COURSE OVERVIEW PE0152
Process Design - Intermediate (E-Learning Module)

Course Title
Process Design - Intermediate
(E-Learning Module)

Course Reference
PE0152

Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration
30 online contact hours
(3.0 CEUs/30 PDHs)

Course Description

This E-Learning course is designed to provide participants with a detailed and up-to-date overview of process design. It covers the process engineering, process equipment, nature of design and design constraints; the petroleum properties, homogeneous and heterogeneous solutions and separation of mixture; the common separation techniques, filtration, crystallization, distillation, extraction, separation and conversion processes, finishing processes and hydrocarbon processing; the hydrocarbon; and the project life cycle, process design in project cycle, development of process data, process calculations types & methods, material balance diagram, equipment flow diagram, process flow diagram (PFD), piping & instrument diagram (PID) and system distribution diagrams.

Further, the course will also discuss the drawing symbols equipment, drawing symbols valves, drawing symbols piping and drawing symbols pipe connections; the cost estimation, economic feasibility and cost estimate escalation; the process design basis codes & standards and documentation the equipment sizing and selection, fluid flow and piping; and the process equipment categories, fundamentals of hydro-dynamics, fluid flow, pressure drop calculation and pipe design and sizing.

During this interactive course, participants will learn the pipe properties, flow of air, water pipe, steam, gas pipe sizing, standards and wall thickness and hoop and longitudinal stress; the classification of pumps and compressors, pumps and pumping systems, surge, process vessels and reactors, distillation column packing, ancillary equipment and steam jet ejectors; the pressure relief devices & safety devices, dynamic force balances, heat exchangers, reboilers, air coolers and fin fans; the thermal performance calculations, heat transfer calculation, mean temperature difference calculation, sizing and designing; the heater-controlled system, PID controls, feed-back & feed-forward controls, combustion control, flame monitoring devices, fractionation columns and distillation and boiling point diagram; the main components of fractionation unit and carryout column design method, process design and distillation column tray design; the relieving devices, knock-out drums/blow-down system, blow-down system for vapor relief stream, blow-down system for liquid relief stream, sizing methods for flare headers and design of blow-down components; and the basic control loops, operation during transitions, process design for reliability, equipment protection and control valve loop.

Course Objectives

At the end of this course, the Trainee will be able to:-

- Apply and gain a good working knowledge on process design
- Explain the importance of performing process design using industry and international standards
- Describe and analyse process design documents and specifications
- Collect and verify data required for process design calculations
- Perform calculations for pump performance curves, NPSN, desalter and dehydrator, relief and flare systems, compressors, orifice and control valves, safety valve sizing, etc.
- Calculate pressure drops in oil and gas network, injection network, hydrate formation and compressor discharge temperature based on gas composition
- Provide technical support in resolving process design problems
- Describe steps for developing process design packages and technical specification documents
- Verify technical viability of drawings and specification documents such as equipment data sheets etc.
- Discuss process engineering, process equipment, nature of design and design constraints
- Set the design basis and identify petroleum properties, homogeneous and heterogeneous solutions and separation of mixtures
- Employ common separation techniques, filtration, crystallization, distillation, extraction, separation and conversion processes, finishing processes and hydrocarbon processing

- Characterize hydrocarbon including the purpose, types and contents of specification package
- Illustrate project life cycle, process design in project cycle, development of process data, process calculations types & methods, material balance diagram, equipment flow diagram, process flow diagram (PFD), piping & instrument diagram (PID) and system distribution diagrams
- Identify drawing symbols equipment, drawing symbols valves, drawing symbols piping and drawing symbols pipe connections
- Apply cost estimation, economic feasibility and cost estimate escalation
- Discuss process design basis codes & standards and documentation as well as equipment sizing and selection, fluid flow and piping
- Recognize process equipment categories, fundamentals of hydro-dynamics, fluid flow, pressure drop calculation and pipe design and sizing
- Identify pipe properties, flow of air, water pipe, steam, gas pipe sizing, standards and wall thickness and hoop and longitudinal stress
- Classify pumps and compressors, pumps and pumping systems, surge, process vessels and reactors, distillation column packing, ancillary equipment and steam jet ejectors
- Discuss pressure relief devices & safety devices, dynamic force balances, heat exchangers, reboilers, air coolers and fin fans
- Employ thermal performance calculations, heat transfer calculation, mean temperature difference calculation, sizing and designing
- Recognize heater-controlled system, PID controls, feed-back & feed-forward controls, combustion control, flame monitoring devices, fractionation columns and distillation and boiling point diagram
- Identify the main components of fractionation unit and carryout column design method, process design and distillation column tray design
- Determine relieving devices, knock-out drums/blow-down system, blow-down system for vapor relief stream, blow-down system for liquid relief stream, sizing methods for flare headers and design of blow-down components
- Discuss basic control loops, operation during transitions, process design for reliability, equipment protection and control valve loop

