CONCEPT

Process Engineering Fundamentals: PFDs, P&IDs, Balances and Equipment Calculations

19 – 23 September 2027
Dammam - Eastern Province five-star



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Introduction:

Process engineering fundamentals are often assumed rather than taught, so new graduates and engineers arriving from mechanical, electrical or operations backgrounds misread flowsheets, trust unchecked numbers and struggle to question design data. This Core Concept course builds the working toolkit of a process engineer: reading PFDs and P&IDs, closing material and energy balances, estimating line pressure drop, exchanger duty and separator size, and understanding how pumps, compressors, control loops and relief devices fit a plant system. Participants build a Process Engineering Calculation Workbook of hand calculations for a small plant flowsheet.

Course Objectives:

- Interpret PFDs, stream tables and P&IDs, including equipment symbols, line numbers and instrument tags, to trace a process from feed to product
- Calculate steady-state material and energy balances around units with recycle, bypass and purge streams using physical property and steam table data
- Estimate line pressure drop, pump head and compressor duty to judge whether a flow system can deliver its design rate
- Determine heat exchanger duty and required area and select a suitable exchanger type for a service
- Explain how distillation, absorption and gravity separators achieve a separation and check their basic sizing with shortcut methods
- Apply equipment sizing rules of thumb, control loop logic and basic overpressure protection to review a small process design

Target Audience:

- Recently graduated engineers who are starting in process, technical services or plant engineering teams
- Mechanical and electrical engineers who are moving into roles that require process calculations and flowsheet reviews
- Operations and shift staff who run process units and need to understand the engineering behind operating limits
- Maintenance and reliability engineers who interface with process engineers on equipment performance
- Project and design support engineers who check vendor data and process datasheets
- Laboratory and quality specialists who supply stream composition data for balances

Course Outline:

Day 1: Process Plant Documents and Flowsheet Reading

- Block Flow Diagram, PFD and P&ID Document Hierarchy and Revision Status
- PFD Stream Tables and Heat and Material Balance Sheet Reading
- Equipment and Valve Symbols per ISO 10628 on a Sample P&ID
- Instrument Tag Letters and Loop Numbers per ISA S5.1
- Engineering Unit Systems, Conversion Factors and Gauge Versus Absolute Pressure

Day 2: Physical Properties, Phase Behaviour and Balance Calculations

- Density, Viscosity and Specific Heat Data from Property Tables and Correlations
- Vapour Pressure, Bubble Point and Dew Point on a Phase Envelope
- Steam Tables for Sensible Heat, Latent Heat and Flash Calculations
- Material Balance Method with Recycle, Bypass and Purge Streams
- Energy Balance with Enthalpy Datum, Heat of Reaction and Mixing Duty

Day 3: Fluid Flow, Heat Transfer and Machines at System Level

- Reynolds Number, Moody Friction Factor and Darcy-Weisbach Line Pressure Drop
- Pump System Curve, Operating Point and NPSH Available Check
- Compressor Pressure Ratio, Discharge Temperature and Staging Decision
- Exchanger Duty and Area with the LMTD Method and Overall U Coefficient
- Shell-and-Tube, Plate and Air-Cooled Exchanger Type Selection Matrix

Day 4: Separation, Control Loops and Process Safety Basics

- McCabe-Thiele Stage Count and Minimum Reflux for Binary Distillation
- Gas Absorption Solvent Rate and Stripping Factor Shortcut
- Two-Phase and Three-Phase Separator Sizing with Souders-Brown Velocity
- Feedback Loop Elements, Control Valve Fail Position and Cascade Arrangement
- Overpressure Scenarios, Relief Device Types and Inherent Safety Principles

Day 5: Calculation Exercises and Workbook Build

- Rules of Thumb for Vessel Residence Time, Line Velocity and Exchanger Flux
- Exercise: Balance Closure for a Gas Dehydration or Water Treatment Flowsheet
- Exercise: Transfer Line Sizing and Pump Head Calculation
- Exercise: Cooler Duty and Separator Diameter Check
- Process Engineering Calculation Workbook Assembly and Peer Review

Skills You Will Gain:

- Flowsheet and P&ID Interpretation
- Material Balance Closure
- Steam Table Use
- Line Pressure Drop Estimation
- Exchanger Duty Calculation
- Separator Shortcut Sizing
- Control Loop Reading
- Overpressure Scenario Recognition

Why Attend This Course:

- Return with a Process Engineering Calculation Workbook of checked hand calculations you can reuse on your own plant
- Hold informed technical discussions with senior process engineers, vendors and operators from your first weeks in a process role
- Spot unrealistic flow, duty or sizing figures in datasheets before they reach design or operation
- Practise with engineers from oil and gas, chemicals, water treatment and power sectors who face the same learning curve

Conclusion:

A process engineer is trusted when flowsheets are read correctly and numbers are checked by hand before they are relied upon. The week moves from plant documents and unit discipline through physical properties, balances, fluid flow, heat transfer, rotating machines at system level, separation, control loops and relief basics. The final day turns these methods into a Process Engineering Calculation Workbook covering balances, line sizing, pump head, exchanger duty and separator checks for a small flowsheet.