

COURSE OVERVIEW ME0172-4D
INDUSTRIAL EQUIPMENT & TURBOMACHINERY

Pumps, Compressors, Turbines & Motors: Selection, Sizing, Applications, Operation, Diagnostic Testing, Troubleshooting, Maintenance & Failure Analysis

Course Title

INDUSTRIAL EQUIPMENT & TURBOMACHINERY: Pumps, Compressors, Turbines & Motors: Selection, Sizing, Applications, Operation, Diagnostic Testing, Troubleshooting, Maintenance & Failure Analysis



Course Date/Venue

Session 1: August 19-22, 2024/Fujairah Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE

Session 2: November 25-28, 2024/Al Aziziya Hall, The Proud Hotel Al Khobar, Al Khobar, KSA

Course Reference

ME0172-4D



Course Duration/Credits

Four days days/2.4 CEUs/24 PDHs

Course Description



This practical and highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.



Maximum efficiency, reliability, and longevity of pumps, compressors, turbines, bearings and motors are of great concern to many industries. These objectives can only be achieved by understanding the characteristics, selection criteria, sizing calculations, sealing arrangements, common problems, troubleshooting, repair techniques, preventive and predictive maintenance of those turbo machineries.



This course is a MUST for anyone who is involved in the selection, calculations, sizing, applications, troubleshooting or maintenance of pumps, compressors, turbines, bearings or motors. It covers how this equipment operates and provides the guidelines and rules that must be followed for a successful application.

Their basic design, specification and selection criteria, sizing calculations as well as all maintenance issues including troubleshooting, vibration analysis, and used oil analysis are covered in detail.

This course is designed to provide delegates with a detailed and up-to-date overview of the fluid mechanic fundamentals and operating practice of pumps, compressors, turbines and motors. It will address aspects of both axial and centrifugal compressors. Upon the successful completion of this course, participants will have acquired the practical knowledge to enable them not only to choose the correct device for a particular application but also be in a position to resolve many commonly occurring operating problems.

This course is ideal for those personnel in the oil, gas, petrochemical, chemical, power and other process industries who require a wider and deeper appreciation of pumps, compressors, turbines and motors, including their design, performance and operation. No prior knowledge of the topic is required. Participants will be taken through an intensive primer of turbo-machinery principles, using the minimum of mathematics, and will learn how to solve the many and varied practical industrial problems that are encountered. The course makes use of an extensive collection of VIDEO material.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply an in-depth knowledge and skills in various industrial equipment and turbomachines including pumps, compressors, turbines and motors
- Implement systematic techniques on selection, sizing, application, operation, testing, troubleshooting and maintenance of various industrial equipment and turbomachineries
- Identify the various types of compressors, performance measurement and preventive maintenance
- Illustrate the operation and characteristics of centrifugal and axial compressors as well as compressor systems calculations
- Define and categorize pumps and discuss centrifugal pump theory, general performance and basic components
- List types of bearings and explain statistical nature of bearing life
- Demonstrate viscosity of lubricants and oil analysis
- Describe the characteristics of induction motors including their speed control, maintenance, troubleshooting techniques and diagnostic testing for failures in three-phase stator windings.
- Illustrate vibration instrumentation and analysis, the cause of vibration and predictive maintenance
- Implement proper techniques and procedures of turbomachinery maintenance and troubleshooting
- Recognize the root causes of machine failure like the vibration and employ the proper steps to troubleshoot anomalies
- Employ troubleshooting techniques in accordance with the turbomachinery API & ISO standards and specifications

Exclusive Smart Training Kit - H-STK®



Participants of this course will receive the exclusive “Haward Smart Training Kit” (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials, sample video clips of the instructor’s actual lectures & practical sessions during the course conveniently saved in a **Tablet PC**.

