QUEST
Professional Center

PROFESSIONAL TRAINING COURSE

Course No. 1349

Mass & Energy Balances Training Course

PROCESS ENGINEERING
INDUSTRIAL ENGINEERING, MAINTENANCE & OPERATIONS

DURATION
5 Days

DELIVERY
Classroom

Course Overview

The Mass & Energy Balances Training Course provides a practical and structured foundation for analyzing material and energy flows across industrial processes, utilities, facilities, and operational systems. The course equips participants with the ability to quantify inputs, outputs, recycles, losses, accumulation, heat duties, utility requirements, and process performance using disciplined engineering and operational methods.

Mass and energy balances are essential tools for government entities, ministries, public sector organizations, oil and gas companies, power and water utilities, manufacturing facilities, banks with critical infrastructure, and large corporations. They support informed decisions on production capacity, energy efficiency, resource use, process safety, environmental performance, equipment sizing, maintenance priorities, and cost control. Accurate balances provide a factual basis for identifying where material, energy, time, and operational value are being lost.

This Mass & Energy Balances Training Course examines the principles of conservation of mass and energy and their application to steady-state and changing operating conditions. Participants will learn how to define system boundaries, identify process streams, collect relevant data, select assumptions, develop balance equations, and interpret results in relation to operational performance. The course also addresses common challenges such as incomplete data, inaccurate measurements, inconsistent units, unmeasured losses, recycles, side streams, and changing process conditions.

The program connects balance calculations with process design, heat exchangers, distillation, separation, pumping, compression, steam systems, cooling systems, utility optimization, process troubleshooting, and yield improvement. Participants will learn how mass and energy balances can reveal bottlenecks, excessive utility consumption, low recovery, leakage, inefficient equipment operation, off-specification production, and opportunities for operational improvement.

Through practical exercises, technical case discussions, and implementation workshops, participants will develop the capability to apply mass and energy balance techniques in their workplace. The course supports executives and managers in strengthening performance oversight and resource decisions, while enabling engineers, specialists, supervisors, and technical teams to analyze processes more effectively and develop realistic improvement actions.

Objectives

- Analyze the principles of mass and energy conservation and their relationship to process performance, resource efficiency, cost, quality, and operational risk during the course.
- Assess process boundaries, operating conditions, material streams, energy streams, recycles, losses, and accumulation for selected process systems.
- Develop clear process flow representations that identify inputs, outputs, internal streams, utilities, emissions, waste, and relevant operating variables.
- Apply consistent units, conversion methods, physical properties, and data-validation practices when preparing mass and energy balances.
- Design mass balance calculations for steady-state processes involving mixing, splitting, separation, recycle streams, product recovery, and material losses.
- Evaluate energy requirements for heating, cooling, phase change, pumping, compression, steam generation, refrigeration, and utility systems.
- Apply energy balance principles to calculate heat duties, estimate utility demand, identify thermal losses, and assess equipment performance.
- Improve process troubleshooting by using balance results to identify leakage, unmeasured losses, poor recovery, excessive consumption, and operating deviations.
- Assess the relationship between mass and energy balance results, equipment capacity, yield, throughput, quality, energy efficiency, and maintenance requirements.
- Implement structured data-collection and verification methods that improve the accuracy and reliability of process calculations.
- Strengthen coordination between operations, engineering, maintenance, quality, energy, finance, and environmental teams through shared performance analysis.
- Develop a time-bound action plan for applying mass and energy balance methods to selected workplace processes after the course.

Who Should Attend

The Mass & Energy Balances Training Course is designed for operations managers, production managers, engineering managers, energy managers, utilities managers, maintenance managers, reliability managers, process safety managers, asset managers, plant managers, facilities managers, and technical services leaders. It is particularly relevant for executives, directors, and decision makers responsible for operational efficiency, energy use, production performance, resource management, asset investment, environmental performance, process safety, and cost discipline.

The course is suitable for process engineers, chemical engineers, production engineers, mechanical engineers, energy engineers, utilities engineers, environmental engineers, maintenance engineers, reliability engineers, project engineers, design engineers, instrumentation and control engineers, quality engineers, technical analysts, and operations supervisors. It is relevant to professionals involved in process design, capacity studies, production monitoring, utility systems, equipment performance, operational troubleshooting, yield analysis, energy optimization, and improvement projects.

Professionals in finance, procurement, supply chain, HSE, sustainability, risk management, internal audit, contractor management, project management, digital transformation, and operational excellence may also benefit where their responsibilities involve operating cost, materials use, energy contracts, emissions, waste, performance reporting, resource planning, or investment evaluation. The course promotes a common analytical approach across technical and business functions.

