

# **Turbines, Compressors & Pumps Oil Analysis**

**October 19-21 and October 24-26, 2011**

**Brunei Liquefied Natural Gas  
Kuala Belait, Brunei**

**presented by**

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**Maximize Performance of Equipment and Achieve Greatest Cost Savings Using State-of-the-Art Technology for Understanding and Applying Oil Analysis Technology**

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

Advanced Vibration Course: 'Very good, balanced course for petrochem engineers' - Texaco Inc.

Advanced Vibration Course: 'Case studies related well to my machinery problems' - M.W. Kellogg

Advanced Vibration Course: 'Analysis methods and techniques were helpful in understanding my motor and pump problems' - Dow Chemical

Turbines, Compressors & Pumps Oil Analysis Course: 'Relevant and useful' – Brunei Liquefied Natural Gas (2009)

Turbines, Compressors & Pumps Oil Analysis Course: 'Excellent experience gained' – Brunei Liquefied Natural Gas (2009)

Turbines, Compressors & Pumps Oil Analysis Course: 'Outstanding instructor skill and

knowledge' – Brunei Liquefied Natural Gas (2009)

### **Capitalize On This Expert Knowledge To Gain Maximum Value On These Vital Issues**

- GET a deeper and stronger understanding of lubrication and oil analysis technology
- BUILD practical lubrication problem solving techniques through case studies and best practices illustrations
- GARNER knowledge about advanced practices and relevant approaches to lubricant analysis to determine early warnings of impending problems and failures
- DEVELOP a systematic thinking process to identify causes of lubricant failure, based on measurement and analysis of lubricant properties
- APPLY time-proven techniques for dealing with lubricant degradation leading to failures in 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.

Benefits include:

- Thorough and customized programs to address current and future lubricant failure concerns
- Illustrations of real-life case studies
- Comprehensive course documentation
- Strictly limited numbers of attendees

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

Discussions and exercises will allow the attendee to share challenges and opinions. Delegates can immediately apply the knowledge gained from the workshop to improve and analyze lubricant health in their machinery and equipment. Following this course, the attendee will depart with a set of more advanced tools to improve machinery lubricant and lubrication programs.

## DAY 1

### PART 1 – PRECISION LUBRICATION AND MACHINE MANAGEMENT STRATEGIES

- The role of lubrication in machine reliability
- Run to failure
- Preventive management strategy
- Predictive management strategy
- Proactive management strategy
- Machine availability

### PART 2 – APPLIED TRIBOLOGY: THE SCIENCE OF PRECISION LUBRICATION

- Surface interaction modes – rolling contact
- Surface interaction modes – sliding contact
- Corrosion
- Hydrodynamic film lubrication
- ElastoHydroDynamic (EHD) lubrication
- Stribeck curve – phase changes

### PART 3 – LUBRICANT CONSTRUCTION

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

### PART 4 – LUBRICANT PERFORMANCE PROPERTIES – IDENTIFICATION AND MEASUREMENT

- Setting limits and targets
- Interpreting and applying oil analysis results
- Particle contamination
- Wear debris detection and 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**

### **PART 5 – 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
- Drum and container handling tools
- Lubricant handling tools
- Clean oil storage options

### **PART 6 – LUBRICANT SELECTION AND APPLICATION**

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

### **PART 7 – LUBRICANT CONDITION AND CONTAMINATION CONTROL – IDENTIFICATION AND MEASUREMENT**

- Contamination control
- Particle contamination
- Moisture contamination
- Fuel contamination
- Soot contamination
- Glycol contamination

### **PART 8 – LUBRICANT SAMPLING FOR OIL ANALYSIS**

- Oil analysis history and definition
- Oil analysis detection capabilities
- Early problem detection
- Optimum oil sampling
- Oil sampling methods
- Oil sampling frequency

## **DAY 3**

### **PART 9 – MACHINE CONDITION BASED OIL ANALYSIS**

- Oil testing and analysis
- Reasons for performing oil analysis
- Review of common used oil analysis tests
- The oil analysis test slate

- Commercially available instruments

#### PART 10 – SPECIAL CONCERNS FOR TURBINE RELIABILITY

- Lubricant degradation cause and effect
- Electrostatic discharge
- Oxidation
- Oxidation process in lubricant base oils
- 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 11 – PRACTICAL APPLICATIONS / CASE STUDIES – TURBINES AND COMPRESSORS

- Gas turbine - static discharge - failure and identification
- Steam turbine - lubricant failure from Group I / Group II incompatibilities
- Gas turbine – thermal failure - varnish measurement and mitigation
- Steam turbine – avoiding catastrophic system sludging
- Case studies

#### **Challenges for Discussion**

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

#### **Why You Should Attend**

This is a highly impactful workshop to provide a solid and comprehensive understanding of lubrication and its impact on machinery failure. This understanding will help you to quickly identify and correct bearing lubricant and lubrication problems and improve 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 44 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.

#### **Who Should Attend?**

This training program is uniquely designed to provide valuable insight on lubricant and lubrication failures for:

- Head of Maintenance or Operations

- Rotating Equipment Engineers
- Reliability Engineers
- Instrumentation and Control Engineers
- Vibration Monitoring Engineers
- Mechanical Engineers
- Equipment Specialists
- Technical Managers/Engineers
- Process Engineers
- Production Engineers
- Project Engineers
- Plant Engineers
- Lubrication Managers
- Facilities Managers

### **About Your Course Presenter**

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. Dr. Badgley's services are 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 44 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
- Flanders Electric
- 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.

### **Program Schedule**

(Day 1, Day 2 and 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