Hydrocracking and Hydrotreating: CoMo and NiMo Loading, Reactor Control and Cycle Optimisation

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Amsterdam - Zuidas business district hotel



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Introduction:

Hydrocracking and hydrotreating decide whether diesel and jet pools meet ultra-low sulphur and smoke point limits, yet many hydrotreaters and hydrocrackers lose cycle length to bed fouling, poor quench, treat gas purity drift and cracking severity that wanders from design. This Core Concept course gives hydroprocessing specialists expert command of HDS and HDN chemistry, CoMo and NiMo loading and sulphiding, reactor internals, quench and treat gas balance, then bifunctional cracking, flow schemes, runaway prevention and deactivation. Participants produce a Hydroprocessing Cycle Evaluation and Optimisation Plan for a case plant.

Course Objectives:

- Relate diesel and jet specification limits to hydrotreater and hydrocracker charge quality, reaction severity and treat gas demand
- Specify CoMo or NiMo systems, bed grading, guard layers, loading method and sulphiding procedure for a hydroprocessing reactor
- Control reactor inlet and bed temperatures, interbed quench and H2 partial pressure to protect activity and diesel and jet quality
- Compare single-stage, two-stage, once-through and recycle hydrocracker schemes by cracking severity, middle distillate selectivity and yield
- Diagnose deactivation, maldistribution, pressure drop build-up and temperature excursions, and set safe responses including emergency depressuring
- Build a Hydroprocessing Cycle Evaluation and Optimisation Plan with cycle length prediction and ranked operating moves

Target Audience:

- Process specialists accountable for hydrotreater and hydrocracker severity, yields and cycle length
- Operations staff and shift supervisors who start up, operate and shut down high-pressure H2 plants
- Technical services staff who trend activity, weighted average bed temperature and reactor pressure drop
- Hydroprocessing technologists who evaluate CoMo and NiMo vendor proposals and change-out timing
- Process safety and inspection specialists who review H2 service hazards and pressure equipment integrity
- Plant planners who set charge rates, cracking targets and diesel, jet and naphtha routing

Course Outline:

Day 1: Hydroprocessing Roles and Diesel and Jet Specification Drivers

- Hydroprocessing Map: Naphtha, Kerosene, Diesel and Vacuum Gas Oil Hydrotreaters Beside the Hydrocracker
- Ultra-Low Sulphur Diesel Drivers: Refractory Sulphur, Cetane Index, Density and Polyaromatics
- Jet Quality Targets: Smoke Point, Freeze Point, Aromatics Limit and Thermal Stability
- Treat Gas Sources: Reformer Off-Gas, Steam Methane Reformer Make-Up and Purity Upgrading
- Hydrotreater Flow Scheme: Charge Heater, Reactors, Hot and Cold Separators, Recycle Loop and Stripper

Day 2: Charge Stock Characterisation and Hydrotreating Reaction Chemistry

- Charge Analysis Set: Simulated Distillation, Sulphur Speciation, Basic Nitrogen, Bromine Number and Contaminants
- Cracked Stock Co-Processing: Light Cycle Oil and Coker Gas Oil Effects on Severity
- HDS Pathways: Direct Hydrogenolysis Versus Hydrogenation Route for Dibenzothiophenes
- HDN, Olefin Saturation and Aromatic Saturation Equilibrium at End-of-Cycle Temperature
- Hydrodemetallisation: Nickel, Vanadium, Silicon and Arsenic Pick-Up Profiles

Day 3: CoMo and NiMo Systems, Loading Methods and Sulphiding

- CoMo Versus NiMo on Alumina: MoS2 Edge Sites and Duty-Based Selection
- Graded Bed Design: Guard Layers, Trap Materials and Particle Size Grading Against Fouling
- Sock Loading Versus Dense Loading: Bed Density, Void Fraction and Channelling Risk
- Sulphiding: Liquid-Phase Versus Gas-Phase Activation and DMDS Injection Control
- Start-Up Temperature Ramp, H2S Breakthrough and Fresh Charge Stabilisation

Day 4: Reactor Internals, Quench Control and Treat Gas Management

- Inlet Distributor Trays, Scale Baskets and Liquid Distribution Quality Checks
- Interbed Quench Zones: Quench Gas Mixing, Redistribution and Radial Temperature Spread
- Exotherm Management: Bed Outlet Temperature Limits and Heater Firing Control
- H2 Partial Pressure, Gas-to-Liquid Ratio and Chemical Consumption Calculation
- Recycle Compressor Duty, High-Pressure Amine Scrubber and Purge for Purity Control

