Process Design with Thermodynamics and Phase Equilibrium Training Course

05 - 09 Oct 2026

Rome

5800 € (Per Person)

Ref: #ACE6573_254321

Course Introduction / Overview:

This intensive training course provides a comprehensive exploration of applied thermodynamics and phase equilibrium, crucial for effective chemical process design, optimization, and troubleshooting. Moving beyond basic principles, the curriculum delves into the practical application of thermodynamic models to solve real-world engineering challenges. Participants will gain a deep understanding of how to select and apply appropriate equations of state and activity coefficient models for various chemical systems, including highly non-ideal and azeotropic mixtures. The course draws upon foundational concepts established by pioneers like J.M. Smith in works such as "Introduction to Chemical Engineering Thermodynamics," translating complex theory into actionable skills. At BIG BEN Training Center, we bridge the gap between academic knowledge and industrial practice, focusing on the nuances of vapor-liquid, liquid-liquid, and solid-liquid equilibria. This program is meticulously designed to empower engineers and scientists to make informed decisions that enhance process efficiency, ensure product quality, and maintain operational safety. By mastering these advanced concepts, attendees will be equipped to design robust separation processes, predict mixture behavior accurately, and leverage thermodynamic data for innovative process development and simulation.

Target Audience / This training course is suitable for:

- Chemical Engineers.
- Process Design Engineers.
- Research and Development Scientists.
- Process Simulation Engineers.
- Production and Operations Engineers.
- Plant Managers and Supervisors.
- Technical Service Engineers.
- Academics and Researchers in Chemical Engineering.

Target Sectors and Industries:

- Oil and Gas Exploration and Production.
- Petrochemicals and Refining.
- Pharmaceuticals and Biotechnology.
- Specialty and Fine Chemicals Manufacturing.
- Food and Beverage Processing.
- Environmental Engineering and Waste Management.

- Governmental bodies and regulatory agencies.
- Polymer and Plastics Industry.

Target Organizations Departments:

- Process Engineering and Design.
- Research and Development (R&D).
- Plant Operations and Production.
- Process Safety Management.
- Engineering and Technology.
- Quality Control and Assurance.
- Technical Support and Services.

Course Offerings:

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

- Apply the fundamental laws of thermodynamics to complex, open and closed systems.
- Analyze the properties of pure fluids and mixtures using various equations of state.
- Select the most appropriate thermodynamic model for a given chemical system and process condition.
- Perform rigorous vapor-liquid equilibrium (VLE) and liquid-liquid equilibrium (LLE) calculations.
- Understand and model the behavior of non-ideal and azeotropic systems.
- Apply thermodynamic principles to the design and optimization of separation processes like distillation and extraction.
- Evaluate the thermodynamic consistency of experimental data.
- Utilize thermodynamic insights for process safety analysis and hazard identification.
- Implement thermodynamic models within process simulation environments for accurate predictions.

Course Methodology:

The training methodology at BIG BEN Training Center is designed to foster a deep and practical understanding of advanced thermodynamics. This course moves beyond traditional lectures by integrating a dynamic, hands-on learning environment. Each session combines core theoretical presentations with interactive problem-solving workshops, where participants tackle real-world engineering scenarios. We emphasize the use of case studies drawn from various industries, such as petrochemical refining and pharmaceutical manufacturing, to illustrate the direct application of phase equilibrium principles in process design and troubleshooting. Collaborative group discussions are a key component, encouraging participants to share experiences and develop innovative solutions to complex thermodynamic challenges. The instructor will facilitate these sessions, providing expert guidance and personalized feedback to ensure concepts are not just learned but mastered. This immersive approach ensures that participants leave with not only a robust theoretical foundation but also the confidence and practical skills to apply their knowledge immediately in their professional roles, enhancing process efficiency and safety.

Course Agenda (Course Units):

Unit One: Foundations of Engineering Thermodynamics

- Review of the First and Second Laws of Thermodynamics.
- Volumetric Properties of Pure Fluids.
- Introduction to Equations of State (EOS) for real gases.
- The Virial Equation of State.
- Cubic Equations of State (van der Waals, Redlich-Kwong, Soave-Redlich-Kwong, Peng-Robinson).
- Generalized Correlation for Thermodynamic Properties.
- Heat Effects and Enthalpy Calculations.

Unit Two: Thermodynamics of Solutions and Phase Equilibria

- The Phase Rule and Duhem's Theorem.
- Fundamental Property Relations for Mixtures.
- Fugacity and Fugacity Coefficient for Pure Species and Mixtures.
- Ideal and Non-Ideal Solutions.
- Excess Properties and Activity Coefficients.
- Gibbs-Duhem Equation and its Applications.
- Models for the Excess Gibbs Energy (Margules, van Laar).

Unit Three: Vapor-Liquid Equilibrium (VLE) Modeling

- The Nature of Equilibrium and VLE Calculations.
- Raoult's Law and Modified Raoult's Law.
- Bubble-point and Dew-point Calculations.
- Flash Calculations for VLE systems.
- Activity Coefficient Models (Wilson, NRTL, UNIQUAC).
- Thermodynamic Consistency Tests for VLE Data.
- Fitting Activity Coefficient Models to Experimental Data.

Unit Four: Advanced Phase Equilibria and Separation Processes

- Liquid-Liquid Equilibrium (LLE) and Vapor-Liquid-Liquid Equilibrium (VLLE).
- Solid-Liquid Equilibrium (SLE) and Solubility Calculations.
- Thermodynamics of Azeotropic Systems.
- Application of Thermodynamics to Distillation Processes.
- Thermodynamic Principles of Liquid-Liquid Extraction.
- Absorption and Stripping Process Analysis.
- Introduction to Membrane Separation Thermodynamics.

Unit Five: Chemical Reaction Equilibria and Process Simulation

- The Equilibrium Criterion for Chemical Reactions.
- The Standard Gibbs Energy Change and the Equilibrium Constant.

- Effect of Temperature and Pressure on the Equilibrium Constant.
- Evaluation of Equilibrium Constants from Data.
- Gibbs Energy Minimization for Complex Reaction Systems.
- Case Studies: Applying Thermodynamic Models in Process Simulators.
- Thermodynamics in Process Safety (e.g., predicting runaway reactions).

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:

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

Considering the increasing complexity of chemical mixtures in modern industries, how can the limitations of current thermodynamic models be overcome to ensure both process efficiency and safety?

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This course distinguishes itself by focusing intensely on the practical art and science of selecting the correct thermodynamic model for a specific industrial application, a critical skill often underdeveloped in standard academic curricula. While other courses may cover the theory, this program emphasizes the "why" and "how" of model application, addressing the nuances of non-ideal systems, azeotropes, and electrolyte solutions that are prevalent in real-world processes. We move beyond textbook examples to dissect complex industrial case studies, challenging participants to troubleshoot and optimize processes like reactive distillation and supercritical fluid extraction. The curriculum is uniquely structured to build a bridge between fundamental principles and their implementation in process simulation software, empowering attendees to not only run simulations but to critically evaluate and validate the underlying thermodynamic data. The emphasis is on developing a deep, intuitive understanding of phase behavior, enabling participants to make sound engineering judgments that directly impact process viability, profitability, and safety, rather than just performing routine calculations.