COURSE OVERVIEW DE0090
Tight Reservoir Characterization & Modeling (E-Learning Module)

Course Title
Tight Reservoir Characterization & Modeling (E-Learning Module)

Course Reference
DE0090

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 Reservoirs have been created by complex sedimentary and diagenetic processes, and modified by a history of tectonic change. Reservoirs are complex systems on all scales. Decisions such as pumping and injection, new well placement, and drilling in an active oil field, are typical of the complex relationships between reservoir engineering and oil field/reservoir management.

A reservoir's life begins with exploration that leads to discovery, which is followed by delineation of the reservoir, development of the field, production by primary, secondary, and tertiary means, and finally to abandonment. Integrated, sound reservoir management is the key to a successful operation throughout a reservoir's life.

Further, the need to enhance recovery from the vast amount of remaining oil and gas-in-place, plus the global competition, requires better reservoir management practices. Reservoir engineering is the application of scientific principles to solve issues arising during the development and production of oil and gas reservoirs.

This E-Learning covers the engineering operations involved in analysing the production behaviour of oil and gas wells, including well performance engineering, reservoir aspects of well performance, restricted flow into the wellbore, rate decline analysis, and fundamentals of artificial lift.

This course is designed to provide many tools and techniques to help address the challenges of providing a more reliable and sounder reservoir engineering & management. In addition to a wealth of classic information on the concepts and processes involved in reservoir engineering and management, the course presents insights about data acquisition, reservoir performance analysis & forecast, reservoir management economics and improved recovery processes. Further, the course is illustrated through a number of case studies which will be shown to the participants to help them appreciate the concepts presented in the course.

Course Objectives

After completing the course, the employee will:-

- Apply systematic techniques in tight reservoir characterization and modeling
- Discuss the tight reservoir characteristics at the basin scale
- Discuss the characteristics of tight reservoirs
- Discuss all geological and seismic aspects related to modeling tight reservoirs
- Integrate geology, geophysics and well data in application
- Explain the integration of geoscience and engineering and know the reasons for integrating exploration and development technology
- Ensure the proper execution of the reservoir management process
- Illustrate the proper procedure for data acquisition, analysis and management which includes validation, storing, retrieval and application
- Explain the role of reservoir models as well as the importance of reservoir surveillance
- Apply the different methods of reservoir performance analysis and forecast & give emphasis on the integration of production/injection data, log data, pressure data and any subsurface data for analysis
- Provide details on the reservoir management economics which includes economic criteria, scenarios, economic evaluation, risk and uncertainties
- Acquire an up to date knowledge on the improved recovery processes related to waterflooding, thermal methods, chemical methods and EOR screening guidelines
- Implement reservoir management plans for newly discovered fields, secondary and EOR operated fields
- Plan the outlook and the next step & be ready with the current challenges and areas of further work for reservoir engineering and management

Who Should Attend

This course provides an overview of all significant aspects and considerations of tight reservoir characterization and modeling for those who are involved in analysis, characterization, simulation, integration, statistics and naturally fractured for reservoir. This includes engineers, geologists, geophysicists, managers, government officials, field operation staffs and other technical staff.

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

- Applied Reservoir Engineering & Management: Analysis, Characterization, Simulation, Integration, Statistics & Naturally Fractured
- Reservoir Management
- Definition of Reservoir Management
- What Is Reservoir Management?
- Reservoir Management's Prime Objectives
- Sequential Activities
- Reservoir Life Cycle
- New Concession
- Reservoir Management Process
- Basic Reservoir Engineering Functions
- Development Plan is Subject to Change
- Reservoir Management Resources
- Reservoir Management Input/Output System
- The Reservoir Management Challenge
- Product of Reservoir Management
- Reservoir Management Team

