



A Successful 8-Day In-house Training Course

Sulzer Pump System, Operation and Maintenance

ISO 29990:2010 Certified



ISO 9001:2015 Certified



This course is Designed, Developed, and will be Delivered under
ISO 29990:2010 Standards & ISO 9001:2015

Sulzer Pump System, Operation and Maintenance

WHY CHOOSE THIS TRAINING COURSE?

Power Plant and other petrochemical industries deal with different types of pumps. Understanding the design, operation & characteristics of pumps will have an important reflection on the process quality, equipment and plant reliability and the economics of the whole activity. Identifying the problems associated with pumps is essential for diagnosis and troubleshooting and the needed maintenance for the particular type of pumps. This course is designed to provide an in-depth perspective of Sulzer pump technology in terms of selection, operation, maintenance and troubleshooting. Topics include Sulzer pump types and terminology. The course will also cover single stage and multi stages centrifugal pumps and positive-displacement pumps. Packing, mechanical seals, sealing systems, wear rings, coupling and alignment and other vital components will be explained in details. Sulzer pump operation, troubleshooting and maintenance will be dealt with in depth. The course will feature a unique blend of practical application experience and basic analysis methods. The course aim is to convey a thorough understanding of pump operating principles, operating systems, advantages and disadvantages of various pump types.

The course will concentrate on thorough understanding of technical principles of fluid flow in pumping systems as a prerequisite for successful pump installation and operation.

The course will also include various examples selected from real-life technical practice that will be solved and discussed in order to illustrate methods of efficient operation and maintenance of pumping systems.

WHO IS THIS TRAINING COURSE FOR?

This course is recommended for anyone involved in the selection, inspection, maintenance and troubleshooting of pumps. This includes:

- Mechanical Maintenance Engineers
- Operation Engineers
- Mechanical Maintenance Supervisors
- Mechanical Maintenance Technicians
- Plant Field Supervisors and Section Heads
- Plant Field Operators

WHAT ARE THE GOALS?

The purpose of this course is to provide the participants good information on the fundamentals of different types of Sulzer pumps, which used in petrochemical industry and to explain how they work.

Also, it will provide a thorough understanding of Sulzer pumps construction and all related parts such as different types of mechanical seals, packing's, bearings, casings and impellers through discussion of the operation procedures and kinds of maintenance practices necessary to keep them operating efficiently and safely.

Upon completion of this course participants will be able to understand the following:

- Know the basic principal of pump operations
- Learn the different types of pumps
- Understand the pump construction
- Learn how the performance curve of pump is measured

QUALITY CERTIFICATIONS



- Use the similarity laws to calculate the pump performance at different speed and rotor size
- Highlight the importance of the related international standards of pumps
- Familiarize with different auxiliary systems for pumps (oil system and protection system)
- Understand the basics of sealing systems (mechanical seals and packing) as well as the different types of bearings and its applications
- Learn the maintenance procedure of pumps
- Learn the common causes of pump failures (e.g. cavitation and vibrations)
- Familiarize the attendees with different types of seals
- Understand the mechanical design of the mechanical seal
- Learn the principles of operation of the mechanical seal
- Highlight the importance of seals on the rotating machines availability
- Learn the Up-to date maintenance of the mechanical seal
- Learn the failure analysis and troubleshooting the mechanical seal
- Familiarize the attendees with different types of bearings, couplings and their associated problems
- Different types of alignment will be explained in details
- Casing, wear rings and impeller types and their usage will be discussed

COURSE DURATION

The course duration will be (8) eight days. It will commence promptly at 08:00 am, each day will conclude at 2:00 pm daily.

HOW WILL THIS TRAINING COURSE BE PRESENTED?

- A highly interactive combination of lectures and discussion sessions will be managed to maximize the amount and quality of information and knowledge transfer. The sessions will start by raising the most relevant questions, and motivate everybody find the right answers.
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- The delegates will also be encouraged to raise their own questions and to share in the development of the right answers using their own analysis and experiences. Tests of multiple-choice type will be made available to examine the effectiveness of delivering the course.

This interactive training course includes the following training methodologies as a percentage of the total training hours:-

50%	Lectures and presentations
30%	Practical Exercises
20%	Videos & General Discussions

COURSE ASSESSMENT:

Pre-Test: To measure a starting point or the amount of pre-existing knowledge on the course topic.

Post-Test: To measure the learning as a result of the course experience.