Learning Outcomes

- Explain the principles of mass and energy conservation and their practical importance in process operations and performance improvement.
- Define suitable system boundaries, process streams, assumptions, and data requirements for selected mass and energy balance problems.
- Develop process flow diagrams that show material inputs, outputs, recycle streams, waste streams, utilities, and energy flows.
- Apply unit conversions, physical-property data, and calculation checks to ensure consistent and reliable balance results.
- Prepare mass balances for mixing, splitting, separation, recycle, purge, recovery, loss, and accumulation scenarios.
- Prepare energy balances for heating, cooling, phase change, combustion, pumping, compression, and utility-demand calculations.
- Estimate heat duties, energy losses, utility requirements, and equipment performance using operating data and balance principles.
- Identify discrepancies between expected and actual process performance, including material loss, leakage, poor recovery, inefficient operation, and excessive energy use.

- Assess the impact of process changes on production capacity, yield, product quality, energy intensity, equipment loading, and operating cost.
- Use mass and energy balance findings to support troubleshooting, process optimization, equipment sizing, and improvement projects.
- Develop data-collection plans that improve measurement quality, data ownership, reconciliation, reporting, and verification.
- Produce an initial mass and energy balance improvement plan relevant to the participant's workplace.

Course Outline

DAY 01

Fundamentals of Mass and Energy Balances

- The role of mass and energy balances in process design, operational control, resource efficiency, cost management, safety, and environmental performance.
- Conservation principles, system boundaries, control volumes, process streams, steady-state conditions, transient conditions, and accumulation.
- Process flow diagrams, stream identification, material inputs and outputs, energy flows, utilities, emissions, waste, and recycle streams.
- Units, conversions, physical properties, measurement accuracy, assumptions, data quality, and calculation validation.

> **PRACTICAL APPLICATION OR DISCUSSION**
>
> Defining system boundaries and preparing a process flow representation for a selected operational process.

DAY 02

Mass Balance Applications and Material Efficiency

- General mass balance equations and their application to steady-state and non-steady-state process systems.
- Mass balances for mixing, splitting, dilution, concentration, separation, recycling, purging, and product recovery.

DAY 02 — CONTINUED

- Component balances, composition data, moisture content, concentration, density, flow measurement, and mass-accountability methods.
- Identifying material losses, leakage, waste, emissions, rework, contamination, inventory changes, and yield gaps.

PRACTICAL APPLICATION OR DISCUSSION

Developing a mass balance for a selected process and identifying material-efficiency improvement opportunities.

DAY 03

Energy Balance Principles and Utility Requirements

- Energy forms, enthalpy, sensible heat, latent heat, phase change, heat capacity, pressure effects, and energy-flow concepts.
- Energy balances for heating, cooling, evaporation, condensation, boiling, drying, blending, combustion, pumping, and compression.
- Utility systems: steam, fuel, electricity, cooling water, refrigeration, compressed air, hot oil, and heat-recovery systems.
- Estimating heat duties, utility demand, energy losses, equipment loading, and operating implications.

PRACTICAL APPLICATION OR DISCUSSION

Preparing an energy balance and estimating heat or utility requirements for a selected operating scenario.

DAY 04

Integrated Process Analysis and Performance Improvement

- Combining mass and energy balances to evaluate throughput, yield, recovery, quality, energy intensity, emissions, and equipment performance.
- Using balances to assess heat exchanger, distillation, separation, boiler, furnace, pump, compressor, cooling, and utility-system performance.

DAY 04 — CONTINUED

- Data reconciliation, trend analysis, comparison against design conditions, baseline development, and identification of performance deviations.
- Applying balance results to troubleshooting, bottleneck identification, process optimization, maintenance planning, and energy-efficiency initiatives.

PRACTICAL APPLICATION OR DISCUSSION

Analyzing an integrated mass and energy balance case to identify losses, constraints, and priority improvement actions.

DAY 05

Implementation, Governance, and Continuous Improvement

- Developing measurement plans, metering strategies, data ownership, verification routines, reporting standards, and documentation requirements.
- Integrating mass and energy balances into operating reviews, maintenance programs, energy management, quality assurance, environmental reporting, and project evaluation.
- Communicating balance results to executives, managers, operators, engineers, and non-technical stakeholders using clear performance indicators.
- Managing operational changes, validating improvement actions, monitoring results, documenting lessons learned, and sustaining improvements.

FINAL WORKSHOP, ACTION PLAN, OR IMPLEMENTATION EXERCISE

Developing a 90-day Mass & Energy Balances action plan with priority processes, required data, improvement opportunities, accountable owners, milestones, performance indicators, and review mechanisms.

Register or Request More Information

Course page: https://quest-training.com/courses/mass-energy-balances-training-course
Website: https://quest-training.com
Email: info@quest-training.com
Phone: +905016771440