



# Rotating Equipment Start Up, Operation, Maintenance & Troubleshooting



## Introduction:

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Rotating Equipment's are the pieces of equipment which are used in almost all manufacturing and processing plants. The effectiveness of their selection, specifications, operations, maintenance and troubleshooting has tremendous impact on plant productivity. An understanding of the basic principles involved, how they work, what can go wrong, troubleshooting and preventive maintenance can go a long way to increase productivity. In addition, pumps and compressors are generally critical machines in any production process, and hence it is vital that maintenance is most effective for these units.

## Who Should Attend?

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Plant and process engineers, operators, supervisors and team leaders and managers in maintenance engineering and production. It is suitable for those who expects to become involved at any stage in project application and applicable maintenance technologies. The seminar will also benefit anyone who wishes to update themselves on pump and compressor technology, judge the suitability of different types of rotating equipment's for their needs, and learn how to operate and maintain them for the benefit of their organizations

## Methodology:

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This interactive Training will be highly interactive, with opportunities to advance your opinions and ideas and will include;

- Lectures
- Workshop & Work Presentation
- Case Studies and Practical Exercise
- Videos and General Discussions

## Certificate:

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**BTS** attendance certificate will be issued to all attendees completing minimum of 80% of the total course duration.

## Course Objectives:

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The program assumes familiarity with troubleshooting and maintenance of rotating equipment. It adopts the approach to understanding the failure of all types of pumps and compressors. From a component-by-component perspective, the program investigates the root causes of failure, and relates these to operating conditions and process parameters. Installation, lubrication and wear related failure mechanisms are identified and a detailed understanding of the troubleshooting and diagnostic methods needed to detect and identify these is developed. The program provides participants with the knowledge needed to be effective in the inspection, monitoring and diagnostics of pumps and compressors, with emphasis placed upon the importance of a combined condition monitoring and strip-down inspection approach to maintenance. The main objective of this course is to enhance skills of plant personnel to increase productivity. This program aims to provide delegates with a comprehensive understanding of how to use a combined predictive and preventive maintenance approach to achieve maximum reliability and greatest understanding of any deterioration that may occur. This course focuses on the essentials to add to the skills of those who are responsible for plant equipment to reduce breakdowns and get more operation hour.

## Course Outline:

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### TECHNOLOGY OF PUMPS

- Parts of the machine: casing, rotor, bearing, coupling.
- Auxiliaries: heating, cooling, lubrication.

**Maintenance: strip-down, assembly, inspection, clearance, adjustment.**

- Video: Basic Pump Types and Technology.
- Summary of Thermodynamic Concepts involving Entropy.

### OPERATION & PERFORMANCE

- Process aspects
- Operating parameters; head, flow, rpm, efficiency.
- Characteristic curves.
- Effect of wear.
- Mechanical issues.
- Video: Fundamentals of Pump Performance 1. .

### TECHNOLOGY OF COMPRESSORS

- Compression Methods
- Positive-Displacement And Rotodynamic compressors

#### 1.Reciprocating compressors technology and maintenance

- Different types of machine for the compression of gas
- Piston compressors
- Design applications of reciprocating compressors with one or more stages
- Types of construction

- Machines with and without crossheads

## 2.Compression cycle of reciprocating compressors and basic calculations

- Ideal cycle of piston compressor
- Real cycle departure from ideal cycle
- Volumetric efficiency
- Example of calculation
- Capacity
- Power
- Compression in several stages
- Allowable pressure and temperature
- Allowable speed
- Rod loading

## Main Parts and Construction

- Frame and crankshaft assembly
- Crosshead
- Connecting rod
- Bearing and bushes
- Cylinders and clearance volume
- Pistons rings and rider rings
- Stuffing boxes
- Valves

## 3.Capacity control

## 4.Compressor Performance

- Ideal gas compression, power

- P-V diagram
- Actual operating conditions, valves behavior
- Characteristic curves
- Efficiency

