PD777
Pipe Sizing, Pipe Wall Stresses, and Water Hammer

Day 1

Review of Dimensions & Unit Systems
- SI; British Gravitational; Engineering or US or Imperial System
- Conventional unit systems
- Conversions
- Measurement Scales
- Miscellaneous Measurements

Fluid Properties
- Introduction
- Density, Specific Gravity, Specific Weight
- Viscosity
- Kinematic Viscosity
- Compressibility Factor
- Pressure
- Measurement of Viscosity
- Measurement of Pressure
- Manometry

Equations of Fluid Mechanics (Steady Flow)
- Continuity Equation
- Momentum Equation
- Energy Equation
- Bernoulli Equation
- Miscellaneous Problems

Piping Systems I
- Pipe Specifications & Attachment Methods
- Water Tubing Specifications & Attachment Methods
- Laminar Flow of a Newtonian Fluid in a Circular Duct
- Turbulent Flow in a Circular Duct
- Curve Fit Equations for the Moody Diagram
- Solution Methods
- Noncircular Ducts: Rectangular Ducts, Annular Ducts

Day 2

Piping Systems II
- Minor Losses Using K Factors
- Minor Losses Using Equivalent Length
- Hydraulic Gradient Line
- Energy Gradient Line

Equations of Fluid Mechanics (Unsteady Flow)
- Continuity Equation
- Momentum Equation
- Energy Equation
- Bernoulli Equation
- Miscellaneous Problems

Introduction to Unsteady Flows: Sampling of Problems
- Draining Tank Problems (using velocity)
- Draining Tank Problems (alternative formulation)
- Discharge of Flow With Varying Head

Day 3

Unsteady Startup of Flow in a Pipeline
- Description, Analysis, and Equations
- Constant Friction Factor Method
- Numerical Method
- Comparison of Solution Methods
- Polynomial Equation

Stresses in Pressure Vessels
- Poisson's Ratio
- Dilation of Pressure Vessels
- Cylindrical Vessel Under Internal Pressure
- Stresses in Thin Walled Pressure Vessels
- Stresses in Thick Walled Pressure Vessels
- Lamé Thick Cylinder Wall Equations
- Deformation of a Thick Walled Cylinder

Water Hammer I
- Description of the Problem
- Mathematical Model
- Fluid Properties Needed for the Model
- Bulk Modulus
- Conservation of Mass
- Conservation of Momentum
- Wave Speed
- Wall Stresses

Water Hammer II
- Sample Calculations
- Thin and Thick Wall Models
- Comparison of Solutions
- Air Entrainment

Day 4

Differential Equations for Transient Conditions
- Unsteady Flow in a Pipeline
- Spreadsheet Solution of the Equations
- Investigation of Various Effects on pipe stresses

Valve Closure Equation Models
- Definitions
- Instantaneous Closure
- Sudden Closure
- Rapid Closure
- Slow Closure
- Spreadsheet Solutions

Other Unsteady Problems
- Oscillating Positive Displacement Pump
- Undamped Free Vibration
- Energy Method
- Damped Free Vibration
- Critical Damping
- Oscillating Liquid in a U-tube

Exercises

The coursework includes many worked sample problems, and the participants are required to solve similar problems.