Who Should Attend

This course provides an overview of all significant aspects and considerations of industrial equipment and turbomachinery for those who are involved in the selection, sizing, applications, operation, testing, troubleshooting, maintenance and failure analysis of pumps, compressors, turbines and motors. Engineers, supervisors, foremen and other technical staff dealing with industrial equipment, turbomachinery and rotating equipment will benefit from this course.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

- 30% Lectures
- 20% Practical Workshops & Work Presentations
- 30% Hands-on Practical Exercises & Case Studies
- 20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Fee

US\$ 4,500 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations


Certificates are accredited by the following international accreditation organizations: -

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The International Accreditors for Continuing Education and Training (IACET - USA)

Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units (CEUs)** in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

Haward Technology Middle East will award **2.4 CEUs** (Continuing Education Units) or **24 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

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British Accreditation Council (BAC)

Haward Technology is accredited by the **British Accreditation Council for Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:



Mr. Attalla Ersan, PEng, MSc, BSc, is a **Senior Mechanical Engineer** with over **35 years** of extensive experience within the **Oil & Gas, Hydrocarbon** and **Petrochemical** industries. His expertise widely covers the areas of **Boiler & Steam System Management, Waste Heat Recovery, Boiler Plant Safety, Boiler Controls, Steam Distribution Systems, Steam Traps, Pollution Control, Cracked Gas Compressor, Reboilers, Selection & Operation, Boiler Inspection & Maintenance, Boiler instrumentation & Controls, Boiler Start-up & Shutdown, Boiler Operation & Steam System Management, Boiler Water Chemistry & Treatment, Boiler Efficiency & Waste Heat Recovery, Boiler Inspection & Testing, Boiler Troubleshooting & Safety, Boiler Emissions & Pollution Control, Pumps Maintenance & Troubleshooting, Valve Maintenance, Plunger Valve, Maintenance & Reliability Best Practices, Maintenance & Reliability Management, Process Plant Operations, Process Plant Startup & Operating Procedure, Ethylene & Vinyl Chloride, Ethane Cracking Furnaces Operations, Ethylene & Polyethylene Operation, Acid Gas Treatment, Sulphur Recovery, EDC & VCM, Caustic Soda Storage, Debottle-necking, Process Operation, Safety Audits, Process Engineering, Root Cause Investigations, Pyrolysis Cracking, Gas Plant Commissioning, Loss Prevention Techniques, Occupational Hazards, Hot Tapping & Tie-Ins, Pre-Start-Up Safety Review (PSSR), Standard Operating Procedure (SOP), Emergency Operating Procedure (EOP), Permit to Work Systems (PTW), Steam Cracking, Steam Generation, Binary Fractionators Operations, Tanks Farm & Metering Station Techniques, Gas Treatment, Sulphur Recovery Process Unit Operation, Permit to Work System, Emergency Response Planning, Sulphur Unit Air Blower, Steam Turbine, Distillation Columns, Gas Treatment, Waste & Water Treatment Units, Water Meter Reading System (MMR), Utility Regulation, Best Water Equipment, Water Fittings, Water Tanks Filling Stations, Pumping Station, Water Chemistry, Water Network Design, Pumps, Compressors, Turbines, Motors, Turbo-expanders, Gears, Heat Exchanger, Hazard and Operability (HAZOP) Study, Process Hazards Analysis (PHA), HAZOP Facilitation, Loss Prevention, Consequence Analysis Application, Gas Detectors Operation, Accident/Incident Investigation (Why Tree Method), Occupational Exposure Assessment, Fire Fighting & First Aid, Environmental Management and Basic Safety Awareness. Further, he is also well-versed in Project Management, Human Resources Consultancy, Manpower Planning, Job Design & Evaluation, Recruitment, Training & Development and Leadership, Creative Problem Solving Skills, Work Ethic, Job Analysis Evaluation, Training & Development Needs, Bidding & Tendering, Technical Report Writing, Supervisory Leadership, Effective Communication Skills and Total Quality Management (TQM). He is currently the **CEO of Ersan Petrokimya Teknoloji Company Limited** wherein he is responsible for the design and operation of Biogas Process Plants.**

