Fluid Mechanics and Piping Hydraulics: Line Sizing, Pressure Drop and Pump Systems

5 – 9 April 2027
London - Central London four-star



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Introduction:

Fluid mechanics and piping hydraulics errors show up on plants as starved pumps, noisy lines, eroded elbows and transfer rates that never reach design, usually because pressure drop was guessed and line sizes copied from the last job. This Core Concept course gives process, mechanical and operations engineers a calculation method built on fluid properties, the mechanical energy balance, Darcy-Weisbach friction loss, fitting resistance, pump and system curves and NPSH. Participants build a Line Sizing and Hydraulic Calculation Package for a case process system.

Course Objectives:

- Calculate density, viscosity and vapour pressure inputs and apply continuity and the mechanical energy balance to a piped circuit
- Determine friction factor and pressure drop in straight pipe, fittings and valves using Reynolds number, relative roughness, K values and equivalent length
- Select liquid and gas line diameters against velocity, pressure drop per length and erosion criteria, including screening for compressible and two-phase flow
- Match pump characteristic and system resistance curves and check NPSH margin across the operating range
- Solve flow distribution in parallel lines and simple piping networks and evaluate orifice and valve restrictions at hydraulic level
- Diagnose cavitation, flashing, line vibration, erosion and choked flow from field symptoms and hydraulic evidence

Target Audience:

- Process engineering functions that set line sizes, hydraulic profiles and pump duties on new units and modifications
- Mechanical and piping engineering functions that check pipework routing, fittings and pump installations against flow requirements
- Operations engineering functions that investigate rate limits, noisy lines and pump trips on running units
- Technical services functions that debottleneck transfer systems, utilities and cooling water circuits
- Rotating equipment functions that review suction conditions and operating points for centrifugal pumps

Course Outline:

Day 1: Fluid Properties, Flow Regimes and the Energy Balance

- Density, Specific Gravity and Temperature Correction from Property Tables
- Dynamic and Kinematic Viscosity for Newtonian and Viscous Hydrocarbon Liquids
- Vapour Pressure Curves and Flashing Risk at Low-Pressure Points
- Continuity Equation for Mass and Volumetric Flow Through Changing Bore
- Bernoulli Equation Head Terms and the Mechanical Energy Balance with Friction and Pump Work

Day 2: Friction Factor and Pressure Drop in Pipes and Fittings

- Reynolds Number Screening: Laminar, Transition and Turbulent Bands
- Darcy-Weisbach Friction Loss with Laminar f = 64/Re and Fanning Factor Conversion
- Moody Chart Reading and Colebrook-White Iteration for Relative Roughness
- Resistance Coefficient K and Equivalent Length Methods for Elbows, Tees and Reducers
- Entrance, Exit, Sudden Expansion and Contraction Loss Calculation Sheet

Day 3: Line Sizing, Compressible Flow and Pumped System Hydraulics

- Liquid Line Sizing Criteria: Velocity Bands and Pressure Drop per 100 m for Suction and Discharge
- Gas and Steam Line Sizing with Density Change, Momentum Term and Sonic Velocity Limit
- Isothermal and Adiabatic Compressible Flow Approximations for Short Process Lines
- Centrifugal Pump Characteristic, System Resistance Curve and Operating Point Shift
- NPSH Available Build-Up Versus NPSH Required with Temperature and Level Sensitivity

Day 4: Two-Phase Flow, Networks, Restrictions and Flow Problems

- Gas-Liquid Flow Pattern Maps: Bubbly, Stratified, Slug and Annular Regimes
- Homogeneous and Separated-Flow Two-Phase Pressure Drop Estimates for Mixed Lines
- Parallel Lines, Loops and Hardy Cross Balancing of Small Piping Networks
- Orifice Plate and Restriction Orifice Differential Head and Permanent Loss
- Cavitation, Flashing, Flow-Induced Vibration, Erosional Velocity and Choked Flow Diagnosis

Day 5: Case Process System Line Sizing and Hydraulic Calculation

- Case Data Pack: Process Flow Diagram Extract, Stream Properties and Isometric Lengths
- Case Line Size Selection and Pressure Drop Tabulation for Liquid and Gas Circuits
- Case Pump Head, Operating Point and NPSH Margin Check
- Case Hydraulic Profile Plot and Troubleshooting Scenario Review
- Line Sizing and Hydraulic Calculation Package Presentation and Peer Challenge

Skills You Will Gain:

- Fluid Property Estimation
- Friction Factor Determination
- Fitting Loss Calculation
- Process Line Sizing
- Pump System Curve Matching
- NPSH Margin Assessment
- Two-Phase Flow Regime Screening
- Hydraulic Troubleshooting

Why Attend This Course:

- Leave with a Line Sizing and Hydraulic Calculation Package for a case process system that can be reused as a template on your own units
- Replace copied line sizes and rule-of-thumb pressure drops with calculations that reviewers and vendors can check line by line
- Trace pump trips, noisy lines and rate shortfalls back to hydraulic causes before spending on new equipment
- Compare hydraulic practice with engineers from oil and gas, petrochemical, water and power utility plants

Conclusion:

Piping systems deliver design rates only when fluid properties, friction losses, line sizes and pump curves are calculated together and checked against what the plant shows. The week moves from properties and the mechanical energy balance, through friction factor and fitting losses, to line sizing, compressible flow, pump curves and NPSH, then to two-phase flow, networks, restrictions and flow problem diagnosis. The final day produces a Line Sizing and Hydraulic Calculation Package for a case process system.