Day 5: Guided Case: Diesel Hydrotreater Performance Review

- Case Data Pack: Diesel Hydrotreater Charge Blend, Operating Log and Laboratory Tests
- Required Temperature Calculation to Hold Diesel Sulphur Under a Heavier Charge
- Treat Gas Balance Check: Make-Up, Purge, Solution Losses and Consumption per Barrel
- Quench and Distribution Findings from Bed Thermocouple Radial Spread
- Case Findings Record and Plant Selection for the Capstone Plan

Day 6: Hydrocracking Chemistry, Bifunctional Systems and Flow Schemes

- Hydrocracking Reaction Network: Ring Opening, Paraffin Isomerisation and Carbon-Carbon Scission
- Bifunctional Systems: Metal Hydrogenation Function and Amorphous or Zeolite Acid Function
- Pretreat Stage Organic Nitrogen Slip Control Ahead of Zeolite Cracking Beds
- Single-Stage, Single-Stage Recycle and Two-Stage Hydrocracker Scheme Selection
- Once-Through Partial Cracking Versus Full Recycle and Unconverted Bottoms Bleed

Day 7: Cracking Severity, Selectivity, Yields and Hydrocracker Fractionation

- Per-Pass Versus Overall Cracking Severity and Recycle Cut Point Setting
- Middle Distillate Selectivity Versus Naphtha and Light Ends Make Across the Cycle
- Hydrocracker Yield Estimation from Charge Properties and Cracking System Type
- Main Fractionator, Debutaniser and Side Stripper Operation for Kerosene and Diesel Cut Quality
- Heavy Polynuclear Aromatics Accumulation in Recycle Bottoms and Bleed Rate Control

Day 8: Temperature Runaway Prevention, Depressuring and Hydroprocessing Safety

- Temperature Excursion Mechanisms in Cracking Beds and Early Warning Thermocouple Patterns
- Emergency Depressuring System: Rate Selection, Trip Logic and Board Operator Actions
- H2S Hazards in Separator Off-Gas, Sour Water and Spent Material Handling
- High-Pressure H2 Leak, Jet Fire and Loss of Containment Scenarios
- High Temperature Hydrogen Attack Overview: Decarburisation, Methane Fissuring and Chromium-Molybdenum Alloy Selection

Day 9: Deactivation, Cycle Length and Performance Monitoring

- Deactivation Signatures: Coke Lay-Down, Metals Poisoning and Nitrogen Inhibition
- Weighted Average Bed Temperature Normalisation and Activity Decline Trending
- Reactor Pressure Drop Build-Up: Fouling Diagnosis, Skimming and Top-Bed Replacement
- End-of-Cycle Criteria, Cycle Length Prediction and Change-Out Timing Decisions
- Ex-Situ Regeneration, Rejuvenation and Spent Material Handling Options

Day 10: Capstone: Hydroprocessing Cycle Evaluation and Optimisation Plan

- Capstone Build: Case Plant Baseline of Charge, Severity, Treat Gas and Diesel and Jet Quality
- Capstone Build: Troubleshooting Findings Ranked by Margin and Cycle Length Impact
- Capstone Build: Optimisation Moves for Cracking Severity, Selectivity and Treat Gas Use
- Capstone Build: Cycle Length Forecast and Change-Out Recommendation
- Plan Presentation and Challenge by a Hydroprocessing Technical Review Panel

Skills You Will Gain:

- Charge Stock Evaluation
- Loading and Sulphiding Supervision
- Interbed Quench Control
- Treat Gas Balance Calculation
- Hydrocracker Yield Analysis
- Temperature Excursion Response
- WABT and Pressure Drop Trending
- Cycle Length Forecasting

Why Attend This Course:

- Return with a Hydroprocessing Cycle Evaluation and Optimisation Plan built on a real case plant and challenged by peers
- Read bed thermocouple and pressure drop patterns early enough to act before a cycle is cut short
- Question vendor claims on activity, selectivity and cycle length with your own plant data
- Exchange hydrotreater and hydrocracker practice with specialists from sites of different configurations and crude diets

Conclusion:

Hydrotreaters and hydrocrackers carry the sulphur, quality and cracking targets of a modern fuels site. Days one to five build expert command of hydrotreating: diesel and jet specifications, charge characterisation, HDS and HDN chemistry, CoMo and NiMo loading and sulphiding, reactor internals, quench and treat gas balance, closing with a diesel hydrotreater case. Days six to nine add bifunctional cracking, flow schemes, selectivity and fractionation, runaway prevention and depressuring, deactivation and cycle length. The final day produces a Hydroprocessing Cycle Evaluation and Optimisation Plan ready for technical review.