During his career life, Mr. Ersan has gained his practical and field experience through his various significant positions and dedication as the **Policy, Organization & Manpower Development Head, Training & Development, Head, Ethylene Plant – Pyrolysis Furnace Engineer, Production Engineer, Mechanical Engineer, Boiler Mechanic**, Process Training Coordinator, Ethylene Plant Shift Supervisor, Ethylene Plant Panel & Fit Operator, Process Training & Development Coordinator, **Technical Consultant**, and **Instructor/Trainer** for Qatar Vinyl Company Limited and Qatar Petroleum Company (QAPCO).

Mr. Ersan is a **Registered Professional Engineer** and has a **Master’s degree of Education in Educational Training & Leadership** and a **Bachelor’s degree of Petrochemical Engineering**. Further, he is a **Certified Instructor/Trainer** and has delivered numerous trainings, courses, workshops, conferences and seminars internationally.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1

0730 – 0800	<i>Registration & Coffee</i>
0800 – 0815	<i>Welcome & Introduction</i>
0815 – 0830	PRE-TEST
0830 – 0930	Turbo Machinery-Introduction <i>Centrifugal Compressors • Centrifugal Pumps • Turbines</i>
0930 – 1030	Compressors <i>Compressor Types and Performance Measurement • Positive Displacement Compressors, Reciprocating Compressors, Trunk Piston Compressors, Sliding Crosshead Piston Compressors, Diaphragm Compressors, Bellows 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, Unloading System • Intercoolers and Aftercoolers, Filters and Air Intake Screens • Preventive Maintenance and Housekeeping</i>
1030 – 1045	<i>Break</i>
1045 – 1145	Centrifugal & Axial Compressors <i>Operation and Characteristics • Surging, Choking, Bleed Valves, Variable Stator Vanes, Inlet Guide Vanes</i>
1145 – 1245	Compressor Systems Calculations <i>Calculations of Air Leaks, Annual Cost of Air Leakage • Centrifugal Compressor Power Requirement • Compressor Selection, Calculations of Air System Requirements • Characteristics of Reciprocating Compressors, Blowers • Selection of Compressor Drive • Selection of Air Distribution System, Water Cooling Requirements • Sizing of Compressor System Components, Sizing of Air Receiver • Calculations of Receiver Pump-Up Time</i>
1245 – 1300	<i>Break</i>
1300 – 1400	Turbines <i>Types of Turbines • Industrial Heavy Duty Gas Turbines • Major Turbine Components • Performance Characteristics • Performance Calculations</i>
1400 – 1420	Gas Turbine Cycles <i>Reversible Cycles with Ideal Gases • Combustion Processes • Stoichiometric</i>
1420 – 1430	Recap <i>Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow</i>
1430	<i>Lunch & End of Day One</i>

Day 2

0730 – 0830	Pumps <i>Definition & Categories: Dynamic & Displacement, Reciprocating & Rotary • Centrifugal Pumps: Theory of Operation, Casings and Diffusers, Radial Thrust, Hydrostatic Pressure Tests • Impeller, Axial Thrust, Axial Thrust in Multistage Pumps, Hydraulic Balancing Devices, Balancing Drums, Balancing Disks • Mechanical Seals, Bearings, Couplings, Bedplates, Minimum Flow Requirement • Centrifugal Pumps General Performance Characteristics, Cavitation, Net Positive Suction Head</i>
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0830 – 0930	Centrifugal Pump Mechanical Seals Basic Components, Temperature Control, Seal Lubrication/Leakage, Typical Single Inside Pusher Seal • Recommended Maintenance, Vibration Analysis, Equipment Condition
0930 – 0945	Break
0945 – 1045	Bearings 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
1045 – 1145	Lubrication Viscosity of Lubricants, Flow Through Pipes, Variation of Viscosity with Temperature and Pressure, Viscosity Index • Non-Newtonian Fluids, Greases, VI Improved Oils, Variation of Lubricant Viscosity with Use, Oxidation Reactions, Physical Reactions, Housing and Lubrication, Lubrication of Antifriction Bearings • Oil Analysis: 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
1145 – 1245	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
1245 – 1300	Break
1300 – 1420	Pumping System Calculations Pumps in Series, Pumps in Parallel, Driver Speed Selection, Affinity Laws, Centrifugal Pump Selection, Performance of the Prototype Pump, Suction Specific Speed, Centrifugal Pump Capacity/Efficiency/Operating Speed, Pump Head, Friction Losses, Power Requirement, Pump Selection & Evaluation
1420 – 1430	Recap Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow
1430	Lunch & End of Day Two

