CONCEPT

Heat Exchangers: Design, Operation, Fouling Control and Maintenance

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Introduction:

Heat exchangers lose duty quietly: fouling builds, tubes vibrate or thin, bundles leak, and units run below target long before anyone schedules a cleaning or inspection. This Core Concept course gives process, mechanical and maintenance engineers a working method to rate shell-and-tube, plate, air-cooled and double-pipe heat exchangers, check pressure drop, trend fouling resistance, choose cleaning methods, diagnose vibration and tube failures, and plan eddy current and hydrostatic testing. Participants build a Heat Exchanger Condition and Performance Dossier for exchangers from their own plant.

Course Objectives:

- Identify shell-and-tube construction using TEMA nomenclature and compare it with plate, plate-fin, air-cooled and double-pipe exchangers for a given service
- Rate an existing exchanger with the LMTD and effectiveness-NTU methods and check shell-side and tube-side pressure drop against allowable limits
- Calculate fouling resistance from plant data and trend the overall heat transfer coefficient to decide when cleaning pays back
- Select chemical, hydro-jetting, projectile or bundle-pull cleaning methods and plan the work to limit downtime and tube damage
- Diagnose flow-induced vibration, tube leaks, corrosion and erosion failures and recommend design or operating corrections
- Plan eddy current, remote field and hydrostatic tests and interpret the results to set plugging, retubing or replacement decisions

Target Audience:

- Process engineers who monitor exchanger duty, approach temperatures and run length on operating units
- Mechanical and static equipment engineers who review exchanger datasheets, bundle modifications and repairs
- Maintenance engineers and supervisors who plan bundle pulls, cleaning campaigns and retubing work
- Inspection and integrity engineers who schedule tube testing and assess remaining tube wall
- Technical services engineers who investigate exchanger underperformance and propose corrections
- Reliability engineers who analyse repeat exchanger failures and cleaning frequency

Course Outline:

Day 1: Exchanger Heat Transfer and Equipment Types

- Conduction, Convection and Film Coefficients in Exchanger Service
- Overall U Coefficient Build-Up from Film, Wall and Fouling Resistances
- Counterflow, Parallel Flow and Multi-Pass Arrangements with Temperature Profiles
- Plate, Plate-Fin and Double-Pipe Exchanger Construction and Duty Limits
- Air-Cooled Exchanger Finned Tube Bundles, Fans and Forced Versus Induced Draft

Day 2: Shell-and-Tube Construction and TEMA Nomenclature

- TEMA Nomenclature for Front Head, Shell and Rear Head Types
- Fixed Tubesheet, U-Tube and Floating Head Bundles with Removability Trade-Offs
- Segmental Baffles, Tube Pitch Layouts and Tube Pass Partition Arrangements
- Tube and Shell Material Selection: Carbon Steel, Stainless, Copper Alloys, Titanium and Nickel Alloys
- Tube Rupture Scenarios and Protection with Relief Valves or Rupture Discs

Day 3: Thermal Rating and Hydraulic Checks

- LMTD Rating with Correction Factor for Multi-Pass Shell-and-Tube Units
- Effectiveness-NTU Rating When Outlet Temperatures Are Unknown
- Shell-Side Flow Streams: Crossflow, Bypass and Leakage Effects on Duty
- Tube-Side and Shell-Side Pressure Drop Check Against Allowable Values
- Rating Spreadsheet Build: Design Versus Actual Duty and Excess Area

Day 4: Fouling, Cleaning, Vibration and Tube Failures

- Six Fouling Mechanisms: Scaling, Particulate, Corrosion, Reaction, Solidification and Biofouling
- Fouling Resistance Monitoring and Cleaning Interval Economics
- Cleaning Methods: Chemical Circulation, Hydro-Jetting, Projectile Pigs and Plate Pack Disassembly
- Flow-Induced Vibration: Vortex Shedding, Fluid-Elastic Instability and Baffle Damage
- Tube Failure Modes: Pitting, Erosion at Inlets, Tube-to-Tubesheet Joint Leaks and Thermal Stress

Day 5: Inspection, Testing and Troubleshooting Case Work

- Conventional Eddy Current and Remote Field Testing of Exchanger Tubing
- Hydrostatic Shell and Tube-Side Testing After Repair or Retubing
- Tube Plugging Limits, Retubing and Bundle Replacement Decision Matrix
- Troubleshooting Case: Crude Preheat, Cooling Water Cooler and Air Cooler Underperformance
- Heat Exchanger Condition and Performance Dossier Assembly and Peer Review

Skills You Will Gain:

- Exchanger Thermal Rating
- Pressure Drop Checking
- Fouling Resistance Trending
- Cleaning Method Selection
- Vibration Failure Diagnosis
- Tube Inspection Interpretation
- Bundle Repair Planning
- Exchanger Troubleshooting

Why Attend This Course:

- Return with a Heat Exchanger Condition and Performance Dossier covering rating, fouling trend and inspection findings for exchangers from your own unit
- Justify cleaning and bundle pull dates to operations and planning with fouling cost figures instead of fixed calendar intervals
- Stop repeat tube leaks by tracing them to vibration, velocity, material or joint causes rather than plugging tubes each shutdown
- Compare exchanger practice with process, mechanical and maintenance peers from refining, petrochemicals, power, gas processing and utilities

Conclusion:

An exchanger that is rated, trended and inspected with a clear method rarely surprises its owners. The week moves from heat transfer and exchanger types, through shell-and-tube construction and TEMA nomenclature, to LMTD and effectiveness-NTU rating with pressure drop checks, then to fouling, cleaning, vibration and tube failures, and finally to eddy current and hydrostatic testing and troubleshooting cases. Participants leave with a Heat Exchanger Condition and Performance Dossier ready for their next unit review or turnaround.