.

DAY 1 / 9th June 2010

PART 1 – LUBRICATION AND BEARING RELIABILITY

- ❖ Introduction
- ❖ Course objectives
- ❖ The role of lubrication in bearing reliability
- ❖ Life management strategies
- ❖ Availability

PART 2 – BEARING DESIGN

- ❖ Surface interaction modes - rolling contact
- ❖ Surface interaction modes – sliding contact
- ❖ Corrosion
- ❖ Hydrodynamic film lubrication
- ❖ Spring and damping coefficients
- ❖ ElastoHydroDynamic (EHD) lubrication
- ❖ Stribeck Curve - Phase Changes

PART 3 – BEARING LUBRICANTS

- ❖ General
- ❖ Types of Bearing Lubricants
- ❖ Liquid lubricants
- ❖ Lubricant categories
- ❖ Additives
- ❖ Grease thickeners
- ❖ Viscosity

PART 4 – OIL ANALYSIS FOR BEARING ASSESSMENTS

- ❖ Setting limits and targets
- ❖ Interpreting and applying oil analysis results
- ❖ Particle contamination
- ❖ Wear debris detection
- ❖ Wear debris analysis
- ❖ Abnormal viscosity
- ❖ Moisture contamination
- ❖ Additive depletion
- ❖ Oxidation stability
- ❖ Glycol contamination
- ❖ Fuel dilution
- ❖ Soot load and dispersancy
- ❖ Alkalinity reserve
- ❖ Wrong oil
- ❖ Thermal failure
- ❖ Corrosive conditions

DAY 2 / 10th June 2010

PART 5 – BEARING LUBRICANT STORAGE AND HANDLING

- ❖ Lubricant consolidation
- ❖ Bulk and packaged product receipt and storage
- ❖ In-plant handling and management
- ❖ Lubricant delivery
- ❖ Container marking
- ❖ Lubricant in-plant storage practices
- ❖ Lubricant handling tools
- ❖ Clean oil storage options

PART 6 – BEARING LUBRICANT SELECTION

- ❖ Lubricant selection
- ❖ Brief discussion of Tribological analysis theories
- ❖ EHD lubrication theory
- ❖ Lubricant selection criteria
- ❖ Lubricant selection
- ❖ Lubricant options
- ❖ Lubricant application

PART 7 – LUBRICANT CONTAMINATION

- ❖ Types Of Contaminants
- ❖ Solids
- ❖ Atmospheric
- ❖ Machine debris
- ❖ Moisture
- ❖ Air
- ❖ Heat
- ❖ Oxidation byproducts: varnish, sludge
- ❖ Contaminant exclusion
- ❖ Contaminant removal

PART 8 – OIL ANALYSIS AND TESTING

- ❖ Oil analysis history and definition
- ❖ Oil analysis capabilities for early problem detection
- ❖ Oil sampling intervals and methods
- ❖ Oil sampling frequency and testing
- ❖ Reasons for performing oil analysis
- ❖ Commonly-used oil analysis tests
- ❖ Test slate, alarms and limits
- ❖ Several commercially-available instruments

DAY 3 / 11th June 2010

PART 9 – CAUSES OF BEARING OIL DEGRADATION

- ❖ Lubricant degradation cause and effect
- ❖ Electrostatic discharge
- ❖ Oxidation
- ❖ Varnish, lacquer and sludge
- ❖ Testing for lubricant health, varnish and deposit tendency
- ❖ Methods to monitor level of oil degradation
- ❖ Methods to monitor consumption of additives
- ❖ Varnish and lacquer remediation methods
- ❖ Filter element analysis

PART 10 – ROLLING-ELEMENT BEARING FAILURE

- ❖ General characteristics of ball bearings
- ❖ Bearing life
- ❖ Typical lubrication systems
- ❖ Lubricants
- ❖ Lubricated contact mechanics and EHD
- ❖ Bearing radial stiffness
- ❖ Ball bearing internal vibration

PART 11 – JOURNAL BEARING FAILURE

- ❖ Characteristics of journal bearings
- ❖ Bearing stiffness and damping
- ❖ Pedestal dynamic properties
- ❖ Rotor dynamic motions
- ❖ Rotor balance
- ❖ Journal bearing failure precursors
- ❖ Journal bearing failures

PART 12 – APPLICATIONS AND CASE STUDIES

- ❖ Static discharge failure and identification
- ❖ Lubricant failure from Group I / Group II incompatibilities
- ❖ Varnish measurement and mitigation
- ❖ Catastrophic system sludging
- ❖ Condition based oil changes
- ❖ Case studies

CHALLENGES FOR DISCUSSION

Dr. Badgley encourages delegates to bring challenges / issues from their home organizations to the workshop for discussion.