Day 3

0730 – 0830	Centrifugal Pump Maintenance, Re-rate & Retrofit Case Gasket • Checking for Wear Clearance • Oil Change • Storage • Impeller Cut • NPSH • De-Staging • Electric Motor Sizing • Viscosity Changes
0830 – 0930	Centrifugal Pump Troubleshooting Bearing Failures • Bearing Housing Oil Leakage • Cavitation Noise and Damage • Impeller Cavitation/Erosion • Vibration • Cracked Volute Tongues • NPSH • Viscosity Effects
0930 – 0945	Break



0945 – 1230	<p>Motors <i>Construction, Concepts, Rotor Slip and Electrical Frequency, the Equivalent Circuit, the Rotor Circuit Model, Losses and the Power-Flow Diagram • Torque-Speed Characteristics and Curves, Squirrel-Cage Rotor Design, Deep Bar and Double-Cage Rotor Designs. • Starting Induction Motors • Line Frequency, Line Voltage, Rotor Resistance • Solid-State Drives, Motor Protection • Induction Generator, Induction Motor Ratings • Characteristics, Enclosures & Cooling Methods, Insulation • Failures in Three-Phase Stator Windings, Predictive Maintenance, Troubleshooting, Diagnostic Testing • Stator Insulation Tests, DC Tests, Windings, Insulation Resistance and Polarization Index • Failures in Three-Phase Stator Windings</i></p>
1230 – 1245	Break
1245 – 1315	<p>Maintenance Planning <i>Selecting Maintenance Approaches • Inspection Regimes • Analytical On-Line Condition Monitoring</i></p>
1315 – 1420	<p>Vibration–Possible Causes <i>Turbine Misalignment • Unbalanced Turbine • Rubbing Parts • Lubrication Problems • Cracked or Worn Parts</i></p>
1420 – 1430	<p>Recap <i>Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow</i></p>
1430	Lunch & End of Day Three

