PD539
Bolted Joints and Gasket Behavior

CEUs: 1.5
PDHs: 15
Number of Days: 2

Bolted and gasketed joints are critical to pressure-containing and industrial systems worldwide. This two-day course is an engineer's guide to bolting and gasket design, selection and installation. It provides an overview of bolted joint fundamentals and focuses on the roles of bolts and gaskets in developing and maintaining leak-tight connections of bolted flange joints, including troubleshooting of existing bolted flange connection.

This course examines how to assess a successful value of bolt load, as well as explains the importance of specifying a tightening procedure. It introduces the subject of PVRC (Pressure Vessel Research Council) leak tightness calculations and presents an overview of current trends and practices to achieve reliable leak-tight bolted joint solutions.

By participating in this course, you will learn how to successfully:

- Explain how the bolted joint functions as a mechanical system that relies on the simultaneous interaction of the three primary components to successfully seal the connection
- Assess the mechanical stress and strain of a bolt and explain the challenges that one encounters when specifying an optimum bolt load
- Evaluate the total state of stress in bolts and how this effects the selection of a given bolt type and grade
- Describe the effects of in-service conditions and how they reduce or increase bolt load
- Describe the concept of leak tightness as a predictable value of gasket stress and how to use leak tightness as the basis of specifying bolt loads
- Identify conditions that create bolt failure
- Use ASME PCC-1 Guidelines for compliance to successful sealing of bolted, gasketed connections
- Discern how to use either stress or strain to select bolt load
- Evaluate the various methods of attaining bolt load.

Course Materials (included in purchase of course)

- Digital course notes via ASME's Learning Platform

Supplemental Course Materials (not included with course, purchase separately)

- Scientific calculators are required for course exercises

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Who Should Attend
This course is intended for engineers with the responsibility for, or are involved in, the specification and assembly of bolted joints and gasketed bolted flange connections. Two years of engineering experience would be beneficial but is not required. The course is also useful to Engineering Management that wishes to assess the value of the material, and to mechanics that would like a broader understanding of the subject.

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Day One

- Introduction to the Bolted Joint
  - Basic Concepts & Mechanics of Bolted Joints
  - Bolt Flange Joint as a Single Mechanical System
  - Importance of Distinguishing Between Bolt Load and Clamping Force
  - Bolting Strength, both Elastic and Plastic Properties
  - Stress Distribution within a Bolt
  - Introduction to Actual Versus Ideal Loadings on a Bolt
  - Combining Tensile and Shear Stresses, Both Ductile and Brittle Material
  - Threading Basics
- Properties Affecting In-service Conditions
  - Transient Loads
  - Effect of Changes in Elasticity
  - Clamping Force Stability
  - Nut Selection and Condition
  - High and Low Temperature Operation
- Stress and Strain Considerations:
  - Hook's Law and Understanding Spring Rate
  - Application of Spring Rate to Evaluate Bolt Stretch
  - Spring Rate(s) Inherent in the Gasketed, Bolted Flange Joint
  - Introduction to Bolt Loading Diagrams
  - Estimating Preload Variability
  - Understanding the Importance of Load Factor
- Gasket Behavior, Selection and Specification
  - Introduction to the Concept of PVRC Leak-Tightness Prediction
  - **R**oom **O**nly **T**emperature **T**esting, the Basis of a, G_b and G_s
  - Historical Perspective on the Evolution of Leak-Tightness Predictability
  - How to Evaluate the Leak Tightness Parameter, T_{Pmin}
  - The Meaning of Leak Tightness Class
  - Gasket Limits
  - Gasket Selection Criteria
  - Understanding Gasket Blowout and How to Prevent it

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Day Two

- Introduction to Assembly and Clamping Force
  - How to Evaluate Torque, Short and Long Form Equations
  - Understand Nut Factor and its Potential Variability
  - Real-world Challenges to Getting and Maintaining Preload
  - Bolting Procedures and Why No-Nut-Movement can be so Important
  - Preload Methods; Hydraulic, Stretch, Turn-of nut and Ultrasonic
- ASME PCC-1 Guidelines
  - Scope
  - Assembly; Bolting Specialist Training Program
  - Conditional Assessment of Equipment; Damage and Alignment Requirements
  - Tightening Procedures
  - Important Terms
  - Record Keeping
- Understanding & Preventing Gasket Failure
  - Excessive Bolt Loading
  - Uneven Bolt Loading
  - Corrosion
  - Galling
  - Self-Loosening
  - Fatigue
  - Basic Cause Investigation
- Joint Calculation Methods
  - ASME Section VIII, Division 1, Appendix 2
  - EN 1591-1 Flange Analysis
  - Finite Element Analysis (FEA)
  - Importance of Component Elasticity in Creating Gasket Stress Distribution
  - Pressure Vessel Research Council Leak Tightness Evaluation and Use
  - ASME BFJ Leak-tightness Based Flange Design … future considerations