Program Schedule

(Day 1 - Day 3)

08:30	Registration
09:00	Morning Session Begins
10:40 - 11:00	Refreshments & Networking Break
12:45	Luncheon
14:00	Afternoon Session begins
15:30 - 15:50	Refreshments & Networking Break
17:00	Course Ends

Who Should Attend?

This training program is uniquely designed to provide valuable insight on bearing failures for:

- ✓ Lubrication Managers
- ✓ Head of Maintenance or Operations
- ✓ Rotating Equipment Engineers
- ✓ Reliability Engineers
- ✓ Integrity Engineers
- ✓ Vibration Monitoring Engineers
- ✓ Mechanical Engineers
- ✓ Equipment Specialists
- ✓ Technical Managers/Engineers
- ✓ Process Engineers

Why You Should Attend

This is a highly impactful workshop to provide you with a solid and comprehensive understanding of lubrication and its impact on bearing failure. This understanding will help you to quickly identify and correct bearing lubrication problems and improve bearing lubrication performance. Dr. Badgley will share with you some advanced knowledge and solutions for problems resulting from lubricant selection and changes, unintended or unexpected operating conditions, maintenance deficiencies, and effects of various external environments. This is a course developed based on proven methodology and Dr. Badgley's over 43 years of experience in machinery and equipment troubleshooting and lubrication technology. Through a series of practical illustrations and real life case studies, you will return with a new set of perspectives and practical skills.

PRE-COURSE QUESTIONNAIRE

To ensure that you gain maximum value from this course, a detailed questionnaire will be forwarded to you upon registration to establish your exact training needs and issues of concern. Your completed questionnaire will be analysed by the course trainer prior to the event and addressed during the event. You will receive a comprehensive set of course documentation to enable you to digest the subject matter in your own time.

About your course facilitator

Dr. Robert Badgley is owner of Emcon Systems, which offers a range of professional technical consulting services for machinery of many types and sizes (compressors, turbines, bearings, generators, marine equipment etc.)

At Emcon Systems, Dr. Badgley currently provides expert technical consulting services and training to a range of firms at US and international locations. The focal point of Dr. Badgley' services is forensic engineering, directed at understanding and resolving machinery failure problems, sometimes catastrophic, in various types of plant machinery, including fans, blowers, motors, generators, compressors and turbines

With over 43 years of experience, Dr. Badgley has built up a wealth of practical experience with organizations throughout the world. He has undertaken successful projects in Canada, Europe, the Middle East, and Asia, as well as extensively in the US. His partial client list includes:

- ✓ ADMA-OPCO
- ✓ ARCO Dubai
- ✓ Baker Engineering and Risk Consultants, Inc.
- ✓ Barking Power Station, London, England
- ✓ BP · Syncrude
- ✓ Canadian Forces
- ✓ ChevronTexaco
- ✓ ExxonMobil
- ✓ General Electric
- ✓ Global Santa Fe
- ✓ Haier
- ✓ Pemex
- ✓ PetroCanada
- ✓ Rolls Royce Inc
- ✓ Seagate Technology
- ✓ Singapore Air Force
- ✓ Smithsonian Air & Space Museum
- ✓ Suncor
- ✓ TECO-Westinghouse Motor Company
- ✓ US Air Force
- ✓ US Army
- ✓ US Coast Guard
- ✓ US Navy
- ✓ Washington Gas

Dr. Badgley is registered as a Professional Engineer in the State of New York, and is a Life Member of the American Society of Mechanical Engineers. He has authored or co-authored 43 technical publications. He received the Bachelor of Science degree in Mechanical Engineering from Rutgers University, the Master of Science degree in Nuclear Engineering from Massachusetts Institute of Technology, and the Ph.D. degree in Mechanical and Industrial Engineering from Cornell University.