Who Should Attend

This course is intended for process engineers engaged in the design of new process equipment and revamp of existing plants and who also in-charge of troubleshooting and maintaining of such equipment. The course is also recommended for mechanical, equipment and project engineers who wish to learn basic principles of process design and process equipment and who are willing to troubleshoot and maintain such equipment.

Course Certificate(s)
Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations
Certificates are accredited by the following international accreditation organizations: -

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Fee

As per proposal

Course Contents

- Introduction
- Process Engineering Definition
- Process Equipment
- Nature of Design
- Design Constraints/1
- Setting the Design Basis
- Petroleum Properties & Definitions
- Physical Property
- Chemical Property
- Physical Changes
- Chemical Changes
- Pure Substances versus Mixtures
- Substance
- Mixture
- Homogeneous vs. Heterogeneous Solutions
- Homogeneous
- Heterogeneous

- Separation of Mixtures
- Common Separation Techniques
- Filtration
- Crystallization
- Distillation
- Extraction
- Chromatography
- Properties & Definitions
- Flammable (Explosive) Limits
- Stoichiometry & Composition
- Perfect Gas or Ideal Gas
- Partial Pressure
- Composition of Petroleum
- Petroleum Processing Overview
- Processes
- Separation Processes
- Conversion Processes
- Finishing Processes
- Petroleum Processing Separation Processes
- Petroleum Processing Conversion Processes
- Hydrocarbon Processing
- Hydrocarbon Characterization
- Pure Hydrocarbons
- Properties and Definitions
- Viscosity is Temperature Dependent
- Purpose & Contents of Specification Package
- Types & Contents of Specification Packages
- Project Life Cycle
- Process Design in Project Cycle
- Ability to Influence Final Project Cost
- Development of Process Data
- Design Basis
- Crude Oil Distillation Unit (Typical)

- Design Basis, Product Specifications
- Design Basis, Design Philosophy
- Process Calculations Types & Methods
- Computer Simulation Programs
- Process Simulation Programs
- Some Commercial Packages
- Material Balance Diagram
- Equipment Flow Diagram
- The Flow Sheet
- Block Flow Diagram – Classroom Example
- Pictorial representation
- Process Flow Diagram (PFD)
- Piping & Instrument Diagram (PID)
- System Distribution Diagrams
- Plot Plan & Elevation Drawings
- CAD Drawings
- Drawing Symbols Equipment
- Drawing Symbols Valves
- Drawing Symbols Piping
- Drawing Symbols Pipe connections
- Cost Estimating
- Cost Estimation & Economic Feasibility
- Cost Estimation
- Example Form for Feasibility Study
- Cost Estimate Escalation
- Process Design Basis Codes & Standards and Documentation
- Design Work Process
- How do companies implement this design process?
- The Design Team
- Specialization and Outsourcing
- Company Performance by Sector
- Implications
- The Project Plan

- Design Work Process
- Example: 11-Week Plan for a Process Design Project
- What's in a Project Plan?
- Tools for Project Planning
- The Design Basis
- Process Design Basis
- What's in the Design Basis?
- Design Practices: Codes & Standards
- Design Practices: Design Factors (Design Margins)
- Design Documentation
- What's in a Spec Sheet?
- Standard Templates
- Conclusion: What Makes a Process Design in Industry
- Equipment Sizing & Selection, Fluid Flow & Piping
- Process Equipment Categories
- Required vs. Calculated Data
- Fundamentals of Hydro-dynamics
- Fluid Flow
- Energy of a Fluid in Motion
- Fanning Friction Factor & Reynolds No.
- Value Index of Pipe Roughness
- Pressure Drop Calculation
- Equivalent Piping Length
- Use for Pressure Drop Estimations
- Economic Pipe Diameter
- Recommended Velocity
- Piping Sizing Guidelines
- Maximum Continues Liquid Velocity
- Two Phase Horizontal Flow (Gas-Liquid)
- Calculating the flow rate & Δ P for Gases
- Notes on Pipe Sizing & Design
- Pipe Design and Sizing
- Pipe Sizing

