COURSE OVERVIEW DE0286
Performance Analysis, Prediction, and Optimization Using NODAL Analysis (E-Learning Module)

Course Title

Performance Analysis, Prediction, and Optimization Using NODAL Analysis (E-Learning Module)

Course Reference

DE0286

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

Oil and gas wells are essential elements of oil and gas production systems. A production system can be roughly defined as the equipment required to produce hydrocarbons from a subsurface reservoir to the point of sale.

This E-Learning is designed to provide participants with a detailed and up-to-date overview of performance analysis, prediction and optimization using NODAL aalysis. It covers the production engineering, oil & gas production systems, system models, topology and flow & effort variables; the element equations and system equations; the nodal analysis, principle, classic procedure and production optimization; and the properties of reservoir fluids, fluid properties, production variables, and pressure/temperature phase diagram.

Further, the course will also discuss the equations of state, oil models, compositional models, volatile oil model, black oil model and fluid property calculations; the gas formation volume factor, oil formation volume factor, black oil and single-phase flow in wellsand pipelines; the governing equations; and head loss, friction loss, pressure drop components, single-phase oil flow and governing equations.

Moreover, the course will also cover the single-phase gas flow, tubing performance, intake curves and flow in annular geometry; the pressure drop analysis, governing equations, holdup & friction correlations, element equations, tubing intake curves and lift tables; the single-phase oil flow, permanent pressure drop and single-phase gas flow; the isentropic flow, critical flow and pressure drop in chokes; the multiphase flow-empirical models, multiphase choke models, empirical models for critical flow and multiphase flow: theoretical models; the polytropic flow, critical flow, pressure drop in chokes and the importance of inflow performance; the well operation and reservoir flow stages, governing equations, friction force, single-phase oil flow and average reservoir pressure; and the semisteady-state flow, combined expression, the skin factor, formation damage, thick skin and single-phase gas flow.

During this interactive course, participants will learn the predictive mode, initial pressure above bubblepoint, multilayer inflow performance and two-dimentional reservoir flow; the laplace equation, polar coordinates, linear superpositions, image wells, anisotropic permeability, horizontal wells, box-shaped reservoir and horizontal flow; the near-well radial flow, skin & geometric skin, average reservoir pressure, anistropic permeability, combined expression, partially penetrating wells and elliptic coordinates; the horizontal flow, near-well radial flow, skin & anisotropy, specific PI and other horizontal well models; the semi- analytical approach and complex well configuration; the point sources, multilateral wells, extended functionality, relative permeabilities and pressure gradient; the phase saturations, closed-form approximations for primary recovery and water and gas fronts in secondary recovery; the field development planning and field management; and the artificial lift, gas lift and electric submersible pumps.

Course Objectives

After completing the course, the employee will:-

- Apply systematic techniques on performance analysis, prediction and optimization using NODAL Analysis
- Apply NODAL Analysis concepts viewing the total producing system as a whole from the reservoir rock through the completion, well bore and gathering system, to the market while honoring system rate/pressure constraints
- Avoid improper design where any one component, or a mismatch of components, adversely affects the performance of the entire system
- Perform a system-wide analysis to increase well rates by identifying bottlenecks and design an efficient field-wide flow system, including wells, artificial lift, gathering lines, and manifolds
- Use NODAL Analysis, together with reservoir simulation and analytical tools, for planning new field development
- Discuss production engineering, oil & gas production systems, system models, topology and flow & effort variables
- Identify the element equations and system equations as well as carryout nodal analysis, principle, classic procedure and production optimization
- Recognize the properties of reservoir fluids, fluid properties, production variables, and pressure/temperature phase diagram

- Illustrate equations of state, oil models, compositional models, volatile oil model, black oil model and fluid property calculations
- Discuss gas formation volume factor, oil formation volume factor, black oil and single-phase flow in wellsand pipelines
- Interpret governing equations including mass balance, momentum balance and equation of state
- Determine head loss, friction loss, pressure drop components, single-phase oil flow and governing equations
- Describe single-phase gas flow, tubing performance, intake curves and flow in annular geometry
- Illustrate the multiphase flow in well sand pipes, multiphase flow concepts, flow regimes, slip & holdup and pressure drop analysis
- Explain governing equations, holdup & friction correlations, element equations, tubing intake curves and lift tables
- Interpret flow through restrictions, single-phase oil flow, permanent pressure drop and single-phase gas flow
- Describe isentropic flow, critical flow and pressure drop in chokes as well as apply computations and illustrate multiphase flow-empirical models, multiphase choke models, empirical models for critical flow and multiphase flow: theoretical models
- Identify polytropic flow, critical flow, pressure drop in chokes and the importance of inflow performance
- Recognize well operation and reservoir flow stages, governing equations, friction force, single-phase oil flow and average reservoir pressure
- Discuss semisteady-state flow, combined expression, the skin factor, formation damage, thick skin and single-phase gas flow
- Explain predictive mode, initial pressure above bubblepoint, multilayer inflow performance and two-dimentional reservoir flow
- Determine the laplace equation, polar coordinates, linear superpositions, image wells, anisotropic permeability, horizontal wells, box-shaped reservoir and horizontal flow
- Discuss near-well radial flow, skin & geometric skin, average reservoir pressure, anistropic permeability, combined expression, partially penetrating wells and elliptic coordinates
- Recognize horizontal flow, near-well radial flow, skin & anisotropy, specific PI and other horizontal well models
- Employ semi- analytical approach and complex well configuration as well as discuss point sources, multilateral wells, extended functionality, relative permeabilities and pressure gradient
- Identify phase saturations, closed-form approximations for primary recovery and water and gas fronts in secondary recovery
- Analyze well performance, review the summary of analysis methods and apply field development planning and field management
- Improve inflow performance, change the tubing or choke size and discuss artificial lift, gas lift and electric submersible pumps