- Reservoir Management Approach
- Old System-Conventional Organization
- New System-Multidisciplinary Team
- Reservoir Management Requires a Plan
- Reservoir Management Plan Components
- Data Acquisition & Analysis
- Reservoir Knowledge
- Data Management
- Data Collection & Analysis
- Reservoir Data
- Data Collection & Analysis
- Data Required for Reservoir Performance Analyses
- Data Application
- Data Types
- Reservoir Management Data
- How the Data are Used
- Reservoir Management Plan Components
- Reservoir Management
- Infill Drilling
- Reserves Estimation and Reservoir Management
- Determination of Hydrocarbon in Place
- Integrating the Information
- Decision Tree Approach
- Making the Decision
- Making the Decision - Analogy
- How to Improve Success in Implementing a Reservoir Management
- Evaluation
- Reservoir Simulation
- Economic
- Economic Evaluation
- Economic Evaluation Example
- Summary
- Overview of Reservoir Engineering Data

- Oil Production Operations
- Reservoir Management Team
- Synergy
- Oil Production Processes
- Primary Recovery
- Thermal EOR Methods
- Non-thermal EOR Methods
- Average Recovery Factors
- Factors Common to all Recovery Methods
- Rock and Fluid Properties
- Factors Common to All Recovery Methods
- Porosity
- Classification of Porosity
- How to Measure Porosity
- Measurement of Porosity With Cores
- Porosity Measurements
- Effect of the Depth on Porosity
- Permeability
- Darcy Law
- Effective & Relative Permeability
- Calculating Effective Permeability
- Relative Permeability
- Laboratory Methods for Measuring Relative Permeability
- Laboratory Procedure, Displacement (Unsteady-State) Method
- Relative Permeability
- Unsteady State Techniques
- Relative Permeability
- Factors Affecting Effective and Relative Permeabilities
- Effect of Saturation History
- Choosing the Right Curve
- Importance of Relative Permeability Data
- Relative Permeability Curve @ Zero IFT
- Capillary Pressure

- Capillary Pressure Curve
- Capillary Pressure Concept
- Relation Between Capillary Pressure and Fluid Saturation
- Height Above Free Water Level
- Using of RFT Data to Calculate FWL
- Capillary Pressure Data Applications
- Effect of Permeability on Capillary Curve
- Effect of Contact Angle
- Effect of Interfacial Tension
- Effect of Density Difference
- Typical Drainage and Imbibition Capillary Pressure Curves
- Laboratory Methods for Measuring Capillary Pressure
- Wettability
- In Hydrocarbon Reservoirs
- Implications of Wettability
- Nonwetting Phase Fluid
- Additives That Can Alter Rock Wettability
- Reservoir Fluid Properties
- Reservoir HC Fluid Classification
- Reservoir Hydrocarbon Fluid Classification
- The Five Reservoir Fluids
- Black Oils
- Phase Diagram For Black Oil
- Volatile Oils
- Retrograde Condensate Gas
- Wet Gas
- Phase Diagram For Gas-condensated
- Dry Gas
- Phase Diagram For Dry Gas
- Equation of state
- Class Problem
- Class Problem Solution
- Gas Formation Volume Factor

- Gas Formation Volume Factor (β_g)
- Gas Viscosity
- Viscosity Calculation
- Oil Properties
- Oil Formation Volume Factor
- Typical Shape – Oil Formation Volume Factor
- Solution Gas/Oil Ratio
- Oil Viscosity
- Dependence of Oil Viscosity on Pressure
- Oil Density
- Water Properties
- Water Salinity
- The Influence of the Reservoir Characteristics
- The Influence of the Fluid Characteristics
- Reserves Estimation and Classification
- Why Reserve Estimates?
- Oil Reserve Classification
- Remaining Reserves
- Definition
- Proved Reserves
- Reserve Status Categories
- Proved Undeveloped Reserves
- Oil Reserve Classification
- Unproved Reserves
- Probable Reserves
- Energy Source Criteria for Oil Reserve Classification
- Reserves Changes
- Placing proved, probable, and possible on the distribution
- Reserves-to-Production Ratio
- Role of Reserves
- Reserves Estimates
- Method Used for Estimating Dependent on Data
- Original Oil and Gas in Place Calculation

