
PERFORMANCE MONITORING OF PUMPS AND COMPRESSORS



WHAT YOU WILL LEARN:

- Optimising equipment performance
- Performance monitoring strategies
- General hydraulic concepts in relation to performance monitoring
- Centrifugal pumps - construction, operational principles, selection criteria, power requirements, efficiencies and losses, characteristic curves, performance calculations
- Gas properties - thermodynamic concepts and processes, Thermodynamic and gas laws, ideal gases, computation of gas properties, gas power cycles
- Reciprocating compressors - construction, operation, compression terms, performance calculations, evaluating efficiencies and methods to estimate them, analysis of PV diagrams
- Centrifugal and axial flow compressors - design and operational aspects, compression terms, performance calculations, evaluating adiabatic and polytropic efficiencies and methods to estimate them

WHO SHOULD ATTEND:

Anyone who deals with design, selection, sizing, operation and maintenance of pumps and compressors in the course of their work, including:

- Mechanical Engineers
- Maintenance Engineers
- Reliability Engineers
- Electrical Engineers
- Professional Engineers
- Utility Advisors and Planners
- Municipal and Regional Planners
- Operations Managers
- Maintenance Managers
- Project Managers
- Contract Managers
- Asset Managers
- Technical Managers

The Workshop

As the process plants have got bigger, the machines have become larger in terms of their power ratings and complexity. At the same time, the demand for efficient operation and higher availability of these machines has been on the rise and this in turn has led to the adoption of modern maintenance strategies and practices by the industry, so that these objectives may be achieved.

Condition Monitoring of equipment is one best practice that has proven itself over the years. It is now considered an integral part of an effective plant asset management strategy. Condition monitoring of plant equipment comprises of

- Mechanical health monitoring
- Performance monitoring

The former includes techniques such as vibration analysis, oil and wear particle analysis, thermography, ultrasonics and others.

Performance monitoring on the other hand is the thermodynamic and hydraulic evaluation of the equipment. This technique determines the efficiency with which energy conversions occur in the equipment.

Performance calculations enable the computation of energy requirements of equipments. This helps in benchmarking their performance. In case gaps are noticed, this technique has the ability to trouble-shoot equipment problems. It can also indicate equipment problems that may not be normally detected by mechanical health monitoring. When used together, they help provide efficient operation of the equipment and at higher availability levels.

Another utility of the performance monitoring technique is that the same theory and concepts can be employed in the sizing, selection and re-rating of the equipment. It thus becomes a useful tool especially during the process of evaluation of technical bids.

This workshop covers in detail, the technique of performance monitoring as applied to centrifugal pumps and positive displacement, centrifugal and axial flow compressors. The topics of discussion include

- Principles of operation
- Thermodynamic and hydraulic evaluation
- Important performance parameters and selection considerations
- Methods to derive the above from first principles and empirical relationships
- Handling gas and gas mixture properties
- Interpretation of results

The course includes a large number of practical examples that help to learn and clarify the concepts. These can then be readily applied to real machines in plants, to evaluate their present performance, benchmark with rated values and analyse the causes for the gaps. Additionally, examples involving sizing and selection of the equipment are also included.

The workshop will be of immense benefit to those involved in the procurement, operation and maintenance of pumps and compressors.

The Program

INTRODUCTION AND FUNDAMENTALS

- Equipment degradation and loss in efficiency
- Optimising equipment performance and establishing best maintenance practices
- Introduction to performance monitoring
- Performance monitoring strategies and techniques
- Benefits of performance monitoring

HYDRAULIC PRINCIPLES AND CONCEPTS

- General liquid characteristics and properties
- Concepts related to pressure, volume, flow, head and resistance
- Pascal's law and momentum equation
- Hydraulic power and pump efficiency
- Specific speed
- Cavitation, recirculation and Net Positive Suction Head (NPSH)
- Impact of jet on normally fixed plates, inclined fixed plates and hinge plates
- Impact of jet on a fixed curved vane, moving curved vane and series of vanes
- Velocity triangles

CENTRIFUGAL PUMPS

- Principle of working of centrifugal pumps
- Centrifugal pump components
- Range of operation
- Selection considerations
- Multi-stage operation in centrifugal pumps
- Abnormal operation
- Power requirements, efficiencies and losses in centrifugal pumps
- Pump characteristic curves
- Improving pump reliability
- Performance calculations

SOLVED EXAMPLES AND PRACTICAL EXERCISES

WORKGROUP ASSIGNMENTS

GAS PROPERTIES AND THERMODYNAMIC CONCEPTS

- Basic thermodynamic concepts
- Working substance and thermodynamic processes
- State of a system and its transformations
- Ideal gases
- Equilibrium state
- Overview of the various gas laws
- Laws of thermodynamics
- Gas power cycles

RECIPROCATING COMPRESSORS

- Principle of operation and construction of reciprocating compressors
- Classification of reciprocating compressors
- Mechanism of a single-stage reciprocating compressor
- Work done in a single-stage reciprocating compressor
- Multi-stage reciprocating compressors
- Work done in a multi-stage reciprocating compressor
- Volumetric efficiency and performance
- Achieving maximum efficiency in multi-stage reciprocating compressors
- P-V diagrams and their analysis

CENTRIFUGAL AND AXIAL-FLOW COMPRESSORS

- Construction and principle of working of centrifugal compressors
- Classification of centrifugal compressors
- Design and operation of axial-flow compressors
- Efficiency and performance characteristics
- Adiabatic and polytropic efficiencies
- Methods used to evaluate efficiencies

Practical session comprising quiz questions and sample performance calculations + exercises

SUMMARY, OPEN FORUM AND CLOSING

Practical Sessions

This is a practical, hands on workshop enabling you to work through practical exercises which reinforce the concepts discussed.

To gain full value from this workshop, please bring your laptop/notebook computer.