Fundamentals of Pipe Stress Analysis with Introduction to CAESAR II

WHAT YOU WILL LEARN:

Piping system design constitutes a major part of the design and engineering effort in any facility. Stress analysis is a critical component of piping design through which important parameters such as piping safety, safety of related components and connected equipment and piping deflection can be addressed. The objective of pipe stress analysis is to prevent premature failure of piping and piping components and ensuring that piping stresses are kept within allowable limits.

This workshop is designed for personnel from a wide range of abilities and backgrounds and will cover the fundamental principles and concepts used in pipe stress analysis. In addition to meeting the needs of design, the course is structured to provide you an in-depth understanding of the engineering principles involved in material selection, application of code criteria and the capabilities and tools incorporated in stress analysis softwares. The extensive use of case studies and practical exercises during the course of the discussion ensures as comprehensive coverage of the material as possible.

WHO SHOULD ATTEND?

This course is designed for personnel who want to understand the engineering principles involved in pipe stress analysis. Those who will benefit the most from this workshop include the following:

- Personnel from EPC (Engineering, Procurement and Construction) companies.
- Mechanical Engineers.
- Piping Designers and Piping Engineers
- Equipment Designers and Engineers.
- Structural Designers and Engineers.
- Chemical (Process) Engineers.
- Project Engineers.
- Plant Layout and Piping Design Personnel.
- Consulting Engineers.
- Plant Maintenance Personnel.

THE WORKSHOP:

The pipe stress analysis course is a comprehensive, highly practical and interactive course. Along with learning the fundamentals of piping stress, you will also learn to appreciate the need for stress analysis in piping systems and the various design principles and procedures involved. You will have an opportunity to learn about the failure theories and codes governing piping design and stress analysis. Piping load characteristics and procedures used in designing pipe wall thickness will be outlined in sufficient detail. The importance of stress analysis software in piping system design will be emphasized through a comprehensive overview of the CAESAR II software. Practical examples from actual projects will be used extensively to illustrate the principles involved, to enable a better understanding. You will also be provided with a high quality course manual that will prove useful for many years to come.

WORKSHOP OBJECTIVES

At the end of this workshop delegates will understand:

- How stress analysis is carried out in piping systems.
- The fundamental aspects related to selection of piping materials.

- The objective and scope of piping codes.
- The theory behind piping system stresses and failure theories.
- The basis for determining the design pressure and temperature conditions.
- The methods employed to determine pipe wall thickness.
- Piping system loads and their characteristics along with code criterion for designing piping systems.
- The design criteria for thermal stresses in piping systems.
- The significance of pipe stress analysis software in general, with particular emphasis on CAESAR II and the tools and procedures used in the creation of stress models.

THE PROGRAM

DAY 1

Introduction to Pipe Stress Analysis
• Need for stress analysis.
• Consequences of overstress.
• Physical Quantities and Units used in pipe stress analysis.

Piping Materials
• Introduction
• Material Classification Systems and Specifications.
• Common ASTM Piping Materials.
• Material Requirements of Codes.
• Selection Criteria for Materials.
• Piping Specifications (Piping Classes).
• Material Testing and Certificates.

Codes Governing Piping Design and Stress Analysis
• ASME B31.3, ASME B31.4, and ASME B31.8.
• Other codes including applicable local codes.
• Role and scope of codes.
• Information available from codes.
•Typical organization of code material.

Principal Stresses and Failure Theories
• Longitudinal, Circumferential and Radial Stresses.
• Principal Axes and Principal Stresses.
• Failure Theories:
    - Maximum Principal Stress Failure Theory.
    - Maximum Shear Stress Failure Theory.

Design Pressure, Design Temperature and Allowable Stress
• Definition of Design Pressure and Design Temperature.
• Basis for Allowable Stress.
• Allowable Stresses at “hot” and “cold” conditions, that is, S_h and S_c.
• Code Tables for Allowable Stresses.

DAY 2

Design of Pipe Wall Thickness for Internal Pressure

•Wall Thickness Design Equations – ASME B31.3, ASME B31.4, and ASME B31.8.
• Calculation of Maximum Allowable Working Pressure (MAWP).
• Pressure – Temperature Class Ratings for Flanges.
• Determining Appropriate Flange Pressure Class.

Loads on Piping Systems

• Primary and Secondary Loads.
• Self – Limiting and Non-Self – Limiting Characteristics of Loads.
• Sustained and Occasional Loads.
• Static and Dynamic Loads.
• Bending Stresses in Pipes.
• Longitudinal Stress and Torsional Stress.
• Code Criteria for Design.

Thermal Stresses in Piping Systems

• Thermal Expansion / Contraction of Materials.
• Stresses Due to Thermal Expansion / Contraction.
• Thermal Fatigue and Cyclic Stress Reduction Factor.
• Design Criteria for Thermal Stresses:
    - Stress Intensification Factors (SIFs).
    - Allowable Stress Range for Thermal Expansion.
    - Calculation of Expansion Stress Range

Pipe Stress Analysis Software

• Introduction to CAESAR II Stress Analysis Software:
    - Overview of CAESAR II software.
    - Piping Input and Creation of Model.
    - Navigation and Toolbars.
    - Static Analysis and Output.
    - Checking for Code Compliance.

CAESAR II Practical Exercises

• Piping Input – Creating the Model.
• Running the Analysis.
• Output and Interpretation of the Results.
• CAESAR II Practical Exercises I and II.

SUMMARY & OPEN FORUM

COMPLETE FEEDBACK SHEETS

CLOSING