- Recovery and Efficiency Calculations
- Analogy Method
- Correlations
- Waterfloods
- Ultimate Recovery
- Decline Curve Analysis
- Reservoir Simulation
- Example Applications of Reservoir Simulation
- Steps in a Reservoir Simulation Study
- Reservoir Drive Mechanisms and Producing Characteristics
- Oil Reservoir Drive Mechanisms
- Gas Reservoir Drive Mechanisms
- Reservoir Energy Sources
- Solution-Gas Drive in Oil Reservoirs
- Well & Reservoir Inflow Performance
- Solution-Gas Drive in Oil Reservoirs - Formation of a Secondary Gas Cap
- Solution Gas Expansion Characteristics
- Solution Gas Drive - Main Producing Characteristics
- Solution-Gas Drive in Oil Reservoirs - Typical Production Characteristics
- Solution Gas Drive
- Gas-Cap Drive in Oil Reservoirs
- Gas-Cap Drive in Oil Reservoirs
- Gas Cap - Expansion Characteristics
- Gas Cap Drive - Main Producing Characteristics
- Well & Reservoir Inflow Performance
- Gas-Cap Drive in Oil Reservoirs - Typical Production Characteristics
- Gas-Cap Drive in Oil Reservoirs
- Water Drive in Oil Reservoirs
- Water Drive in Oil Reservoirs - Edgewater Drive
- Water Drive in Oil Reservoirs - Bottomwater Drive
- Strong Water Drive
- Water Drive - Expansion Characteristics
- Well & Reservoir Inflow Performance

- Strong Water Drive - Main Producing Characteristics
- Water Drive in Oil Reservoirs - Typical Production Characteristics
- Strong Water Drive
- Combination Drive in Oil Reservoirs
- Gravity Drainage in Oil Reservoirs
- Gravity Drainage
- Pressure and Gas/Oil Ratio Trends
- Gas Reservoir Drive Mechanisms
- Volumetric Gas Reservoirs
- Water Drive in Gas Reservoirs
- Gas Reservoir Drive Mechanisms - Summary of Source(s) of Reservoir Energy
- Average Recovery Factors - Oil Reservoirs
- Properties Favorable for Oil Recovery
- Characteristics of Various Driving Mechanisms
- Estimating Oil Recovery Factors
- Applications of Waterflooding
- Effects of Gravity
- Barriers To Vertical Flow
- Lateral Pay Discontinuities
- Completion Interval Inconsistencies
- Attic Gas Injection
- Exercises - Recovery Methods
- Determination of Hydrocarbon in Place
- Reserves Estimates Importance
- Original Oil and Gas In Place Calculation
- Volumetric Method
- Inputs to Volumetric Reserves
- Reservoir Area and Volume
- Net Oil Pay Isopach Map
- Calculating Reservoir Bulk Volume
- Determination of Reservoir Bulk Volume
- Volumetric Calculations
- Recoverable Reserves Definition

- Summary
- Original Oil and Gas In Place Calculation
- What is Material Balance ?
- Material Balance Applications
- Material Balance Method
- Summary of Different Material Balance Methods
- Depletion Drive Oil Reservoir (F vs. Etot. OIP = 105.33 MMSTB, S () = 3.83%)
- Depletion Drive Oil Reservoir (F vs. Etot. OIP = 74.63 MMSTB, S () 4.58%)
- Depletion Drive Oil Reservoir (Campbell Plot. OIP = 76.28 MMSTB, S () = 19.17%)
- Depletion Drive Oil Reservoir (Comparison of Pressure Matches)
- Gas Cap Drive Oil Reservoir (F/Eo vs. Eg/Eo. OIP = 108.71 MMSTB, Gascap Fraction = .5412, S () = 5.32%)
- Gas Cap Drive Oil Reservoir (F vs. Etot. OIP = 111.63 MMSTB,S () = .49%)
- Water Drive Oil Reservoir (Campbell Plot. OIP = 47.75 MMSTB, S () = 9.34%)
- Water Drive Oil Reservoir (Hurst Steady-State Aquifer. OIP = 46.89 MMSTB, S () = 4.33%)
- Water Drive Oil Reservoir (Schilthuis Steady-State Aquifer. OIP = 52.53 MMSTB, S () = 4.93%)
- Water Drive Oil Reservoir (Unsteady-State Radial Aquifer — Mm S (). OIP = 38.81, ra/ro = 15.0, tdf = .20, S () = 3.75%)
- Example Solution Gas Drive Reservoir Performance)
- Depletion Drive Gas Reservoir (p/z method2: fit line not pass (pzi,0) OGIP = 615.188 BCF, S () = 4.98%)
- Abnormally Pressured Gas Reservoir (Ramagost p/z plot: abnormal p reservoir. OGIP = 449.270 BCF, S () 2.99%)
- Water Drive Gas Reservoir (Cole Plot. OGIP = 347.837 BCF, S () = 9.76%)
- Water Drive Gas Reservoir (Unsteady-state infinite linear aquifer. OGIP = 309.050 BCF, S () = 3.10%)
- Production Decline Curve
- General Equation
- Hyperbolic Exponent b
- 2 Sets of Equations
- Exponential Decline
- Assumptions
- Why Do We Use Decline Curve Analysis?

