CONCEPT

Reservoir Simulation: Upscaling, History Matching and Probabilistic Forecasting

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Introduction:

Reservoir simulation models often reach development decisions with coarse grids that lose the geology, poorly equilibrated initial pressures and history matches forced by unrealistic multipliers, so forecasts collapse once new wells come online. This Core Concept course takes experienced subsurface teams through the numerical simulation workflow: grid design and upscaling from the geostatistical model, fluid and saturation-function inputs, initialisation, wells and aquifers, manual and assisted history matching, prediction runs and probabilistic forecasting. Participants build a History-Matched Simulation Model and Probabilistic Forecast Report for a sector case.

Course Objectives:

- Define the purpose, scale and fit-for-purpose complexity of a dynamic simulation model before any grid is built
- Design simulation grids and upscale porosity, permeability and net-to-gross from geostatistical realisations while preserving flow barriers and connectivity
- Assemble and check PVT tables, relative permeability and capillary pressure inputs, then initialise and equilibrate the model to contacts and measured pressures
- Represent producers, injectors and aquifer support with well connection factors, rate and pressure controls and analytical or numerical aquifers
- Calibrate the model to pressure, water cut and gas-oil ratio history with manual and assisted history matching and document the parameter changes
- Run development scenarios, quantify uncertainty across multiple realisations and issue P10, P50 and P90 forecasts, and audit simulation models supplied by partners or consultants

Target Audience:

- Reservoir engineers who build and maintain dynamic flow models for field development and depletion planning
- Simulation engineers who calibrate models to production history and run prediction cases
- Geomodellers who deliver static property grids and realisations for upscaling into flow models
- Asset reservoir engineers who review simulation studies submitted by partners, contractors or consultants
- Petroleum engineers who prepare production forecasts and development scenario comparisons from simulation output

Course Outline:

Day 1: Simulation Workflow, Model Purpose and Numerical Formulation

- Simulation Study Scoping: Model Purpose, Decision Questions and Required Resolution
- Mass Conservation, Darcy Flow and Finite-Volume Discretisation
- Black-Oil Versus Compositional Formulation Selection with Equation-of-State Inputs
- Fully Implicit and IMPES Solution Schemes, Time-Step Control and Convergence
- Full-Field, Sector and Conceptual Model Selection Matrix

Day 2: Grid Construction and Upscaling from the Static Model

- Corner-Point, Stratigraphic and Unstructured Grid Design with Local Grid Refinement
- Layering Strategy from Geostatistical Realisations and Flow Unit Boundaries
- Arithmetic, Harmonic and Flow-Based Permeability Upscaling Methods
- Fault Transmissibility Multipliers, Pinch-Outs and Non-Neighbour Connections
- Flow Diagnostics: Time-of-Flight and Drainage Region Checks After Coarsening

Day 3: Fluid and Rock Inputs, Initialisation, Wells and Aquifers

- PVT Table Construction and Consistency Checks for Simulation Decks
- Saturation Function Tables: Relative Permeability End Points and Capillary Pressure Scaling
- Equilibration to Fluid Contacts, Pressure Datum and Initial Fluid in Place Reconciliation
- Well Connection Factors, Skin and Rate or Bottom-Hole Pressure Control Modes
- Analytical and Numerical Aquifer Representation and Boundary Influx

Day 4: History Matching and Prediction Runs

- History Match Hierarchy: Field Pressure, Well Water Cut, Gas-Oil Ratio and Bottom-Hole Pressure
- Manual History Matching: Sensitivity Screening and Defensible Parameter Changes
- Assisted History Matching with Objective Functions, Maximum Likelihood and Ensemble Methods
- Prediction Deck Set-Up: Well Constraints, Group Controls and Economic Limits
- Development Scenario Runs: Infill Wells, Injection Patterns and Plateau Rate Testing

Day 5: Modelling Build: History-Matched Simulation Model and Probabilistic Forecast Report

- Uncertainty Parameter Ranking with Tornado Charts and Experimental Design
- Multiple Realisation Forecasting and Proxy Models for P10, P50 and P90 Profiles
- Model QC Checklist: Material Balance Error, Grid Orientation and Numerical Dispersion
- Third-Party Simulation Model Audit and Review Findings Log
- Probabilistic Forecast Report Presentation and Peer Challenge

Skills You Will Gain:

- Simulation Grid Design
- Property Upscaling
- Model Initialisation and Equilibration
- Well and Aquifer Modelling
- Assisted History Matching
- Production Forecast Uncertainty
- Simulation Model Auditing

Why Attend This Course:

- Leave with a History-Matched Simulation Model and Probabilistic Forecast Report for a sector case, challenged by peers
- Replace unexplained permeability multipliers with a documented match that geologists and managers can trace
- Present development options as P10, P50 and P90 ranges rather than a single deterministic profile
- Use a structured checklist to accept or challenge flow models delivered by partners and consultants

Conclusion:

A reservoir simulation model is only as useful as the questions it was built to answer and the evidence behind its match. The week moves from model purpose and numerical formulation to grid design and upscaling, then to fluid and saturation inputs, initialisation, wells and aquifers, and on to manual and assisted history matching and prediction runs. The final day turns this work into a History-Matched Simulation Model and Probabilistic Forecast Report, with a QC checklist ready for the next model review.