LDI Training
"Leading Edge Courses for Professionals" ™

A LDI Training Course

PUMPS AND COMPRESSOR SYSTEMS

How to Design, Select, Specify, Install, Operate and Trouble-Shoot

Dr. Maurice Stewart, PE, CSP

Who Should Attend

- New engineers, Capital Projects team members, Engineering & Construction engineers, construction, maintenance and operations personnel who are or will be responsible for the selection, sizing, specification, installation, testing, operation and maintenance of pumps, compressors and drivers used in surface production facilities, gas handling, conditioning and processing facilities and petrochemical plants.
- Experienced professionals who want to review or broaden their understanding of pumps, compressors and drivers used in surface production facilities, gas handling, conditioning and processing facilities and petrochemical plants.
- Professionals with little to moderate production facility design and/or operations background
- Other professionals who want a better understanding of the subject matter

What You Will Learn

- Develop a "feel" for the important parameters in designing, selecting, specifying, installing, operating and maintaining pumps, compressors and drivers
- Understand the difference between suction head, suction lift and total dynamic head
- How to develop system head vs. capacity curves
- How to develop pump performance curves for series and parallel operation
- How to specify the materials and details of construction for bearings, seals, lubrication system, wear rings, couplings and valves
- How to determine NPSHA and margin
- Understand piping and foundation requirements
- Understand suction and discharge velocity requirements
- How to select the appropriate driver, such as, internal combustion engine (2-cycle/4-cycle; spark ignition vs. compression ignition), turbine or electrical motor
- How to apply API 610, API 674 and ANSI B78.1
- Develop a "feel" for the important parameters in selecting and operating compressor stations
- How to specify the materials and details of construction for bearings, seals, lubrication system, couplings and valves (if appropriate)
- How to determine the number of stages, compressor type, break horsepower, isentropic head, inter-stage pressure loss, discharge temperature, vibration and pulsation suppression, piping requirements and foundation requirements
- How to develop compressor system performance curves and determine safety settings such as: suction PSH and PSL, discharge PSH and PSL, Recycle valve and Flare valve settings
- How to interpret compressor performance curves such as: Head vs. Capacity, Dimensional and Semi-Dimensional
- How to select and operate gas turbines

- How to select the appropriate internal combustion engine (2-cycle/4-cycle; spark ignition vs. spontaneous ignition) and electrical motors
- How to apply API 617, API 11P and other industry standards

NOTE: Dr. Stewart has structured this workshop so as to provide an intensive comprehensive review of rotating equipment used in upstream and midstream sectors of the oil and gas industry. Emphasis is placed on the application, selection, operation, maintenance and trouble-shooting of such equipment. The workshop maintains a balance between lecture and in-class exercises, and between theory and application. In-class exercise sessions are evenly dispersed throughout the course to emphasize the principles covered.

Dr. Stewart has a storehouse of knowledge and experience that he passes along to help the participants get a unique multidiscipline approach to combine electrical, mechanical, civil, and petroleum methods in solving the problems associated with compressors, pumps and prime movers.

Course Content

General Pump Principles

- Fluid Principles and Hydraulics
- Classification and Types
- Centrifugal Pumps
  - Special Pumps
  - Reciprocating Pumps
  - Rotary Pumps
- Hydraulic principles
- Static head Vs suction lift
- Momentum equation
- Pumping system and design
- Determination of TDH, NPSH
- Determination of power requirements
- Pump selection

Centrifugal Pumps

- Types
  - Axial Flow
  - Mixed Flow
  - Radial Flow
- Application and performance considerations
- Pump performance curves
- Developing system-head curves
- Developing pump performance curves for parallel/series operation
- Pump components and variations in design
- Centrifugal pump types and selection criteria
- Applicable standards and specification selection
- Centrifugal pump installation
- Piping installation guidelines
- Pump driver considerations
- Limitations, operating/maintenance considerations and trouble-shooting
- Application and performance considerations
- Installation considerations
- Limitations, operating/maintenance considerations and trouble-shooting

Reciprocating Pumps

- Types
  - Piston/Plunger
  - Diaphragm
- Application and performance considerations
- Selection criteria
- Flow characteristics
- Mechanical components
- Piping installation guidelines
- Pulsation and vibration considerations
- Pump driver considerations
- Applicable standards and specification selection
- Limitations, operating/maintenance considerations and trouble-shooting

Rotary Pumps

- Types
  - Vane
  - Piston
  - Peristaltic
  - Gear
  - Lobe
  - Screw (Progressing Cavity)
  - Pressure Capability
  - Torque and Power Requirements
  - Pump Geometric Variations
- Pump Manufacturing Processes
- Designations and Specifications
- Elastomers