- Cartesian Rate vs time
- Semilog Rate vs Time
- Log-Log Rate vs Time
- Cartesian Cumulative Production Vs Time
- Cartesian Rate vs Cumulative Production
- Semilog Rate vs Cumulative Production
- Log-Log Rate vs (1 + b D_i t)
- Graphical Analysis for Exponential Decline
- Graphical Analysis for Harmonic Decline
- Log of Production Rate vs. Time
- Production Rate vs. Cumulative Production
- Log of Water Cut vs. Cumulative Oil Production
- Log of Oil Cut vs. Cumulative Oil Production
- O/W Contact or G/O Contact vs. Cumulative Oil Production
- Log Cumulative Gas vs. Log Cumulative Oil Production
- What Can Change the Trend?
- What Can Change the Trend?
- Decline Curve Prediction
- Decline Curve Analysis
- Comparison of 20-Year Forecasts for Exponential, Hyperbolic, and Harmonic Decline
- Decline Curve Analysis Method
- Material Balance & Reservoir Modeling
- Material Balance, Reservoir Modeling & Economics
- Final History Match & Prediction, Pressure vs. Cumulative Produced Oil
- Final History Match & Prediction, Oil Rate vs. Time
- Final History Match & Prediction, Gas/Oil Ratio vs. Cumulative Produced Oil
- Final History Match & Prediction, Pressure vs. Cumulative Produced Gas
- Final History Match & Prediction, Gas Production Rate vs. Time
- Recovery and Efficiency Calculations
- Describing Waterflooding
- Reservoir Life Cycle
- Infill Drilling
- Waterflooding

- History of Waterflooding
- Reasons for Water Injection
- Pressure Maintenance
- Displace Oil With Water
- Gas Phase Effects
- Reservoir Performance
- Primary Drive Mechanisms
- Proposed and Conditions of Gas and Water Injection
- Waterflood Cycle
- Waterflood Surveillance
- Water Injection System
- A Typical Water Flood Project
- Source Waters
- Main Sources of Injection Water
- Injection Water
- Aquifer Water
- Crude Oil Dehydration
- Difficult Emulsions
- Produced Water Treatment
- Produced Water Management Disposal Option
- Produced Water Management
- Typical Water Quality Criteria
- Treatment of Water for Waterflooding
- pH of Natural Waters
- Waterflood Performance Measurements
- Water Flood Planning in an Economic Perspective
- Success of Water Flooding Project
- Optimum Timing for a Water Flood
- Key Questions in Designing a Water Flood
- Water Injection To Sweep Oil
- Pattern Configurations
- Peripheral or Repeating Pattern Flood
- Peripheral Flood

