CONCEPT

Distillation Column Operation and Control: Trays, Packing and Hydraulics

4 – 8 October 2026
Riyadh - KAFD district five-star

Distillation Column Operation and Control: Trays, Packing and Hydraulics

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Introduction:

Distillation column operation decides product purity, throughput and energy use across refineries, gas plants and petrochemical sites, yet many columns run far from their best point because crews cannot read where the hydraulic limits sit or why the control scheme reacts as it does. This Core Concept course gives operators and process engineers the separation basis, tray and packing hydraulics, reboiler and condenser behaviour and control structures behind a stable column. Each participant builds a Column Operating Envelope and Control Sheet for a fractionator, absorber or stripper at their own site.

Course Objectives:

- Calculate relative volatility, minimum stages and approximate reflux needs for a binary or key-component split using vapour-liquid equilibrium data, the McCabe-Thiele diagram and the Fenske equation
- Compare sieve, valve and bubble-cap trays with random and structured packing and select internals suited to pressure, fouling and turndown conditions
- Plot a column stable operating window bounded by jet flood, downcomer backup, weeping, entrainment and foaming limits from tray and packing data
- Operate reboilers, condensers, reflux drums and column pressure control so that heat input and overhead removal stay in balance
- Choose and tune temperature, pressure and dual composition control structures and follow safe start-up and shutdown sequences for a column
- Interpret differential pressure profiles, temperature surveys and gamma scan results and identify reflux, pressure and heat integration measures that cut column energy use

Target Audience:

- Panel and field operating staff responsible for day-to-day running of distillation, absorber and stripper columns
- Process engineering staff responsible for column performance monitoring, test runs and operating targets
- Technical support staff responsible for column internals selection, revamp input and turnaround inspection scope
- Control engineering staff responsible for column control loops, set points and advanced control applications
- Shift supervision staff responsible for column start-up, shutdown and rate change coordination
- Energy and utilities staff responsible for reboiler steam, hot oil and cooling duty on separation units

Course Outline:

Day 1: Separation Basis: Vapour-Liquid Equilibrium and Stage Calculations

- Vapour Pressure, Boiling Point Curves and Vapour-Liquid Equilibrium Diagrams
- Relative Volatility, K-Values and Key Component Selection for a Split
- McCabe-Thiele Diagram: Rectifying and Stripping Operating Lines and the Feed Q-Line
- Fenske Minimum Stages and Minimum Reflux Estimation for Multicomponent Feeds
- Theoretical Stages Versus Actual Trays: Overall and Murphree Efficiency

Day 2: Column Internals: Trays, Random Packing and Structured Packing

- Sieve, Valve and Bubble-Cap Tray Layouts, Downcomers and Weirs
- Random Packing Rings and Saddles Versus Structured Sheet Packing
- Liquid Distributors, Redistributors, Collector Trays and Support Grids
- Height Equivalent to a Theoretical Plate and Packing Pressure Drop Charts
- Internals Selection Matrix for Vacuum, Fouling, Corrosive and High-Pressure Service

Day 3: Column Hydraulics, Heat Exchange Equipment and the Operating Window

- Jet Flood and Downcomer Backup Calculation from Vapour and Liquid Loads
- Weeping, Dumping and Turndown Limits on Sieve and Valve Trays
- Entrainment and Foaming Behaviour with System Factor Adjustment
- Kettle, Thermosiphon and Fired Reboilers and Partial or Total Condensers
- Operating Window Diagram: Plotting Vapour and Liquid Traffic Against Hydraulic Limits

Day 4: Column Control Schemes, Start-Up, Shutdown and Diagnostics

- Column Pressure Control: Flooded Condenser, Hot Vapour Bypass and Inert Venting
- Tray Temperature Control Point Selection Using Sensitivity Analysis
- Dual Composition Control, Material Balance Schemes and Model Predictive Control Overview
- Column Start-Up by Total Reflux and Controlled Shutdown and Draining Sequences
- Differential Pressure Profiles and Gamma Scan Interpretation for Tray and Packing Condition

Day 5: Energy Saving, Related Separations and the Column Operating Envelope Case Work

- Reflux Ratio Optimisation, Feed Preheat and Condenser Pressure Reduction for Energy Savings
- Absorption, Stripping and Liquid-Liquid Extraction Columns at Overview Level
- Case Study: Refinery Crude Fractionator Draw Rates and Pumparound Heat Removal
- Case Study: Gas Plant Deethaniser and Petrochemical Splitter Capacity at Turndown
- Column Operating Envelope and Control Sheet Build and Peer Review

Skills You Will Gain:

- Vapour-Liquid Equilibrium Interpretation
- Graphical Stage Calculation
- Tray and Packing Selection
- Hydraulic Capacity Rating
- Reboiler and Condenser Operation
- Column Control Structure Design
- Column Scan Interpretation
- Separation Energy Optimisation

Why Attend This Course:

- Leave with a Column Operating Envelope and Control Sheet for one fractionator, absorber or stripper, reviewed by peers
- Understand why a column floods, weeps or loses purity from its internals and loads rather than guessing at set point changes
- Work through refinery, gas plant and petrochemical column cases with real tray, packing and reboiler data
- Speak the same language as internals vendors, control engineers and scan contractors when a column needs attention

Conclusion:

A column holds specification and throughput only when its separation basis, internals, hydraulics and controls are understood together. The course moves from vapour-liquid equilibrium, relative volatility and McCabe-Thiele stage work to tray and packing internals, then maps jet flood, downcomer backup, weeping, entrainment and foaming into an operating window. Reboilers, condensers, pressure and composition control, start-up, shutdown and scan diagnostics follow, and the final day adds energy saving, absorption and extraction and case work that produces each participant's Column Operating Envelope and Control Sheet.