CONCEPT

Process Plant Optimisation, Debottlenecking and Energy Conservation

Process Plant Optimisation, Debottlenecking and Energy Conservation

Introduction:

Process plant optimisation often stalls because units run on unreconciled data, hidden constraints and heat recovery that has drifted since design, so margin is lost every day and capacity projects are chosen on guesswork. This Core Concept course equips engineers to baseline unit performance, reconcile measurements against mass and energy balances, locate the true bottleneck, target heat recovery with pinch analysis and cut fuel and steam use. Week two adds fired heaters, utilities, distillation, advanced control, real-time optimisation and margin. Participants build a Unit Optimisation and Debottlenecking Study for their own plant.

Course Objectives:

- Establish a reconciled performance baseline for a process unit from closed mass and energy balances and validated plant data
- Identify the active capacity constraint of a unit and evaluate debottlenecking and revamp options on technical and economic grounds
- Apply pinch analysis to set heat recovery targets and design retrofit changes to an existing heat exchanger network
- Reduce fuel, steam and power consumption in fired heaters, steam systems, distillation columns and exchanger trains through quantified operating and equipment changes
- Assess the benefits of advanced process control, inferential sensors and real-time optimisation and set yield and margin targets they can capture
- Design a KPI monitoring and continual improvement programme that sustains optimisation gains after the study ends

Target Audience:

- Process engineers accountable for unit capacity, yields and operating targets
- Technical services and performance monitoring engineers who analyse plant data and run test runs
- Energy engineers responsible for fuel, steam and power consumption on process units
- Operations engineers and shift leads who implement set point and operating envelope changes
- Control and optimisation engineers who maintain APC applications and inferential models
- Project and revamp engineers who scope capacity expansion and energy recovery projects

Course Outline:

Day 1: Plant Performance Baselining and Balances

- Unit Performance Baseline Definition: Capacity, Yields, Specific Energy and Margin
- Overall and Component Mass Balance Closure Around a Process Unit
- Energy Balance Envelope: Enthalpy Flows, Fuel Duty and Utility Consumption
- Design Versus Actual Gap Analysis Using Datasheets and Historian Trends
- Plant Test Run Planning: Steady-State Criteria, Sampling Plan and Instrument Checks

Day 2: Data Reconciliation and Gross Error Detection

- Measurement Error Types: Random Noise, Bias and Instrument Drift
- Sensor and Topological Redundancy Assessment for a Flowsheet
- Weighted Least Squares Reconciliation Against Balance Constraints
- Gross Error Detection with the Global Chi-Square Test and Individual Measurement Tests
- Unmeasured Variable Estimation and Reconciled Data Set Sign-Off

Day 3: Constraint Identification and Debottlenecking Studies

- Capacity Constraint Mapping: Hydraulic, Thermal, Mechanical and Reaction Limits
- Equipment Rating Checks for Pumps, Compressors, Columns and Exchangers
- Stepwise Throughput Push Test Method and Constraint Shift Analysis
- Debottlenecking Option Screening Matrix with Capacity Gain per Unit Cost
- Revamp Option Evaluation: Internals Replacement, Parallel Equipment and Process Changes

Day 4: Heat Integration and Pinch Analysis

- Stream Data Extraction and Hot and Cold Composite Curves
- Problem Table Algorithm and Minimum Approach Temperature Selection
- Grand Composite Curve for Utility Level Placement
- Cross-Pinch Heat Transfer Diagnosis in an Existing Exchanger Network
- Heat Exchanger Network Retrofit Design with Area and Payback Trade-Off

Day 5: Week-One Integrated Debottlenecking Case

- Refinery Crude Unit Case: Reconciling Test Run Data and Closing Balances
- Preheat Train Case: Pinch Targeting and Retrofit Exchanger Selection
- Gas Plant Case: Locating the Active Constraint During a Throughput Increase
- Debottlenecking Economics: Incremental Margin, Capital Estimate and Net Present Value
- Week-One Findings Review and Study Scope Refinement for Each Participant Unit

Day 6: Fired Heaters, Steam and Utility Systems

- Fired Heater Efficiency: Excess Air, Stack Temperature and Draft Control
- Heater Coking, Tube Metal Temperature and Duty Limits on Run Length
- Steam System Balance: Header Pressures, Letdown Stations and Turbine Versus Motor Drives
- Steam Trap Losses, Condensate Recovery and Flash Steam Utilisation
- Cooling Water and Refrigeration Optimisation: Approach Temperatures and Compressor Loading

Day 7: Distillation and Heat Exchanger Performance

- Column Operating Window: Flooding, Weeping and Entrainment Diagnostics
- Reflux Ratio and Pressure Optimisation Against Product Specifications
- Column Heat Integration Options: Side Reboilers, Pump-Arounds and Feed Preheat
- Exchanger Fouling Resistance Monitoring and Performance Trending
- Cleaning Schedule Economics: Fouling Cost Versus Downtime and Cleaning Cost

Day 8: Advanced Process Control and Real-Time Optimisation

- Regulatory Control Health Check: Loop Tuning, Valve Performance and Service Factor
- Multivariable Model Predictive Control: Manipulated, Controlled and Disturbance Variables
- Inferential Sensor Design and Laboratory Bias Updating
- Real-Time Optimisation Layer: Steady-State Models, Target Setting and Execution Frequency
- APC Benefits Estimation and Operator Acceptance Plan for Control Room Teams

Day 9: Yield, Margin and Continual Improvement Programme

- Yield Optimisation: Cut Point, Conversion and Severity Trade-Offs
- Margin Model Build: Feed Cost, Product Values and Utility Prices per Unit
- Unit KPI Hierarchy: Energy Intensity, Yield, Throughput and Availability Indicators
- Performance Monitoring Dashboard and Deviation Alarm Limits
- Continual Improvement Cycle: Opportunity Register, Benefit Tracking and Management of Change

Day 10: Capstone Unit Optimisation Study

- Capstone Data Pack: Reconciled Baseline and Constraint Map for the Participant Unit
- Capstone Energy Target: Pinch Gap and Utility Savings Estimate
- Capstone Options Ranking: Debottlenecking, Energy and Control Projects by Margin Gain
- Unit Optimisation and Debottlenecking Study Assembly with Improvement Roadmap
- Study Presentation to a Mock Technical Review Panel and Peer Challenge

Skills You Will Gain:

- Mass and Energy Balance Closure
- Plant Data Reconciliation
- Constraint and Bottleneck Diagnosis
- Pinch Targeting
- Fired Heater Tuning
- Steam System Balancing
- Column Performance Diagnostics
- Margin Modelling

Why Attend This Course:

- Return with a Unit Optimisation and Debottlenecking Study built on reconciled data from your own process unit
- Defend capacity and energy proposals to management with a margin case rather than a design estimate
- Recognise when a planned revamp targets the wrong constraint before capital is committed
- Compare optimisation practice with peers from refining, gas processing, petrochemicals and chemicals

Conclusion:

Sustained plant gains come from knowing the true baseline, the active constraint and the energy target before spending money. Week one builds that foundation through balances, data reconciliation, debottlenecking studies and pinch analysis. Week two deepens it with fired heaters, steam and utilities, distillation and exchangers, advanced control, real-time optimisation, yield and margin, and a KPI programme. The final day assembles a Unit Optimisation and Debottlenecking Study with a roadmap ready for technical review.