Who Should Attend

This course covers systematic techniques and methodologies on performance analysis, prediction and optimization using NODAL Analysis for production, operations and reservoir engineers; senior technicians and field supervisors with an engineering background.

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
- Production Engineering
- Development
- Production
- Oil & Gas Production Systems
- System Models
- Topology
- Flow & Effort Variables
- Element Equations
- System Equations
- Nodal Analysis
- Principle
- Classic Procedure
- Production Optimization
- Questions
- Matlab Assignment: Nodal Analysis of a Simple System
- Properties of Reservoir Fluids
- Fluid Properties

- Production Variables
- Pressure/Temperature Phase Diagram
- Equations of State
- Oil Models
- Compositional Models
- Volatile Oil Model
- Black Oil Model
- Fluid Property Calculations
- Gas Formation Volume Factor
- Oil Formation Volume Factor
- Black Oil Correlations
- Questions
- Matlab Assignment: Hydrocarbon Properties
- Single-phase Flow in Wellsand Pipelines
- Governing Equations
- Mass Balance, Momentum Balance and Equation of State
- Head Loss
- Friction Loss
- Pressure Drop Components
- Single-phase Oil Flow
- Governing Equations
- Solutions
- Single-phase Gas Flow
- Solutions
- Tubing Performance and Intake Curves
- Flow in Annular Geometry
- Questions
- Matlab Assignment: Single-Phase Gas Flow
- Objectives
- Assignment
- Deliverables
- Multiphase Flow in Well sand Pipes
- Multiphase Flow Concepts

- Flow Regimes
- Slip & Holdup
- Pressure Drop Analysis
- Governing Equations
- Holdup & Friction Correlations
- Element Equations
- Tubing Intake Curves
- Lift Tables
- Questions
- Matlab Assignment: Drift Flux
- Flow Through Restrictions
- Restrictions
- Single-Phase Oil Flow
- Permanent Pressure Drop
- Single-phase Gas Flow
- Isentropic Flow
- Critical Flow
- Pressure Drop in Chokes
- Computations
- Multiphase Flow: Empirical Models
- Multiphase Choke Models
- Empirical Models for Critical Flow
- Multiphase Flow: Theoretical Models
- Polytropic Flow
- Critical Flow
- Pressure Drop in Chokes
- Matlab Assignment: Choke Flow
- Inflow Performance: The Basics
- The Importance of Inflow Performance
- Well Operation & Reservoir Flow Stages
- Governing Equations
- Mass Balance, Momentum Balance & Equation of State
- Friction Force: Darcy's Law

- Single-Phase Oil Flow
- Average Reservoir Pressure
- Semisteady-State Flow
- Combined Expression
- The Skin Factor
- Formation Damage
- Thick Skin
- Single-Phase Gas Flow
- Numerical Solution
- Multiphase Flow: Empirical Models
- Solution Gas Drive
- Predictive Mode
- Initial Pressure Above Bubblepoint
- Multilayer Inflow Performance
- Questions
- Matlab Assignment: Commingled Production with a Smart Well
- Inflow Performace: Further Topics
- Two-Dimentional Reservoir Flow
- The Laplace Equation
- Polar Coordinates
- Linear Superpositions
- Image Wells
- Anisotropic Permeability
- Horizontal Wells
- Box-shaped reservoir
- Horizontal Flow
- Near-well Radial Flow
- Skin & Geometric Skin
- Average Reservoir Pressure
- Semisteady-State Flow
- Anistropic Permeability
- Combined Expression
- Partially Penetrating Wells

- Elliptic Coordinates
- Horizontal Flow
- Near-well Radial Flow, Skin & Anisotropy
- Specific PI
- Other Horizontal Well Models
- Semi- Analytical Approach
- Complex Well Configuration
- Point Sources
- Multilateral Wells
- Extended Functionality
- Multiphase Flow: Theoretical Models
- Relative Permeabilities
- Pressure Gradient
- Phase Saturations
- Example Gas/Oil Flow
- Closed-Form Approximations for Primary Recovery
- Water and Gas Fronts in Secondary Recovery
- Coning and Cusping
- Matlab Assignment: Horizontal Well Inflow and Pressure Drop
- Well Performance
- Anlayzing Well Performance
- Performance of a Well Operating at Given Tubinghead Pressure
- Intermezzo: Stability of an Operating Point
- Performance of a Well Operating through a Surface Choke
- Summary of Analysis Methods
- Field Development Planning and Field Management
- Improved Inflow Performance
- Changing the Tubing or Choke Size
- Tubing Change-Out
- Artificial Lift
- Gas Lift
- Electric Submersible Pumps
- Matlab Assignment: Well Performance