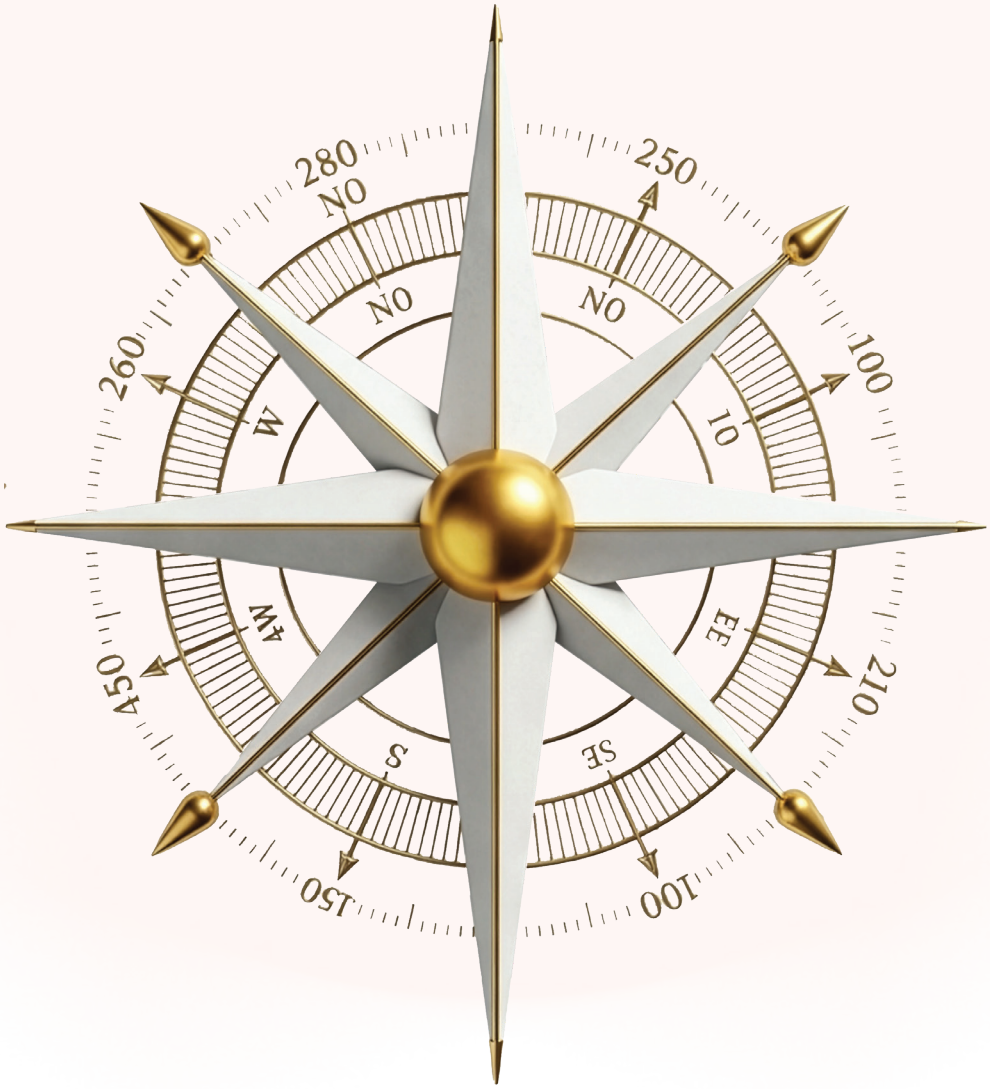
CONCEPT

Reservoir Engineering: Rock and Fluid Properties, Material Balance and Waterflood Management



Reservoir Engineering: Rock and Fluid Properties, Material Balance and Waterflood Management

Introduction:

Reservoir engineering decisions on how much oil and gas is in place, how it will be recovered and whether to inject water are often made from inconsistent core, PVT and pressure data, which leads to missed reserves and early water breakthrough. This Core Concept course builds reservoir engineering practice from rock and fluid properties, volumetrics and material balance in week one, then adds pressure transient analysis, decline curves, waterflood design and surveillance, injection screening and simulation in week two. Participants leave with a Reservoir Management Plan for a waterflooded field.

Course Objectives:

- Derive porosity, permeability, saturation, capillary pressure and relative permeability inputs from core and log data and judge their quality
- Characterise reservoir fluids from PVT laboratory reports and select properties for volumetric and material balance work
- Estimate hydrocarbons in place and classify recoverable volumes by PRMS category using volumetric, material balance and decline curve methods
- Identify drive mechanisms and aquifer support from pressure and production history using material balance diagnostics
- Interpret pressure transient tests to describe reservoir boundaries, heterogeneity and inter-well connectivity
- Design, monitor and adjust a waterflood and compile a Reservoir Management Plan that compares injection options and simulation forecasts

Target Audience:

- Reservoir engineers responsible for in-place estimates, recovery forecasts and reserves submissions
- Petroleum and asset engineers who plan injection, infill wells and field surveillance programmes
- Geoscientists who supply static models and petrophysical inputs to reservoir studies
- Field development planners who compare depletion and injection scenarios for investment decisions
- Surveillance engineers who track injection performance, water cut and reservoir pressure

Course Outline:

Day 1: Reservoir Rock Properties from Core and Log Data

- Total and Effective Porosity from Routine Core Analysis and Density Logs
- Absolute Permeability with Darcy Law and Klinkenberg Gas Slippage Correction
- Archie Water Saturation Calculation and Cementation Exponent Selection
- Net-to-Gross Cut-Offs for Porosity, Shale Volume and Saturation
- Pore Volume Compressibility and Its Effect on Undersaturated Recovery

Day 2: Wettability, Capillary Pressure and Relative Permeability

- Wettability Measurement by Contact Angle and Amott Index
- Capillary Pressure Curves and Leverett J-Function Normalisation
- Transition Zone Height and Free Water Level Definition
- Drainage and Imbibition Relative Permeability Hysteresis
- Corey and LET Correlation Fitting to Special Core Analysis Data

Day 3: Reservoir Fluid PVT and Phase Behaviour

- Phase Envelope Classification: Black Oil, Volatile Oil, Gas Condensate, Wet and Dry Gas
- PVT Laboratory Tests: Constant Composition Expansion, Differential Liberation and Separator Tests
- Oil Formation Volume Factor, Solution Gas-Oil Ratio and Viscosity Correlations
- Gas Compressibility Z-Factor and Gas Formation Volume Factor
- PVT Report Consistency Checks and Representative Sample Selection

Day 4: Volumetrics, Reserves Classification and Drive Mechanisms

- Deterministic STOIIP and GIIP Volumetric Calculation
- Probabilistic Volumetrics with Monte Carlo P90, P50 and P10 Outputs
- PRMS Reserves Categories: Proved, Probable and Possible with 1P, 2P and 3P
- Solution Gas, Gas Cap, Water Drive and Compaction Drive Signatures
- Recovery Factor Ranges and Pressure Profiles by Drive Mechanism

Day 5: Week-One Case Study: Material Balance on a Producing Field

- General Material Balance Equation Terms: Withdrawal, Expansion and Influx
- Havlena-Odeh Straight-Line Plots for Oil In Place and Gas Cap Size
- Gas Reservoir p/z Plot and Overpressure Deviation
- Aquifer Influx Models and Parameter Fitting to Pressure History
- Guided Case: Drive Indices and In-Place Volume from a Field History

Day 6: Pressure Transient Analysis for Reservoir Description

- Bourdet Derivative Flow Regime Identification on Log-Log Plots
- Sealing Fault, Channel and Closed Boundary Detection
- Interference and Pulse Test Design Between Injector and Producer
- Radius of Investigation and Minimum Test Duration Planning
- Dual-Porosity and Radial Composite Reservoir Model Matching

Day 7: Decline Curves, Reserves Governance and Subsurface Uncertainty

- Arps Exponential, Hyperbolic and Harmonic Decline Fitting
- Rate-Cumulative Plots for Estimated Ultimate Recovery
- Reconciliation of Volumetric, Material Balance and Decline Curve Estimates
- Reserves Booking Audit Trail and Annual Revision Categories
- Subsurface Uncertainty Register and Low-Mid-High Case Definition

Day 8: Waterflood Design and Displacement Efficiency

- Fractional Flow Curve and Buckley-Leverett Frontal Advance
- Welge Tangent Method for Breakthrough Saturation and Recovery
- Mobility Ratio and Areal Sweep for Five-Spot and Line-Drive Patterns
- Dykstra-Parsons Layering and Vertical Sweep Efficiency
- Injection Water Source, Quality and Injectivity Agreed with Facilities Teams

Day 9: Waterflood Surveillance, Injection Screening and Simulation

- Voidage Replacement Ratio Tracking by Pattern and Field
- Hall Plot Diagnosis of Injector Plugging and Fracturing
- Chan Water-Oil Ratio Diagnostic Plots for Coning and Channelling
- Gas Injection and EOR Screening Criteria at Overview
- Reservoir Simulation Grid, History Matching and Forecast Cases

Day 10: Capstone: Reservoir Management Plan for a Waterflooded Field

- Field Data Pack Review: Core, PVT, Pressure and Production Histories
- Development Scenario Comparison: Depletion, Waterflood and Gas Injection
- Reservoir Management Plan Drafting with Surveillance Programme and KPIs
- Injection Targets, Infill Candidates and Data Acquisition Priorities
- Plan Presentation and Peer Review Panel

Skills You Will Gain:

- Special Core Analysis Interpretation
- PVT Data Validation
- Probabilistic Volumetrics
- Material Balance Diagnostics
- Pressure Transient Interpretation
- Decline Curve Forecasting
- Waterflood Performance Surveillance
- Recovery Scenario Evaluation

Why Attend This Course:

- Return with a Reservoir Management Plan that sets injection targets, surveillance activities and data priorities for a waterflooded field
- Defend in-place and reserves figures with three independent estimates that reconcile before they reach management review
- Detect injector problems, poor sweep and water channelling early enough to change rates and patterns
- Compare reservoir practice with engineers and geoscientists from national oil companies, independents and consultancies

Conclusion:

Reservoir performance depends on how well rock, fluid and pressure data are combined into consistent estimates and decisions. Week one covers rock and fluid properties, volumetrics, PRMS classification, drive mechanisms and material balance. Week two adds what a shorter course leaves out: pressure transient analysis for reservoir description, decline curve forecasting and reserves governance, waterflood design, surveillance with voidage replacement and Hall plots, injection screening and simulation. The capstone turns this work into a Reservoir Management Plan ready for the next field review.