Process Simulation for Gas Plants: Steady-State and Dynamic Flowsheet Models

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Paris - Right Bank business hotel



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Introduction:

Process simulation underpins design checks, operating targets and capacity decisions in gas plants, yet many flowsheet models are built on the wrong property package, never converge cleanly, drift away from plant data and are handed over without documentation. This Core Concept course trains process, facilities and operations engineers to build steady-state flowsheets in commercial simulators, choose thermodynamic methods with evidence, model separators, exchangers, compressors, columns and gas treating units, validate against field measurements and extend models into dynamic runs. Participants deliver a Validated Gas Plant Simulation Model and Capacity Study.

Course Objectives:

- Build a steady-state flowsheet in a commercial process simulator from a process flow diagram, with a defined component slate, feed characterisation and unit set
- Select and justify cubic equation of state, activity coefficient or steam table property methods for hydrocarbon, glycol, amine and utility streams
- Model separators, heat exchangers, air coolers, compressors, pumps, expanders and control valves and resolve recycle and specification loops to a converged solution
- Simulate distillation and absorption columns, glycol dehydration and amine sweetening, and check hydrate formation and hydrocarbon and water dew points
- Validate a flowsheet against plant measurements and run sensitivity studies that locate equipment limits before throughput changes
- Set up dynamic simulations of control loops, depressuring and start-up, and document models under a controlled model governance procedure

Target Audience:

- Process engineering functions that size equipment and set heat and material balances for gas processing and petrochemical units
- Facilities engineering functions that check separators, compressors and piping hydraulics during brownfield modifications
- Operations and technical support functions that test operating changes and troubleshoot units with a plant model
- Process safety and relief engineering functions that need blowdown and depressuring profiles from dynamic runs
- Engineering functions that review simulation deliverables received from contractors and licensors

Course Outline:

Day 1: Simulation Workflow and Flowsheet Set-Up

- Steady-State Versus Dynamic Process Simulation: Scope, Uses and Limits
- Sequential Modular and Equation-Oriented Solution Methods Compared
- Simulation Basis Document: Feed Compositions, Unit Sets and Design Cases
- Process Flow Diagram to Flowsheet Translation: Streams, Unit Blocks and Energy Streams
- Degrees of Freedom Analysis and Specification Status Checks

Day 2: Component Lists and Thermodynamic Property Packages

- Component Slate Build: Library Components, Hypothetical Components and Petroleum Fractions
- Cubic Equations of State: Peng-Robinson and Soave-Redlich-Kwong for Hydrocarbon Systems
- Activity Coefficient Models for Polar and Non-Ideal Liquid Mixtures
- Steam Tables and Specialised Packages for Glycol, Amine and Sour Water Streams
- Property Method Selection Tree and Binary Interaction Parameter Review

Day 3: Streams, Phase Envelopes, Flash Separation and Heat Transfer Units

- Phase Envelope Generation: Bubble Point, Dew Point, Cricondenbar and Cricondentherm
- Two-Phase and Three-Phase Flash Calculations and Separator Blocks
- Shell-and-Tube Exchanger Models: Simple, End-Point and Rigorous Rating Modes
- Air Cooler Modelling: Ambient Design Temperature, Fan Duty and Approach
- Heat Curve Inspection and Temperature Cross Detection in Exchanger Blocks

Day 4: Rotating Equipment, Valves, Pressure Drop and Flowsheet Convergence

- Centrifugal Compressor Blocks: Polytropic and Isentropic Efficiency, Performance Curves and Anti-Surge Recycle
- Pump and Turboexpander Models with Head, Power and Recovered Work
- Control Valve and Line Pressure Drop: Valve Sizing Coefficient and Pipe Segment Hydraulics
- Recycle, Adjust and Set Logical Operations and Tear Stream Selection
- Convergence Diagnostics: Tolerances, Acceleration Methods and Initial Estimate Strategy