- Flow in Pipes
- The Question of Pipe Size Generally Resolves into Two Specific Cases
- Recommended Velocities
- Bernoulli's Theorem
- Pressure Drop Calculations
- D'arcy-Weisbach Pressure Drop Formula
- Reynolds Number
- Moody Diagram
- Hazen Williams Formula
- Recommended Velocities
- Pressure Loss Chart
- Typical Nominal Chart - Cameron Water Tables – 4" Pipe
- Typical Nominal Chart - Cameron Water Tables – 6" Pipe
- Typical Nominal Chart - Cameron Water Tables – 8" Pipe
- Equivalent Lengths of Fittings
- Pipe Properties
- Flow of Air
- Water Pipe
- Steam
- Undersized Pipework Means
- The Allowance for Pipe Fittings
- The Allowance for the Heat Losses from the Pipe
- Method
- Sizing Pipes on Velocity
- Sizing Pipes for Superheated Steam Duty
- Gas Pipeline ASME B 31.8. CI. 841.11
- Gas Pipe Sizing
- Standards and Wall Thickness
- Wall Thickness Calculations
- Hoop and Longitudinal Stress
- Pressure Design ASME B31.3
- Piping System Pressure Stresses
- What is S? ASME B31.3 Appendix A

- What is E?
- What is Y?
- What is W?
- Calculate t_{min}
- Corrosion Allowance
- ASTM A 312 Mill Tolerance
- Pumps and Compressors
- Pumps and Pumping Systems
- Classification of Pumps
- Centrifugal Pumps
- Impellers Centrifugal Pump
- Centrifugal Pumps/Seals
- Pump Specifications & Properties
- Centrifugal Pumps/ Information's for Purchasing
- Centrifugal Pumps/ Fluid Density
- Centrifugal Pumps/ Pump Curves
- Fundamentals of a Centrifugal Pump
- Centrifugal Pump Selection & Performance
- Pumps and Pumping Systems
- Two Centrifugal Pumps Operation
- Pump Calculation Method
- Centrifugal Pumps/ NPSH
- Centrifugal Pumps Efficiency
- Centrifugal Pumps/Cavitation
- Centrifugal Pumps/ Avoiding Cavitation
- Pump Problem Solving Approaches
- Liquid Pumping TS
- Pumps Terms
- The Relationship Between Head and Pressure
- Total Head Problem
- What is Velocity Head?
- Pumps Terms
- Specific Gravity

- Viscosity
- Pumps Terms
- Pour Point
- Swash Plate Pump
- Peristaltic Pump
- Jet Pump
- Compressors
- Categories and Types of Compressors
- Compression Process
- Reciprocating Compressor
- Reciprocating Compressors
- Compressor Valves
- Reciprocating Compressor - 2 Stage Layout
- Types of Dynamic Compressors
- Single-Stage Centrifugal Compressor
- Multi Stage Horizontal Split Centrifugal
- Multi Sage Vertically Split Centrifugal
- How Centrifugal Compressor Works?
- Control Methods & Performance
- Key Design Parameters
- Compressors & Gas Compression
- Compressors Temperature Rise
- Compressors Horsepower Calculation
- Compressor Calculation Method
- Compressor Calculation Example
- Physical Constants
- Horsepower Determinations by Graph
- Compressor Selection Guidelines
- Compressor Problem Solving Approaches
- What is Surge?
- What Causes Surge?
- Polytropic Process
- Polytropic Head

- Compressors Operating Problems
- Compressors Surge Controls
- Process Vessels and Reactors
- Process Vessels -Types and Functions
- Process Vessels- Vapor Liquid Separation
- Design Orientation for Gas/Liquid Separators
- Types of Gas/Liquid Separators
- Process Vessels- Solid Liquid Separation
- Process Vessels - Design Considerations
- Process Vessels Sizing Criteria
- Design Pressure
- Process Vessels Calculations
- General Tips In Process Vessels Design
- Typical Operating Problems
- Design Temperature and Pressure
- Boiler & Pressure Vessel Design Software
- Reactors
- Reactor Types in process industry
- Catalysed Reactions
- Reversible Reactions
- Le Chatelier's Principle
- Reactor Types with catalyst
- Reactor Types
- Fluidized Bed Reactor
- Ebullated Reactor
- Chemical Reactors
- Reactors Design Consideration
- Reactor Sizing Methods
- Pressure Drop Calculation
- Fixed-Bed Reactors- Internals
- Fixed-Bed Reactors- Catalyst Loading
- Catalyst Loading
- Reactor Problems