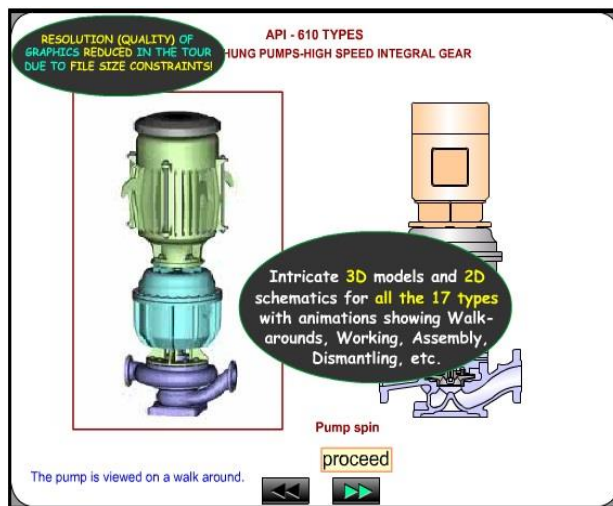
Day 4

0730 – 0830	<p>Monitoring & Diagnostic Systems <i>Pressure Measurement • Temperature Measurement • Vibration Measurement</i></p>
0830 – 0930	<p>Vibrations & Predictive Maintenance <i>Aerodynamic Flow-Induced Vibrations • Interpretation of Collected Data • Establishing Safe Operating Limits for Turbo Machinery • Predictive Maintenance</i></p>
0930 – 0945	Break
0945 – 1045	<p>Problems with Centrifugal Compressors & Pumps <i>Operating Limits</i></p>
1045 – 1145	<p>Troubleshooting as an Extension of Failure Analysis (cont'd) <i>Causes of Machine Failures • The “7-Cause Category Approach” to Root Cause Failure Analysis • Techniques • The Matrix Approach • The Cause and Effect Principle • Bearings • Journal and Tilt-Pad Thrust Bearings • Patterns of Load Paths and their Meaning in Bearing Damage • Noise Signature Recordings • Action Planning and Decision-Making</i></p>
1145 – 1230	<p>Video Presentation <i>Mechanical Troubleshooting of Auxiliary Steam Turbine (Cleaning Turbine Parts, Adjusting Nozzle Clearance)</i></p>
1230 – 1245	Break

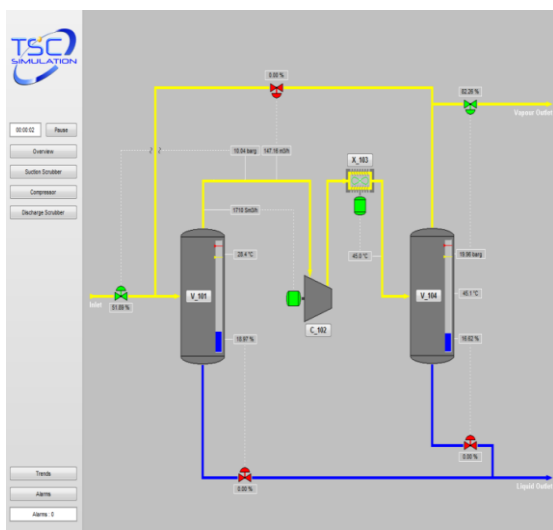
1300 – 1345	Turbo Machinery Standards <i>Applicable API Standards • ISO Standards • Specifications</i>
1345 – 1400	Course Conclusion <i>Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course</i>
1400 – 1415	POST-TEST
1415 – 1430	<i>Presentation of Course Certificates</i>
1430	<i>Lunch & End of Course</i>

Simulator (Hands-on Practical Sessions)

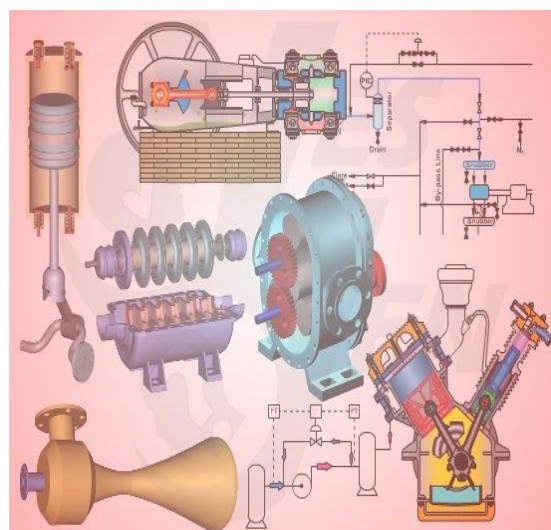
Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using our state-of-the-art simulators “Centrifugal Pumps and Troubleshooting Guide 3.0”, “SIM 3300 Centrifugal Compressor” and “CBT on Compressors”.



Centrifugal Pumps and Troubleshooting Guide 3.0



SIM 3300 Centrifugal Compressor Simulator



CBT on Compressors

Course Coordinator

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