Day 5: Week-One Lab: Gas Inlet Separation and Compression Train Model

- Lab: Slug Catcher, Inlet Separator and Condensate Stabiliser Flowsheet Build
- Lab: Multistage Compression with Intercoolers and Knock-Out Drums
- Lab: Refrigeration Loop Model with Chiller, Expansion Valve and Compressor Recycle
- Lab: Property Package Swap Test and Comparison of Results
- Guided Review of Week-One Flowsheet Files and Convergence Logs

Day 6: Distillation and Absorption Column Modelling

- Shortcut Column Methods: Minimum Reflux, Minimum Stages and Feed Location
- Rigorous Tray-by-Tray Column Set-Up: Specifications, Degrees of Freedom and Solver Choice
- Demethaniser, Deethaniser and Fractionation Train Models for NGL Recovery
- Absorber and Stripper Blocks with Stage Efficiency and Rate-Based Options
- Column Profile Interpretation: Temperature, Composition and Internal Traffic Plots

Day 7: Gas Dehydration, Sweetening, Hydrate and Dew-Point Checks

- Glycol Dehydration Unit Model: Contactor, Flash Drum and Regenerator
- Amine Sweetening Overview: Absorber, Regenerator and Acid Gas Loading
- Hydrate Formation Temperature Prediction and Inhibitor Dosing Estimate
- Hydrocarbon Dew Point and Water Dew Point Specification Checks for Sales Gas
- Heating Value and Wobbe Index Calculation from Simulated Gas Composition

Day 8: Introduction to Dynamic Simulation

- Steady-State to Dynamic Model Conversion: Vessel Volumes, Elevations and Valve Characteristics
- PID Control Loop Configuration and Tuning in the Dynamic Model
- Vessel Depressuring and Blowdown Profiles: Pressure, Temperature and Relief Load
- Start-Up and Shutdown Sequence Simulation and Operator Procedure Testing
- Compressor Trip and Surge Transient Scenarios

Day 9: Model Validation, Sensitivity Studies and Model Governance

- Plant Data Collection for Model Matching: Historian Tags, Laboratory Analyses and Test Runs
- Model Tuning: Exchanger Fouling Factors, Compressor Efficiencies and Column Stage Efficiencies
- Case Study and Sensitivity Tools: Throughput, Feed Composition and Ambient Temperature Sweeps
- Equipment Limit Identification: Column Flooding, Compressor Power and Exchanger Duty Margins
- Model Governance: Version Control, Assumptions Register, Model Report and Handover File

Day 10: Capstone: Validated Gas Plant Simulation Model and Capacity Study

- Capstone Flowsheet: Case Gas Plant Inlet, Dehydration, NGL Recovery and Export Compression
- Capstone Validation: Matching Model Results to Supplied Plant Data Set
- Capstone Capacity Study: Throughput Increase Scenarios and Limiting Equipment Ranking
- Capstone Dynamic Check: Depressuring Profile for a Selected Section
- Model Report Presentation and Technical Panel Challenge

Skills You Will Gain:

- Flowsheet Construction
- Thermodynamic Method Selection
- Phase Envelope Interpretation
- Recycle Loop Convergence
- Column Modelling
- Hydrate and Dew-Point Assessment
- Dynamic Model Set-Up
- Simulation Model Documentation

Why Attend This Course:

- Return with a Validated Gas Plant Simulation Model and Capacity Study built on a case gas plant during the labs
- Stop trusting converged flowsheets that rest on an unsuitable property package or unchecked specifications
- Move from steady-state separation and compression in week one to columns, gas treating, dynamic runs and model matching in week two
- Compare simulation practice with process, facilities and operations engineers from gas processing, refining and petrochemical sites

Conclusion:

A flowsheet model earns trust only when its property methods, specifications and results stand up against plant data. Week one covers the simulation workflow, component lists and property packages, phase envelopes, separators, exchangers, rotating equipment, valves and convergence, closing with a separation and compression lab. Week two adds distillation and absorption columns, dehydration and sweetening, hydrate and dew-point checks, dynamic simulation, validation, sensitivity studies and model governance. The final day produces a Validated Gas Plant Simulation Model and Capacity Study.