- Fixed-Bed Reactors- Safety
- ASME Pressure Vessel Code
- Horizontal and Vertical Vessels Wall Thickness
- Distillation Column Packing
- Tray Columns – Packings
- Tray Columns – Type of Packings
- Tray Columns – Packings Correlations
- Type of Packings – Comparison
- Comparison Trays versus Packing
- Comparison Packing versus Trays
- Ancillary Equipment
- Steam Jet Ejectors
- Steam Jet Ejectors- Key Design Parameters
- Multi-stage Steam Jet Ejectors
- Steam Jet Ejectors- Construction materials
- Pressure Relief Devices & Safety Devices
- Pressure Relief Valve Principles
- Internal Parts Of Safety Valve
- Forces Applied to Disc
- Dynamic Force Balances
- Huddling Chamber- Nozzle Ring Adjustment
- Effect of Blowdown Ring
- Safety Valves- Field Example
- Heat Exchangers, Reboilers & Air Coolers
- Construction Types
- Shell & Tube Heat Exchanger Classification
- HE Flow Configurations
- Double Pipe
- Compact Heat Exchangers
- Plate & Frame Heat Exchangers
- Shell & Tube HE Construction
- HE Process Design Considerations
- TEMA –Code, Designation System

- TEMA Designation System -Shell Types
- Floating Head Exchangers
- Heat Transfer Relation
- Key Design Considerations
- HE Des. Detailed Calculations
- Heat Transfer Basic Equations for Design
- Shell-Tube HE/ LMTD Chart
- Heat Transfer Basic Equations for Design
- Heat Transfer Calculation
- Determine Fouling Of heat exchanger
- Controlling Film Coefficient
- Short Cut Calculation for HE Design
- Example for LMTD
- Procedure for Approximate Size Estimation
- Overall H. Transfer Coeff., Liquid-liquid Media
- General notes on Tube Arrangement
- Exchanger Dimensions
- Size Estimate Chart
- Heat Exchanger Selection for a Given Process
- General Points On Material Selection & Pressure
- Why Shell and Tube H.E
- Heat Exchangers Selection Guidelines
- TS in Shell & tube HE
- Air Coolers
- Air Cooler Types
- Forced Vs Induced Draft Fan Coolers
- Temperature Control
- Key Design Considerations
- Air Fans vs Water Cooling Towers
- Calculation Procedure
- Calculation: Example
- Typical Process Operating Problems
- TS in Air Cooled Exchangers

- Fin Fans (Air Coolers)
- Types of Fin Fans
- Grade Mounted Air Coolers
- Walkways and Handrails
- Typical Arrangement at Fin Fans
- The Most Evident Advantages are
- Fields of Application of Air-cooled Heat Exchangers
- Configuration
- Induced Draft Unit
- Forced Draft Unit
- A Typical Air-Cooled Heat Exchanger
- Mechanical Components of Heat Exchanger
- How are they Constructed?
- Air Cooled Exchangers
- Thermal Performance Calculations
- Calculation of Overall Heat Transfer
- Calculation of Mean Temperature Difference
- Problem Description
- Sizing and Designing
- Assumption
- Sizing
- Design Criteria
- Procedure
- Result
- Air Cooled Exchangers
- Inlet and Outlet Headers
- Direct Fired Heaters
- Direct Fired Heater Types
- Design Considerations
- Primary objectives in Heater System
- Process & Combustion
- Chemical reaction sequence
- Burner Flame

