Steam Cracking and Ethylene Plant Operations: Olefins Value Chain and Cracker Optimisation

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Introduction:

Steam cracking and ethylene plant performance slips when feed slates change faster than furnace severity targets, coke builds up between decokes and the recovery section runs short of compression or refrigeration margin. Olefin yield losses then pass straight to the polymer and intermediate units downstream. This Core Concept course follows the olefins value chain from ethane, propane and naphtha feeds through cracking furnaces, quench, compression, cryogenic separation and product splitters, then on to on-purpose propylene, derivatives and cracker economics. Each participant builds a Cracker Optimisation and Feedstock Selection Plan.

Course Objectives:

- Evaluate ethane, propane, butane and naphtha feed slates by ethylene and co-product yield, cracking severity and value
- Control cracking furnace severity, coke build-up and decoking to extend run length and protect coil and transfer line exchanger integrity
- Diagnose capacity limits in quench, cracked gas compression, acid gas removal, drying and refrigeration systems
- Troubleshoot cold box, turbo-expander, demethaniser, acetylene hydrogenation and C2 and C3 splitter performance against ethylene recovery and product purity
- Assess on-purpose propylene routes, C4 and pyrolysis gasoline handling and the monomer needs of polyethylene, polypropylene, PVC and ethylene glycol plants
- Build a cracker optimisation and feedstock selection plan that links energy efficiency, reliability, turnaround scope and cracker margin

Target Audience:

- Process engineers responsible for furnace severity, olefin yields and recovery section performance
- Operations engineers and shift leaders who run cracking furnaces, cracked gas compressors and cold sections
- Production planning and optimisation engineers who set feed slates and run cracker yield models
- Technical services engineers who track energy use, fouling and product quality in olefins units
- Reliability and turnaround engineers who plan compressor, furnace and cold box maintenance
- Derivative plant process engineers whose units depend on cracker monomer quality and supply

Course Outline:

Day 1: Olefins Market, Feedstocks and Steam Cracking Chemistry

- Ethylene and Propylene Demand Drivers Across Polymer and Intermediate Chains
- Feedstock Slate Comparison: Ethane, Propane, Butane and Naphtha Yield Patterns
- Free Radical Pyrolysis Mechanism: Initiation, Propagation and Secondary Reactions
- Cracking Severity Indicators: Coil Outlet Temperature, Propylene-to-Ethylene Ratio and Conversion
- Residence Time, Hydrocarbon Partial Pressure and Dilution Steam Ratio Effects on Selectivity

Day 2: Cracking Furnace Design, Coking and Transfer Line Exchangers

- Radiant Coil Geometry, Convection Section Heat Recovery and Burner Arrangement
- Tube Metal Temperature Monitoring and Coil Outlet Temperature Control Loops
- Coke Formation Mechanisms, Run Length Prediction and Anti-Coking Measures
- Steam-Air Decoking Procedure: Sequence, Burn Control and End-Point Checks
- Transfer Line Exchanger Fouling, High-Pressure Steam Generation and Outlet Temperature Trends

Day 3: Quench, Cracked Gas Compression, Acid Gas Removal and Refrigeration

- Primary Fractionator and Quench Water Tower Operation for Liquid Feeds
- Multistage Cracked Gas Compressor Performance Maps, Interstage Cooling and Fouling Control
- Caustic Tower and Amine Wash Options for Hydrogen Sulphide and Carbon Dioxide Removal
- Molecular Sieve Dryer Regeneration Cycles and Moisture Breakthrough Detection
- Propylene and Ethylene Refrigeration Cascade: Compressor Levels and Duty Balance

Day 4: Cold Box, Turbo-Expanders, Demethaniser and Product Splitters

- Chilling Train and Plate-Fin Cold Box Temperature Approach Monitoring
- Turbo-Expander Compressor Operation: Isentropic Efficiency, Seal Gas and Trip Protection
- Demethaniser Reflux, Ethylene Loss to Tail Gas and Hydrogen Recovery
- Deethaniser Cut and Front-End Versus Tail-End Acetylene Hydrogenation Converter Control
- C2 and C3 Splitter Reboiler-Condenser Duty, Heat Pump Schemes and Polymer-Grade Purity

