Advanced Heat Exchanger Design and Thermal Performance Training Course



Ref: #ACE4351

Course Introduction / Overview:

This comprehensive training course provides an in-depth exploration of heat exchanger design, thermal performance analysis, and operational optimization. In today's energy-conscious world, the efficiency of thermal systems is paramount, and heat exchangers are the cornerstone of effective heat transfer in countless industrial processes. This program moves beyond basic principles to cover the intricate details of thermal and hydraulic design, material selection, and advanced analysis techniques. Participants will gain a robust understanding of industry standards, including TEMA and ASME codes, ensuring their designs are both efficient and compliant. The curriculum is informed by the foundational work of leading academics like Sadik Kakaç, whose text "Heat Exchangers: Selection, Rating, and Thermal Design" remains a critical resource in the field. At BIG BEN Training Center, we have structured this course to bridge the gap between theoretical knowledge and practical application, equipping engineers and technical professionals with the skills to tackle complex challenges, from mitigating fouling and vibration to implementing heat transfer enhancement techniques for maximum energy efficiency and system reliability.

Target Audience / This training course is suitable for:

- Mechanical Engineers.
- Process Engineers.
- Design and Thermal Engineers.
- Project Engineers.
- Operations and Maintenance Personnel.
- Plant and Facility Managers.
- Research and Development Professionals.
- Technical Consultants involved in thermal systems.
- Inspection and Reliability Engineers.

Target Sectors and Industries:

- Oil and Gas Production and Refining.
- Petrochemical and Chemical Processing.
- Power Generation (Conventional and Renewable).
- Heating, Ventilation, and Air Conditioning (HVAC).
- Manufacturing and Industrial Processing.
- Pharmaceuticals and Food Processing.
- Marine and Aerospace Engineering.
- Governmental bodies and regulatory agencies overseeing energy and industrial standards.

Target Organizations Departments:

- Engineering and Design.
- Operations and Production.
- Maintenance and Reliability.
- Research and Development (R&D).
- Project Management.
- Technical Services.
- Quality Assurance and Control.
- Energy Management and Sustainability.

Course Offerings:

By the end of this course, the participants will have able to:

- Master the fundamental principles of heat transfer and fluid flow as they apply to heat exchangers.
- Perform detailed thermal and hydraulic design calculations for various heat exchanger types.
- Apply TEMA and ASME standards correctly in the design and specification of shell-and-tube heat exchangers.
- Select the most appropriate heat exchanger type for specific industrial applications and process conditions.
- Analyze and diagnose common operational problems such as fouling, corrosion, and flow-induced vibration.
- Develop effective strategies for fouling mitigation, cleaning, and preventative maintenance.
- Evaluate and implement advanced heat transfer enhancement techniques to improve performance and energy efficiency.
- Utilize principles of computational fluid dynamics (CFD) for thermal modeling and performance simulation.
- Conduct performance monitoring and operational optimization of existing heat exchanger networks.

Course Methodology:

The training methodology at BIG BEN Training Center is designed to foster a deep, practical understanding of heat exchanger technology through a dynamic and interactive learning environment. We believe that adult learning is most effective when it combines theoretical knowledge with hands-on application. Therefore, the course heavily emphasizes real-world case studies drawn from various industries, allowing participants to analyze complex design and operational challenges. Interactive sessions, expert-led lectures, and group discussions encourage collaborative problem-solving and the sharing of diverse experiences. Participants will engage in practical exercises and workshops focused on thermal design calculations, material selection, and troubleshooting scenarios. The curriculum incorporates simulations of heat exchanger performance to provide a visual and intuitive grasp of complex concepts like fluid dynamics and thermal gradients. Continuous feedback from the instructor ensures that participants can clarify doubts and solidify their understanding throughout the five-day program, leaving them confident in their ability to apply the learned skills immediately in their professional roles.

Course Agenda (Course Units):

Unit One: Fundamentals of Heat Transfer and Exchanger Classification

- Introduction to heat transfer mechanisms: conduction, convection, and radiation.
- Overall heat transfer coefficient and thermal resistance networks.
- The Log Mean Temperature Difference (LMTD) and Effectiveness-NTU methods.
- Classification of heat exchangers based on construction and flow arrangement.
- Key terminology and performance metrics in heat exchanger analysis.
- Introduction to industry standards (TEMA, API, ASME).
- Basic principles of fluid mechanics in heat exchangers.

Unit Two: Shell-and-Tube Heat Exchanger (STHE) Design and Analysis

- Detailed exploration of TEMA nomenclature and standards.
- Step-by-step thermal design process for STHEs.
- Tube-side and shell-side pressure drop calculations.
- Baffle design, tube layout, and their impact on performance.
- Mean temperature difference correction factors.
- Mechanical design considerations and material selection.
- Analysis of common STHE configurations and applications.

Unit Three: Other Heat Exchanger Types and Applications

- Plate-and-Frame Heat Exchangers: design and advantages.
- Compact Heat Exchangers: plate-fin and microchannel types.
- Air-Cooled and Finned-Tube Heat Exchangers.
- Spiral, Welded Plate, and Gasketed Plate Heat Exchangers.
- Regenerators and their role in energy recovery.
- Selection criteria for different heat exchanger types based on process requirements.
- Specialized designs for high-pressure and high-temperature services.

Unit Four: Operational Challenges and Maintenance Strategies

- Mechanisms of fouling: crystallization, particulate, corrosion, and biological.
- Fouling factor prediction and its impact on design and performance.
- Effective fouling mitigation and cleaning techniques (chemical and mechanical).
- Flow-induced vibration (FIV) phenomena and prevention methods.
- Corrosion mechanisms and material selection for corrosive environments.
- Inspection techniques: NDT, thermal imaging, and pressure testing.
- Developing a robust reliability and maintenance program for heat exchangers.

Unit Five: Advanced Performance Enhancement and Optimization

- Active and passive heat transfer enhancement techniques.
- Use of enhanced tubes, inserts, and surface modifications.
- Introduction to Computational Fluid Dynamics (CFD) for thermal-hydraulic modeling.
- Heat exchanger network design and process integration (Pinch Technology).
- Performance monitoring, data analysis, and operational optimization.
- Troubleshooting common performance issues in industrial settings.
- Future trends in heat exchanger technology and sustainable design.

FAQ:

Qualifications required for registering to this course?

There are no requirements.

How long is each daily session, and what is the total number of training hours for the course?

This training course spans five days, with daily sessions ranging between 4 to 5 hours, including breaks and interactive activities, bringing the total duration to 20 - 25 training hours.

Something to think about:

How might the integration of artificial intelligence and advanced materials science redefine the principles of heat exchanger design for next-generation energy systems?

What unique qualities does this course offer compared to other courses?

This training course distinguishes itself by offering a holistic and deeply practical perspective that transcends standard design theory. While many programs focus solely on the calculations and standards of new equipment design, this course dedicates significant attention to the entire lifecycle of a heat exchanger, including critical operational challenges like fouling, vibration, and corrosion. We bridge the gap between the design engineer's desk and the plant floor, equipping participants with the diagnostic and troubleshooting skills essential for optimizing existing assets and preventing costly failures. The curriculum integrates advanced concepts such as heat transfer enhancement and process integration, providing a forward-looking view on energy efficiency and sustainability. Rather than just presenting software tools, we focus on the underlying engineering principles, ensuring participants can critically evaluate and interpret simulation results. The emphasis on real-world case studies and interactive problem-solving sessions ensures that the knowledge gained is not merely academic but immediately applicable, empowering professionals to make more informed decisions that enhance reliability, improve performance, and drive operational excellence.