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Sulzer Pump System, Operation and Maintenance

Daily Topics

DAY ONE

Introduction and Pumping Fundamentals

- Introduction
- Pre - test
- Hydraulics - A Few Basics
- Vapor Pressure
- Pumping process concept
- Operating Parameters
- Head
- Flow
- RPM
- Power
- Efficiency
- Pressure Concepts
- Pump Net Positive Suction Head (NPSH)

Pumping Methods

- Centrifugal action
- Displacement action
- Rotary displacement pumps
- Pump Classification
- Pump Types and Terminology
- Pump Classification
- Centrifugal Pump Basics
- Principle of Operation
- Understanding of pumping theory
- Classify characteristics of pumps
- Mixed Flow Pumps
- Axial Flow Pumps
- Low-pressure & High-pressure pumps
- Pumping vertically & pumping horizontally
- Single-suction & Double-suction pumps
- Single-stage, Double-stage and Multi-stage pumps
- Volute & Diffuser pumps
- Closed impeller, open, impeller or Semi-open impeller
- Casing Construction (Radially Split, Axially Split, Double Casing)
- Impeller Shrouds (Open, Partially Open, Closed)
- Shaft Position (Horizontal, Vertical)
- Wear Ring Running Clearances

DAY TWO

Pumps performance curves

- Head-Capacity curve
- Power-Capacity curve
- Efficiency-Capacity curve
- NPSH-Capacity curve
- Limits of operation
- Characteristics curves for different types of pumps
- How to obtain these curves experimentally
- How to calculate these characteristic curves

Specific speed and specific diameter

- The significant of the Specific Speed and the Specific Diameter
- How to calculate these numbers
- How to use these number in pumps selection process

Parameters affecting the pump performance

Similarity Laws

- The effect speed variation
- The effect of impeller trimming

Pumps Operation Procedures

- Operating conditions
- Pump curve against piping system curve
- System curve calculation
- NPSH available and required
- Suction system configurations
- NPSH measurement
- Normal operating range
- Best operating condition
- The minimum flow rate limit
- The maximum capacity limit
- Off-design operation
- Operation difficulties

DAY THREE

Materials of Construction of Pumps

- Introduction
- Typical materials
- Corrosion and erosion
- Abrasion resistant materials
- Materials resistant to cavitation damage
- Material selection

Pumps Selection

- Overall procedure in selecting a pump
- Parameters affecting the pump selections
- Properties of liquids being pumped
- Material selection
- Manufacturer data and curves
- Economic consideration
- Pumps application
- Comparison between different types
- Essential data required

Pumps Standards

- Hydraulic Institute Standard
- API standard
- How to use standards for pumps selection
- How standards differ from each other
- How to use standards to write the right specification for pumps

DAY FOUR

Positive Displacement Pumps

- Rotary positive displacement pump theory
- Reciprocating positive displacement pump theory
- Positive displacement pump curves
- Classification of positive displacement pumps by application
- External gear pumps
- Construction of external gear pump
- Internal gear pumps
- Construction of internal gear pump
- Archimedes screw pumps
- Twin-rotor screw pumps
- Progressive cavity pumps
- Lobe pumps (including circumferential piston pumps)
- Vane pumps
- Construction of vane pump
- Peristaltic pumps (including rotary peristaltic pumps)
- Rotary eccentric piston pumps
- Axial and radial piston pumps
- Reciprocation pumps
- Inline piston pumps
- Plunger pumps (includes horizontal and vertical)
- Diaphragm pumps (includes mechanical and hydraulic actuation)
- Air-operated double-diaphragm pumps
- Metering pumps
- Direct-acting reciprocating pumps (includes pneumatic, hydraulic and steam actuation)
- Non-metallic positive displacement pumps
- Positive Displacement pumps failure modes
- Positive displacement pumps troubleshooting

DAY FIVE

Sealing Methods

- Overview (Packing and Mechanical Seals)
- Soft packing
- Difference between packing and mechanical seal
- Packing material
- Cooling methods for packing
- Packing installation procedure

Mechanical Seals

- Mechanical Seal Types / Arrangement / Plans
- Characteristics and Types of Mechanical Seals
- Applications of Mechanical Seals
- Mechanical seals in centrifugal pumps
- Mechanical seals in compressors
- Construction of Mechanical Seals
- Materials of Seal's Components
- Temperature Control of Mechanical Seals
- Sealing and Flushing Fluids
- Mechanical seal plans according to API 682
- Installation of Mech. Seals
- Operation and Applications
- Selection of Seals
- Causes of Seal Failure
- Maintenance and Repair
- Troubleshooting of Seal Failure

DAY SIX

Pump Auxiliary System

- Pump Bearings
- Antifriction bearings
- Journal bearings
- Range of applications
- Lubrication of bearings
- Lubrication – different methods of lubrication
- Lube-oil systems
- Bearings – failure modes and how to extend life

Alignment and Couplings

- Pre-shutdown preparation
- Prior to Misalignment Measurement
- Base preparation
- Coupling run out check
- Shaft run out check
- Soft Foot
- Piping Strain
- Thermal growth

Alignment Calculation

- Balance Dial Indicator
- Converting sweep readings
- Formulas for determining Horizontal and Vertical Moves

Rim and Face Shaft Alignment

- Alignment Accuracies
- Rim and Face Machine Shaft Alignment

Sulzer Pump System, Operation and Maintenance

Daily Topics

- Rough Alignment
- Precision Alignment
- Rough Horizontal Alignment
- Precise Horizontal Alignment
- Presentation for Final Readings