## 5.Compressor Operation

- Start up and loading system
- Capacity control

## Centrifugal Compressors Technology And Maintenance

### 1.Aerodynamic Components

- Axial Compressors
- Centrifugal Compressors
- Interstage Seals
- Balance Piston Seal
- Impeller Thrust
- Efficiency Improvement

### 2.Compressor Characteristics

- Centrifugal Compressors
- Slope
- Stonewall
- Surge
- Off-Design Operation
- Adjustable Vanes

### 3.Systems And Techniques Of Protection

## 4. Technology Of Maintenance

- Disassembly And Assembly Procedures
- Inspection, Repair And Installation Of Labyrinth
- Dry Seal Replacement
- Tribology And Lubrication Of Bearings

## 5. Troubleshooting

- Field Problems (Case Studies)
- Troubleshooting Guide
- Bearing Inadequate Lubrication Failure

## Gas turbine

### Fundamental Thermodynamics:

- Reversible cycles with ideal gases
- Actual gas turbine cycle
- Combustion air compressor performance characteristics
- Combustion processes
- Gas turbine performance calculation
- Comparison of basic specifications

### Gas Turbine Components:

- Axial-flow compressor
- Radial-inflow turbines
- Combustors, construction types
- Igniters
- Fuel nozzles
- Hot path components

- Firing concept and emission control

### Gas Turbine Operation and Maintenance:

- Operating philosophies
- Analytical on-line condition monitoring
- Modern bores copy
- Selecting maintenance approaches
- Maintenance planning
- Spare parts and special tools
- Inspection, overhaul and repair
- Maintenance control and documentation
- Evaluation
- Gas turbine maintenance effectiveness
- Establishing and tracking performance indices

### Steam Turbines:

- Operating Principles, Impulse Turbines, Reaction Turbines
- Turbine Components:
- Turbine Rotors, Blading, Diaphragms, Nozzles, Steam Chests, Glands and Gland Systems, Bearings
- Balancing, Rotor Dynamics, Governing Systems, Lube Oil Management
- Overview of Selection and Sizing of Steam Turbines for Reliability:
- Thermodynamics, Steam (Water) Rates, Condensing and Backpressure Turbines, Single and Multistage Types, Process Considerations –
- Operation and Maintenance of Steam Turbines:
- Operation and Maintenance of Steam Turbines (Continued):
- Steam Turbine Washing, Steam Turbine Inspection, Maintenance, Overhaul and Repair

### LUBRICATION AND BEARING PROBLEMS

- Purpose, different types of oil and grease.
- Anti-friction bearings: types, lifetime, mounting, applications, related problems.
- Plain and pad bearings, thrust bearings: operation, maintenance, incidents.

## COUPLINGS & MISALIGNMENT

- Different types of couplings, related problems
- Different methods of alignment.

## SEALS

- Mechanical pump seals, types, operation, related problems.
- Other seals for positive displacement pumps and reciprocating compressors.
- Pump Sales: Affinity laws. Pump software. Suction lift. Viscosity. Re-rate/retrofit. Head-rise. Radial/horizontal split case

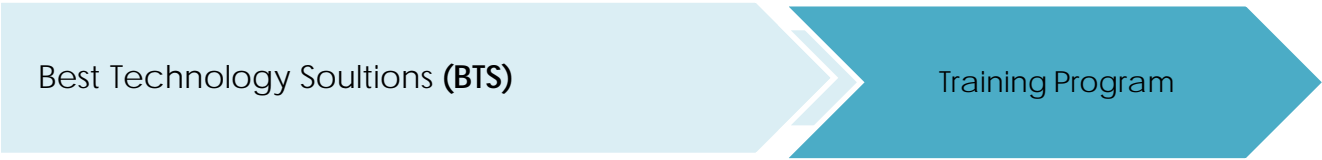
## Alignment Methods & Application

### 1- Introduction

- What's Alignment?
- The alignment Process
- Pre-shutdown preparation
- Prior to Misalignment Measurement
- Base preparation
- Coupling Run out
- Soft Foot
- Piping Strain
- Types of Misalignment

## Condition Monitoring protection





Best Technology Solutions **(BTS)**

Training Program

- Vibration
- Temperature
- Pressure
- Flow