- Burner Construction
- Gas Burners Construction
- Steam and Air Atomizing Burners
- Heater Controlled System
- PID Controls
- A list of Controller Actions
- Limitations of Conventional PID Controllers
- Feed-back & Feed-forward Controls
- Other FB-FF Example
- Combustion Control: Parallel Metering
- Parallel Metered Control System (with Cross Limits)
- Flame Monitoring Devices
- Flame Detector & Safety shutdown
- Flame Detectors
- Micro-Processor Based on BMS
- Typical Process Operating Problems
- TS in Furnaces
- TS in Steam Boiler
- Fractionation Columns
- Fractionation Distillation
- Boiling Point Diagram
- Fractionation Column Classification
- Or According to Column Internals
- Fractionation Series of Flash Stages
- Series of Flash Stages /Fractionation Column
- Main Components of Fractionation Unit
- Fractionation Tower Simplified Sketch
- Operating Lines
- Column Design Method
- Process Design Basic
- Feed Line
- Reflux Ratio
- Minimum Reflux Ratio

- No. of Ideal Stages
- Exercises
- Distillation Column Tray Design
- Distillation Column Tray Types
- Tray & Theoretical Stages
- Tray Efficiency
- Tray Design Hydraulic Criteria
- Distillation Column Trays Performance Constrains
- Distillation Column Trays Performance
- Practical Distillation & Performance Constrains
- Vapour Velocity
- Packed Columns
- Tray Columns - Packings
- How Packed Towers Work
- How Packed Towers Work -Vapor distribution
- Maintaining Functional & Structural Efficiency
- Tray Columns – Type of Packings
- Randomly Packed Towers Column Diameter
- Tray Columns – Type of Packings
- Comparison Trays versus Packing
- Packed Column
- Performance Factors
- Process Data Sheets
- Typical Process Operating Problems
- Useful Notes for Packed Towers Design
- Relieving Devices, Knock-out Drums/Blow-down System
- Pressure Relief Valve Principles of Operation
- Internal Parts of Safety Valve
- Where the Action of Force
- Area, Force, Pressure Relationship
- Static Force Balance
- Forces Applied to Disc
- Dynamic Force Balances

- Reaction Force = F_R
- Huddling Chamber- Nozzle Ring Adjustment
- Effect of Blowdown Ring
- Pressure Terminology
- Relief Device Capacity
- Types & Application of Common Relief Devices
- Super-imposed Back Pressure
- Built-up Back Pressure
- Code & Requirements in Application
- Staggered PSV's
- Inlet Line & Outlet Considerations
- PRV Chattering Action
- Purpose of Blow-down System
- Blow-down System for Vapor Relief Stream
- Blow-down System for Liquid Relief Stream
- Grouping of Systems
- Load Determination
- Diagram of Flare System
- Back Pressure Consideration
- Sizing Methods for Flare Headers
- Design of Blow-down Components
- Knock-out Drums
- Sizing Knock-out Drums
- Liquid Seal Flame Arrestors
- The Way to PID Through Process Design for Operability Reliability and Safety
- 3 Levels of Diagram
- The Block Flow Diagram (BFD)
- Definitions of BFD
- The Block Flow Process Diagram
- Developing a Process
- The Block Flow Plant Diagram
- The Process Flow Diagram
- Equipment Numbering

- Stream Numbering and Drawing
- Stream Information
- Stream Information – Flags
- The Process Flow Diagram
- Basic Control Loops
- Equipment Information
- PFD Summary
- A Process Design Procedure
- Process Design With Operability
- Operability Ensures that the Plant Performs “Well”
- Operability: When do we Influence in the Design Procedure?
- We have to known where we are going before we can design!
- Process Operability : The Operating Window
- Operating Window
- Flash Drum Example
- Operation During Transitions
- Operation During Transitions Startup and Shutdown
- Operation During Transitions Regeneration
- Operation During Transitions Blocked Operation
- Operation During Transitions Blocked Operation- Lube Oil Manufacture
- Operation During Transitions Load Following
- Operation during Transitions Load Following – Boiler & Steam System
- Operation During Transitions Batch Operation
- Operation During Transitions All Situations Considered
- Operation During Transitions Batch Operation – Gasoline Blending
- Process Design for Reliability
- Reliability
- Process Operability: Safety (+Equipment Protection)
- Equipment Protection
- Piping & Instrument Diagram
- The Piping and Instrument Diagram (P&ID)
- What is P&ID
- What Should be Indicated on P&ID?

- What Information can you Get?
- P&ID is Used For
- How to Develop/Finalize
- P&ID Symbols
- P&ID Practices
- PID Controller
- Control Valve Loop
- LT/FT Cascade Control
- Split Range Control
- Draw the PID
- Data sheet for pressure vessel design