Reverse/Cross Dial Alignment Method

- Cross dial method
- Rim Dial reading
- Cross Dialing Alignment Graphical Method
- How to construct the cross dial Graph
- Steps in Drawing the Graph
- Horizontal Cross Dial Graph Example
- Graph Method of Cross Dialing in the Horizontal Plane
- Cross Dial Measurement Method
- Corrective Moves on MTBM
- Misalignment Limits
- Angular Error Check
- Offset Error Check
- Alignment Error Limitations
- Cross Dialing Horizontal Plane Alignment Using Formulae
- Comparing Cross Dialing to Reverse Dialing

Flexible and Rigid Couplings

- Coupling and Shaft Misalignment Tolerances
- What is the Difference
- The Role of Flexible Coupling
- What to Consider when Specifying a Flexible Coupling
- Types of Flexible Couplings
- Rigid Coupling Design
- Flexible Coupling Lubrication
- Coupling Installation
- Coupling Hub Attachment Methods
- Keys and Keyways

DAY SEVEN

Pump Maintenance

- Introduction
- Maintenance Definition
- Maintenance Goals
- Maintenance strategies
- Reactive Maintenance
- Preventative Maintenance
- Predictive Maintenance
- Total Productive Maintenance
- Reliability - Centered Maintenance
- Overall Equipment Effectiveness
- Measuring methods
- Monitoring and Data collection

Maintenance Inspections

- Proper Preventive Maintenance Schedule
- A maintenance schedule includes these types of inspections:
 - » Routine maintenance
 - » Routine inspections
 - » Three-month inspections

Bearing Maintenance

- Bearing lubrication schedule
- Lubricating-oil requirements
- Oil volumes
- Acceptable oil for lubricating bearings

Shaft Seal Maintenance

- Mechanical-seal maintenance

Packed Stuffing-Box Maintenance

- Accepted leakage rate
- Adjustment of gland
- Tightening of packing

Pump Overhauling

Disassembly/dismantling Procedure

- Lock out and Tag out
- Tools required
- Drain the pump
- Remove the coupling
- Remove the back pull-out assembly
- Remove the coupling hub
- Impeller removal
- Seal-chamber cover removal
- Remove the dynamic seal
- Power-end disassembly
- Disassemble the bearing frame
- Pre-assembly inspections
- Replacement guidelines
- Shaft and sleeve replacement guidelines
- Surface inspection locations
- C-face adapter inspection
- Seal chamber and stuffing box cover inspection
- Bearings inspection
- Condition of bearings
- Checklist
- Bearing-housing inspection
- Checklist
- Bearing fits and tolerances

Reassembly

- Assemble the rotating element and the bearing frame:
- Assemble the frame
- Install the impeller
- Post-assembly checks
- Bolt torque values
- Parts dismantle, refurbishment, inspection.
- Wear limit measurement & assembly.
- Shaft-end play measurements
- Adjusting wear ring clearance
- Measuring shaft run out
- Measuring bearing radial clearance
- Measuring impeller clearance

DAY EIGHT

Pump Troubleshooting and Failure Analysis

- Why Machine Failure?
- Types of Failure Causes
- Affect of Failure on the Plant
- Failure Cascading
- Failure Modes
- Chronic vs. Sporadic Failure

Shaft Deflection

- Critical speed and shaft deflection
- Parameters affecting shaft deflection
- Effects of shaft deflection on Mechanical seals and Bearings

Cavitation in Pumps

- Net Positive Suction Head
- Available against required NPSH
- Concept of Pump Cavitation
- Symptoms of cavitation
- Effects of Cavitations
- Avoidance of cavitation

Pump Vibration

- The main reason for pump vibrations:
- Unbalance
- Misalignment
- Mechanical loosens
- Resonance
- Bearing failure
- Cavitation

Operation and Maintenance Troubleshooting

- Pump does not deliver
- Insufficient capacity delivered
- Insufficient discharge pressure developed
- The pump starts and then stops pumping.
- Pump loses prime after starting
- Pump requires excessive power
- Stuffing box / mechanical seal leak excessively
- Packing / mechanical seal has short life.
- The motor requires excessive power.
- Pump vibrates or noisy
- Bearing have short life
- Pump overheats and seizes

Assembly Troubleshooting

- There is excessive shaft end play.
- There is excessive shaft and sleeve runout.
- There is excessive bearing-frame flange Runout.
- There is excessive frame-adapter runout.
- There is excessive seal chamber or stuffing box cover runout.
- There is excessive vane-tip runout of the impeller.

Around 45 specific root-causes have been identified similar to the few listed below:

- Pump not primed
- Suction lift too high
- Insufficient margin between suction pressure and vapor pressure
- Total head required by process lower than pump design
- Specific gravity of liquid different from design
- Operation at very low capacity
- Parallel operation of pumps unsuitable for such operation
- Misalignment
- Bearings worn out
- Wearing rings worn out
- Rotor out of balance causing vibration
- Improper selection, fitting or usage of mechanical seal
- Lack of lubrication

Case Studies




Discussion and Post-Test

Last Day Review

Presentation of Certificates

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