- Waterflood Patterns
- Repeating Pattern Flood
- Basic Flood Patterns
- Basic Flood Pattern Guidelines
- Peripheral Flooding
- Optimum water flood pattern
- Line Drive Patterns
- 5-Spot Pattern
- 7-Spot Pattern
- 9-Spot Pattern
- Characteristics of Waterflood Patterns
- Factors in Pattern Selection
- Factors Affecting Pattern Selection
- Why Water is the best Fluid for Injection?
- Disadvantages
- Controls of Injection Water Quality
- Design Aspects
- Conceptual Planning
- Preliminary Designs
- Waterflood Design Procedure
- Screen Reservoir for Suitability
- Estimate Injection Requirement to Support the Desired Production Rate
- Select Possible Scenarios
- Areal Sweep Efficiency (E_A)
- Mobility
- Mobility Ratio
- Mobility Ratio Effects
- Significance of Mobility Ratio
- Barriers To Vertical Flow
- Lateral Pay Discontinuities
- Completion Interval Inconsistencies
- Well Spacing and Injector-to-Producer Ratio
- Injector-to-Producer Ratio

- Factors Affecting Pattern Selection
- Waterflood Performance Efficiencies
- Areal Sweep Efficiency (E_A)
- Areal Sweep Efficiency - Factors Affecting Areal Sweep Efficiency
- Vertical Sweep Efficiency
- Vertical Sweep Efficiency - Factors Affecting Vertical Sweep Efficiency
- Development Philosophy
- Performance Predictions for a Waterflood Project
- Performance Predictions Methods
- Analogy
- Simulation Technique
- Development Philosophy
- Operating Philosophy
- Waterflood Performance Measurements
- Why do Waterfloods Fall Below Expectations
- Features of Classical Waterflood Prediction Methods
- Comparison of Mathematical Five-Spot Waterflood Data Model Results with Laboratory
- Primary Followed by Waterflood, Oil Production Rate vs. Time
- Comparison of Mathematical Five-Spot Waterflood Data Model Results with Laboratory
- Time Primary Followed by Waterflood, Cumulative Oil Production vs.
- Primary Followed by Waterflood, Pressure vs. Cumulative Oil Production
- Primary Followed by Waterflood, Gas-Oil Ratio vs. Cumulative Oil
- Comparison of Simulation and Classical Pattern Waterflood Solutions
- Typical Successful Waterflood Performance
- Cumulative Injection vs. Cumulative Total Fluid and Cumulative Oil
- Operating Philosophy
- Injection Well Operations
- Water Quality
- Main sources of Injection water
- Injection water
- Typical Water Quality Criteria
- Injection Water Quality

- Water Quality
- Water Treatment Technologies
- Treatment of water for waterflooding
- Aquifer Water
- Water Injection Plant Design
- Typical Sea Water Injection System
- Volume
- Pressure
- Clay Analysis
- Mixing Formation Water and Seawater North Sea (BP Forties) example
- Scale Formation - Calcium Carbonate
- Corrosion Issues
- Water Quality Monitoring
- SRB Growth Media
- Delivery System
- On-Line Monitoring
- Oil Production Processes
- EOR Recovery Mechanisms
- Primary Recovery
- Enhanced (Tertiary) Recovery Methods
- EOR
- Primary Recovery
- Oil-Water interfacial tension can be totally eliminated by
- Non Thermal Methods
- Non-thermal oil recovery methods
- Summary of Screening Criteria for Enhanced Recovery Methods
- Preferred Oil Viscosity Ranges for Enhanced Recovery Methods
- Permeability Guides for Enhanced Recovery Methods
- Depth Limitation for Enhanced Oil Recovery Methods
- The Influence of The Fluid Characteristics
- Development of a Recovery Method
- Costs and Economics of Recovery
- Chemical Methods

- Efficiency of EOR Method
- The Reservoir Characteristics
- The Fluid Characteristics
- General Trend for Viscosity of Gas-Free Crude Oil at 100°F and Atmospheric Pressure
- Viscosity Reduction of Oils and Water
- Water and Polymer Flood Recovery Comparison
- Steamflooding
- In-situ Combustion
- Polymer flooding
- Surfactant/Polymer flooding
- Alkaline flooding
- Hydrocarbon Miscible Flooding
- Carbon Dioxide Flooding
- Nitrogen and Flue Gas Flooding
- Surfactant flooding
- Steps for applications
- Surface Facilities
- Economics