PUMPS AND COMPRESSOR SYSTEMS

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

By 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 OUTLINE

General Pumps 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)
- Basic Principles
  - Gear Pumps
  - Single and Multi-Lobe Pumps
  - Single-Lobe Pumps
  - Components
  - Operation
  - Displacement
  - Pressure Capability
  - Torque and Power Requirements
  - Pump Geometric Variations
- Pump Manufacturing Processes
- Designations and Specifications
- Elastomers
- 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
- Auxillary 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.