Day 5: Week-One Case: Feed Switch from Ethane to Mixed Liquids

- Case Data Pack: Furnace Yields, Compressor Curves and Recovery Section Heat and Material Balance
- Furnace Severity and Run Length Response to a Heavier Feed Slate
- Cracked Gas Compressor and Refrigeration Bottleneck Identification Under the New Feed
- Demethaniser and C2 Splitter Ethylene Recovery Check Against Product Specification
- Week-One Findings Log and Capstone Scope Setting for Each Participant Plant

Day 6: On-Purpose Propylene, C4 Streams and Pyrolysis Gasoline

- Propane Dehydrogenation Overview: Equilibrium Limits, Catalyst Regeneration and Yield
- Olefin Metathesis of Ethylene and 2-Butene to Propylene: Feed Purity and Integration
- Crude C4 Handling: Butadiene Extraction and Raffinate Routing Overview
- Pyrolysis Gasoline Two-Stage Hydrotreating and Aromatics Recovery Routing
- Pyrolysis Fuel Oil and Tar Disposition Options and Their Value Impact

Day 7: Olefin Derivatives at Process Level

- Polyethylene Process Routes: Gas-Phase, Slurry and High-Pressure Tubular Reactors
- Polypropylene Process Routes, Comonomer Use and Catalyst System Choices
- Balanced EDC and VCM Plant: Direct Chlorination, Oxychlorination and EDC Cracking to PVC
- Ethylene Oxide Reactor Selectivity and Ethylene Glycol Hydrolysis Section
- Monomer Trace Impurities and Their Effect on Downstream Polymerisation Catalysts

Day 8: Reliability, Process Safety and Turnaround Planning

- Critical Machinery Reliability: Cracked Gas and Refrigeration Compressor Trains
- Cold Section Hazards: Low-Temperature Embrittlement, Hydrate Plugging and Mercury Attack on Aluminium Exchangers
- Furnace and Decoking Operating Envelope Review Using HAZOP Findings
- Ethylene Plant Turnaround Scope, Critical Path and Pre-Shutdown Inspection Planning
- Post-Turnaround Start-Up Sequence: Dry-Out, Cooldown and Flare Minimisation

Day 9: Energy Efficiency, Cracker Margins and Refinery Integration

- Specific Energy Consumption Benchmarking per Tonne of Ethylene
- Furnace Thermal Efficiency, Steam Balance and Fuel Gas Header Optimisation
- Cracker Margin Build-Up: Feed Cost, Co-Product Credits and Variable Costs
- Feedstock Selection Economics Using Yield Models and Delivered Feed Values
- Refinery-Petrochemical Integration: Off-Gas Recovery, Naphtha Exchange and Hydrogen Balance

Day 10: Capstone: Cracker Optimisation and Feedstock Selection Plan

- Capstone Build: Plant Baseline of Feeds, Furnace Severity and Recovery Section Limits
- Capstone Build: Feed Slate Scenarios With Yield, Energy and Margin Comparison
- Capstone Build: Bottleneck Relief Options Ranked by Ethylene Gain and Cost
- Capstone Build: Reliability and Turnaround Actions Supporting the Chosen Case
- Cracker Optimisation and Feedstock Selection Plan Presentation to a Technical Review Panel

Skills You Will Gain:

- Cracking Severity Control
- Furnace Run Length Management
- Cracked Gas Compression Analysis
- Cryogenic Separation Troubleshooting
- Olefin Recovery Balancing
- Feedstock Yield Evaluation
- Cracker Margin Analysis
- Turnaround Scope Planning

Why Attend This Course:

- Return with a Cracker Optimisation and Feedstock Selection Plan built on the feeds, furnaces and recovery section of your own plant
- Trace how a change at the furnace coil shows up in compressor load, refrigeration duty and splitter purity
- Move from cracking and separation in week one to on-purpose propylene, derivatives, reliability, energy and margin in week two
- Compare olefins practice with process, operations and planning engineers from gas-fed and liquid-fed crackers

Conclusion:

Ethylene plant value is set at the furnace coil and either kept or lost in the recovery section. Week one builds that picture from feedstocks and cracking chemistry through furnaces, decoking, quench, compression, refrigeration, the cold box, turbo-expanders and the product splitters, closing with a feed switch case. Week two adds on-purpose propylene, C4 and pyrolysis gasoline handling, derivative processes, reliability and turnaround, energy use, cracker margins and refinery integration. The final day delivers a Cracker Optimisation and Feedstock Selection Plan ready for technical review.