- Basic Principles
  - Gear Pumps
  - Single and Multi-Lobe Pumps
  - Single-Lobe Pumps
  - Components
  - Operation
  - Displacement
  - Pressure Capability
- Pump Testing, Sizing and Failure Identification
- System Design Components, Considerations and Processes
- Applications
- Installation and Trouble-shooting
- Applicable standards and specification selection

Energy Reduction in Pumping Systems

- Opportunities for Potential Savings
- Pump Economics
- Designing a Pumping System for maximum efficiency
- Pump Performance Characteristics
- Avoiding Excessive Capacity and Total Head Margins
- Selecting the most efficient pump
- Using Variable Speed Drives
- Proper Pump Maintenance

Piping Systems

- Terminology
- Steel Lines
  - Material Specification
  - Pipe Manufacturing Methods
- Non-Metallic Lines
  - Material Specification
  - Joining Methods
- Standards, Codes and Recommended Practices
- Pump piping design practices
- Suction and discharge considerations
  - Manifolds
  - Components
  - Recycle lines and PSV requirements

Lessons Learned and Practical Solutions

- Water injection pump considerations
- Shipping pump considerations
- Oil Transfer Pump considerations
- Energy Reduction Considerations
- Economic considerations
- Field examples

Overview of Compressors

- Terminology and Classification
- Types and Applications
- Reciprocating compressors
  - High-speed "separable" units
  - Low-speed "integral" units
- Rotary compressors
  - Vane units
  - Screw units
- Centrifugal compressors
- Application of compression theory
- Effect of Process on Compressor Selection, Control and Operation
- How to select a compressor
- Determining BHP, discharge temperature, isentropic head
- Applicable standards and specification selection
- Thermodynamics of Compressors

Centrifugal Compressors

- Major components
- Operating principles
- Typical Compressor Installations
- Process considerations
- Series and parallel operation
- Factors affecting performance
- Performance map interpretation
- Surge control and stonewall considerations
- Piping installation guidelines
- Preventive maintenance and trouble-shooting
- Applicable standards and specification selection

Positive Displacement Compressors

- Rotary compressors and blowers
  - Operating principles
    - Lobed blowers
    - Sliding-vane
    - Screw
    - Liquid piston
  - Performance considerations
- Reciprocating compressors
  - Major components
  - Operating principles
  - Design considerations
  - Pulsation and vibration considerations
  - Piping installation guidelines
  - Preventive maintenance and trouble-shooting
- Applicable standards and specification selection

Application of Compression Theory and Practical Solutions to Common Problems

- Determining Compressor Parameters'
- Developing a Compressor Performance Curve
- Determining the Operating Range of a Compressor
- Effects of adding Clearance on Compressor Performance
- Effects of Speed on Compressor Performance
- Determining the Safety Device Set Points
- Designing a Multi-stage Compressor

Internal Combustion Engine Drivers

- High speed reciprocating engines
  - Spark ignition vs. compression ignition
  - 2-cycle vs 4-cycle
  - Naturally aspirated, superchargers and turbo-expanders
  - Carburation vs. fuel injection
- Auxiliary systems
- Installation guidelines
- Environmental considerations
- Preventive/predictive maintenance and trouble-shooting
- Applicable standards and specification selection

Gas Turbines

- Design and operating considerations
- Auxiliary Systems
- Performance considerations
- Coupling methods
- Efficiency
- Selection considerations
- Maintenance, surveillance and trouble-shooting

Electrical Motors

- Basic principles and operating considerations
- Three-phase induction motors
- Three-phase synchronous motors
- Voltage selection
- Equipment specification
- Performance considerations
- Instrumentation
- Motor selection
- Electrical Installation in Hazardous Locations
- Commissioning and start-up
- Maintenance, surveillance and trouble-shooting

Driver Selection

- Size availability
- Purchase price Vs total life cycle cost
- Installation costs
- Fuel considerations
- Power requirements
- Environmental considerations
- Final selection

Course Materials

- A comprehensive set of lecture notes for after course reading and reference
- An extensive set of practical in-class “case study” exercises specifically developed to emphasize the design, selection, specification, installation, maintenance, operation and “trouble-shooting” pitfalls often encountered in oil and water pumping systems.

Your Course Instructor

Dr. Maurice Stewart, PE, CSP, a Registered Professional Engineer with over 40 years international consulting experience in project management; designing, selecting, specifying, installing, operating, plant optimizing, retrofitting and trouble-shooting oil, water and gas handling, conditioning and processing facilities; leading hazards analysis reviews and risk assessments.

