



MUE237

Principles of Rotating Equipment

Course Introduction:

The course will introduce delegates to the different types of pumps, motors and drives and their associated terminology. Centrifugal and positive-displacement pumps and compressors, packing, mechanical seals and sealing systems, bearings and couplings will all be discussed. The application of the different types of pumps and compressors will be discussed along with their suitability for different operational duties. Pump operation, troubleshooting and maintenance will be dealt with in depth. Several methods of monitoring the health and performance of rotating equipment will be addressed.

Continuous improvement of plant reliability by optimizing predictive maintenance for rotating equipment is one of the most important challenges plants face today. To know how to effectively prevent equipment failures, conduct a successful root cause failure analysis and improve condition monitoring for pumps, turbines and compressors are continuing challenges for engineers. Proper analysis and solving of chronic problems at the source saves time and money.

This course is designed to explain the effective method of component condition monitoring for use as both a predictive maintenance and root cause analysis tool. It also details the major failure causes, the world-class proven root cause analysis procedure with exercises and case histories, installation, pre-commissioning planning, functional testing and commissioning, preventive maintenance strategies and more.

Course Objectives:

Upon successful completion of this course, the delegates will be able to:

- ✓ Recognize the concept of organizing for world class operations particularly the characteristics and steps used toward pacesetter performance
- ✓ Explain equipment failure patterns by distinguishing repairable from non-repairable equipment, identifying the types of equipment failure, reviewing why equipment fails and employing actions to minimize failure effect
- ✓ Develop in-depth understanding on the maintenance effect on reliability and recognize how maintenance influences equipment performance
- ✓ Heighten awareness and understanding on root cause failure analysis (RCFA) including the various types and approaches used in rotating equipment's
- ✓ List down and describe the step by step process of root cause failure analysis (RCFA)

- ✓ Know the principle of predictive maintenance and be able to employ the various predictive maintenance techniques and strategies used in rotating equipment's
- ✓ Identify the various types and components of conditioning monitoring techniques and recognize their importance in rotating equipment reliability optimization and continuous improvement
- ✓ Understand the concept of optimizing reliability particularly conditioning monitoring and predictive maintenance and be able to identify its components and importance

Who Should Attend?

This course is directed towards supervisors, team leaders and managers in maintenance, engineering and production. The course will also benefit anyone who expects to become involved at any stage in project applications and applicable maintenance technologies. The course will also benefit anyone who wishes to update themselves on pump and compressor technology, judge the suitability of different types of pumps and compressors for their needs, and learn how to operate and maintain them for the benefit of their organisations.

- Managers, Section Heads and Planners
- Maintenance, Reliability, Machinery and Plant Engineers
- Maintenance, Reliability, Machinery and Plant Superintendents/Supervisors
- Maintenance, Plant and PMV Foremen
- Operations Managers, Engineers and Supervisors

Course Outline:

Day 1:

Compressors

- Compressor types: positive displacement (reciprocating and rotary), and dynamic (centrifugal and rotary), compressor operation, gas laws
- Compressor performance measurement, inlet conditions, compressor performance, energy available for recovery
- Positive displacement compressors, reciprocating compressors, reciprocating compressors, diaphragm compressors
- Rotary compressors, rotary screw compressor, lobe type air compressor, sliding vane compressors, liquid ring compressors
- Dynamic compressors, centrifugal compressors, axial compressors
- Air receivers, compressor control, compressor unloading system
- Intercoolers and aftercoolers, filters and air intake screens

Centrifugal and Axial Compressors

- Principle of operation of centrifugal and axial flow compressors, characteristics of centrifugal and axial flow compressor
- Surging, choking, bleed valves, variable stator vanes, inlet guide vanes

Day 2:

Compressor Systems Calculations

- Affinity Laws for centrifugal compressors
- Calculations of air leaks from compressed-air systems, annual cost of air leakage
- Centrifugal compressor power requirement
- Compressor selection, calculations of air system requirements
- Sizing of compressor system components, sizing of air receiver
- Calculations of receiver pump-up time

Pumps

- Pump definition, pump categories: dynamic and displacement pumps
- Centrifugal pumps: theory of operation of a centrifugal pump, casings and diffusers, radial thrust, hydrostatic pressure tests
- Impeller, axial thrust, axial thrust in multistage pumps, hydraulic balancing devices, balancing drums, balancing disks
- Centrifugal pumps general performance characteristics, cavitation, net positive suction head and requirements

Day 3:

Pump Selection

- Engineering of system requirements, fluid type, system head curves, alternate modes of operation, margins, wear, future system changes
- Selection of pump and driver, pump characteristics, code requirements, fluid characteristics, pump materials, driver type
- Pump specification, specification types, data sheet, codes and standards, bidding documents, technical specification, commercial terms, special considerations, performance testing, pump drivers
- Special control requirements, drawing and data requirements form, quality assurance and quality control, bidding and negotiation

Bearings & Lubrication

- Types of bearings, ball and roller bearings, stresses during rolling contacts
- Statistical nature of bearing life, materials and finish, sizes of bearings, types of rolling bearings, thrust bearings
- Used oil Analysis: proper lube oil sampling technique, test description and significance, visual and sensory inspections, chemical and physical tests, water content, viscosity, emission spectrographic analysis, infrared analysis, total base number (TBN), total acid number (TAN), particle count, summary

Day 4:

Mechanical Seals

- Basic components, temperature control, seal lubrication/leakage, typical single inside pusher seal
- Maintenance recommended on centrifugal pumps, recommended pump maintenance

Day 5:

Vibration Analysis and Predictive Maintenance

- Vibration instrumentation, velocity transducer, acceleration transducer, transducer selection, time domain, frequency domain, machinery example, vibration analysis
- Vibration causes, forcing frequency causes, unbalance, misalignment, mechanical looseness, bearing defects, gear defects, oil whirl, blade or vane problems, electric motor defects, uneven loading, drive-shaft torsion

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Course Certificate:

International Center for Training & Development (ICTD) will award an internationally recognized certificate(s) for each delegate on completion of training.

Course Methodology:

A variety of methodologies will be used during the course that includes:

- (30%) Based on Case Studies
- (30%) Techniques
- (30%) Role Play
- (10%) Concepts

- Pre-test and Post-test
- Variety of Learning Methods
- Lectures
- Case Studies and Self Questionnaires
- Group Work
- Discussion
- Presentation

Course Fees:

To be advised as per the course location. This rate includes participant's manual, hand-outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Timings:

Daily Course Timings:

08:00 - 08:20	Morning Coffee/Tea
08:20 - 10:00	First Session
10:00 - 10:20	Recess (Coffee/Tea/Snacks)
10:20 - 12:20	Second Session
12:20 - 13:30	Recess (Coffee/Tea/Snacks)
13:30 - 15:00	Last Session

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