He is **internationally respected for his teaching excellence and series of widely acclaimed textbooks** in the areas of designing, selecting, specifying, installing, operating and trouble-shooting: 1) oil and water handling facilities, 2) gas handling, conditioning and processing facilities, 3) facility

piping and pipeline systems, 4) gas sweetening, 5) gas dehydration, 6) pumps, compressors and drivers, 7) instrumentation, process control and safety systems, 8) oil and gas measurement and metering systems and 9) conducting safety audits, hazards reviews and risk assessments. Dr. Stewart is one of the co-authors of the *SPE Petroleum Engineering Handbook***.** He has authored and co-authored over 90 technical papers and has contributed to numerous conferences as a keynote speaker. To date, Dr. Stewart has taught over *60,000 professionals in 90 countries***.** He has provided consultation and/or instruction in virtually every oil and gas production sector in the world, including the Middle East, UAE, Northern and Western Africa, Angola, Nigeria, North Sea, Western and Southern Europe, China, Central Asia, Democratic Republic of Congo, Indonesia, Malaysia, Myanmar, Thailand, Brunei, India, Kazakhstan, Central and South America, Australia, Canada and throughout the United States.

He has provided **consultation and/or instruction** to well **over 100 oil and gas related companies worldwide** and is currently held on retainer by a number of companies where he regularly provides consultation regarding complex oil and gas issues related to surface production facilities. A partial list of his clients include: Abu Dhabi Oil Company, Exxon USA, Esso Producing Malaysia Inc, Petronas, Petronas Carigali, Petronas Gas, Sarawak Shell, Gas Malaysia, BP, DeltaAfrik, Occidential Petroleum, Kuwait Oil Company, Saudia ARAMCO, AMOCO, ADNOC, Qatar Oil Company, Nipon Oil Company, Shell USA, Conoco Inc., Brunei Shell, DeltaAfrik, Oryax Ecuador Energy Company, Petro-Amazonas, Petro-Ecuador, British Gas, Texaco, Petro China, Petro Viet Nam, Maxus Indonesia, Maxus Ecuador Inc., CNOOC, Cabinda Gulf Oil Company Ltd., Caltex Pacific Indonesia, Vico Indonesia, Mobil Producing Nigeria Unlimited, PTTEP, Chevron Nigeria Ltd., Chevron Overseas Producing Inc., Chevron USA, Chevron Thailand, Pertamina, UNOCAL Indonesia, UNOCAL USA, Unocal Thailand, Spirit Energy 76 ,ChevronTexaco, Medco, Migas, Total Indonesie, TotalFinaElf Myanmar, Total Fina Elf, Total E&P, Sonangol P&P, Exspan, Tengizchevoil, Exxon Mobil, Mobil USA and Royal Dutch Shell.

He also serves on numerous international committees responsible for developing or revising industry Codes, Standards and Recommended Practices for such organizations as ANSI, API, ASME, ISA, NACE and SPE. Dr. Stewart is currently serving on the following American Petroleum Institute (API) committees: *API RP 14C, RP 14E, RP 14F, RP 14G, RP 14J, RP 500 and RP 75.* Dr. Stewart has developed and taught worldwide short courses for API related to Surface Production Operations. In 1985, Dr. Stewart rived the National Society of Professional Engineers *"Engineer-of-the-year"* award.

He is very active in the Society of Petroleum Engineers (SPE). He served on the board of directors for the Delta Section for over 10 years, chairman and committee member of the professional engineering registration committee for five years and chairman of the continuing education committee for eight years. For twelve years he conducted a review course that prepared petroleum engineers for the "Principles and Practice" examination in Petroleum Engineering. He developed and has taught worldwide short courses for SPE related to Surface Production Operations. For his continuous effort in the advancement of Petroleum Engineering he was awarded the SPE Regional Service Award.

Dr. Stewart holds a BS in Mechanical Engineering from Louisiana State University and MS degrees in Mechanical, Civil (Structural Option) and Petroleum Engineering from Tulane University and a Ph.D in Petroleum Engineering from Tulane University. Dr. Stewart served as a Professor of Petroleum Engineering at Tulane University and Louisiana State University.

Enrollment Information

PT. Loka Datamas Indah
LDI Training

Phone	:	+62 21 6326911
Fax	:	+62 21 6305074
E-mail	:	Lditrain@indo.net.id
Website	:	www.Lditraining.com