CONCEPT

Petroleum Production Engineering: Nodal Analysis, Artificial Lift and Well Stimulation

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Introduction:

Petroleum production engineering decides how much of a reservoir's potential reaches the wellhead, and many wells produce below it because of damaged completions, undersized tubing or poorly matched lift. This Core Concept course takes engineers from inflow performance, completion design and multiphase flow in tubing to nodal analysis in the first week, then adds artificial lift design, stimulation, sand control and well test interpretation in the second. Participants build calibrated well models and leave with a Well Performance Optimisation Plan for their own field.

Course Objectives:

- Construct inflow performance relationships using productivity index, Vogel, Fetkovich and three-phase methods and quantify total skin for producing wells
- Select completion architecture, perforation strategy and tubing size and calculate multiphase pressure traverses in vertical and deviated wells
- Build and calibrate a nodal analysis well model to predict the operating point and test tubing, choke, water cut and depletion sensitivities
- Screen and design gas lift, ESP, rod pump, PCP and jet pump installations and diagnose lifted wells that underperform
- Diagnose formation damage and choose between matrix acidizing, hydraulic fracturing and sand control options for a given well
- Interpret pressure buildup tests and surveillance trends to rank wells and compile a Well Performance Optimisation Plan

Target Audience:

- Production engineers responsible for daily well performance and rate targets
- Petroleum and reservoir engineers who forecast well deliverability and plan well interventions
- Completion and well intervention engineers who design completions, stimulation treatments and sand control
- Artificial lift engineers responsible for lift selection, design and run life
- Well surveillance and asset engineers who review well tests, pressure data and production trends

Course Outline:

Day 1: The Well Production System and Reservoir Inflow Fundamentals

- Sandface-to-Separator Production System Map and Pressure Loss Budget
- Darcy Radial Flow Equation and Drainage Area Geometry
- Straight-Line Productivity Index Above Bubble Point
- Reservoir Fluid PVT Inputs for Well Performance: Formation Volume Factor, Solution GOR and Viscosity
- Total Skin Factor and Additional Pressure Drop Across the Damaged Zone

Day 2: Inflow Performance Relationships Below Bubble Point

- Vogel IPR from a Single Test Point and Reservoir Pressure
- Composite IPR for Undersaturated Reservoirs Crossing Bubble Point
- Fetkovich Multirate Isochronal Test Analysis
- Jones-Blount-Glaze Plot for Non-Darcy Turbulence Effects
- Wiggins Three-Phase IPR for Oil and Water Rate Forecasts

Day 3: Completion Design and Multiphase Flow in Tubing

- Completion Architecture Selection: Cased and Perforated, Open Hole and Multizone
- Perforation Design: Shot Density, Phasing and Penetration Effects on Skin
- Tubing Size Selection with Packer and Downhole Equipment Layout
- Vertical Lift Performance: Gravity, Friction and Acceleration Pressure Gradients
- Multiphase Flow Regime Maps and Pressure Traverse Correlation Selection

Day 4: Nodal Analysis Tools and Well Model Calibration

- Node Placement at Perforations, Bottomhole and Wellhead
- Inflow and Outflow Curve Intersection for Operating Point Prediction
- Well Model Calibration Against Flowing Gradient Surveys and Test Rates
- Sensitivity Runs: Tubing Size, Wellhead Pressure, Water Cut and GOR
- Well Data Quality Checklist for Tests, Pressures and Completion Records

Day 5: Week-One Case Study: Naturally Flowing Well Optimisation

- Liquid Loading Onset and Critical Velocity Check in Gas Wells
- Choke Performance and Critical Flow for Wellhead Rate Control
- Reservoir Depletion Forecast and Future IPR Shift
- Guided Case Study: Tubing Resize and Choke Decision for a Declining Oil Well
- Week-One Nodal Model Review and Peer Challenge

Day 6: Artificial Lift Screening, Gas Lift and ESP Design

- Artificial Lift Screening Matrix: Depth, Deviation, Rate, Sand, Gas and Viscosity
- Continuous Gas Lift Valve Spacing and Injection Depth Design
- Gas Lift Performance Curve and Injection Gas Allocation Across Wells
- ESP Sizing: Total Dynamic Head, Stage Count and Motor Selection
- ESP Gas Handling: Free Gas at Intake, Rotary Separators and Gas Handlers

Day 7: Rod Pump, PCP and Lift Failure Risk Control

- Sucker Rod Pump Design: Stroke Length, Pump Speed and Rod String Loading
- Dynamometer Card Diagnosis of Fluid Pound, Gas Interference and Valve Leaks
- Progressing Cavity Pump Elastomer Selection and Torque Limits for Viscous and Sandy Fluids
- Hydraulic Jet Pump Application in Deviated Wells
- Lift Failure Mode Analysis and Run-Life Improvement Register

Day 8: Formation Damage, Stimulation and Sand Control Decisions

- Formation Damage Mechanisms and Skin Decomposition by Source
- Matrix Acidizing Candidate Selection and Fluid Design for Sandstone and Carbonate
- Hydraulic Fracturing Design Inputs: In-Situ Stress, Permeability Profile, Pad Volume and Proppant
- Sand Control Selection: Screens, Gravel Pack, Frac Pack or Managed Sand Production
- Stimulation Proposal Review with Reservoir, Drilling and Operations Teams

Day 9: Production Surveillance, Well Test Interpretation and KPIs

- Pressure Buildup Test Interpretation: Log-Log Derivative and Semi-Log Analysis
- Permeability and Skin Estimation from Buildup Data
- Surveillance Plots: Rate Decline, Water-Oil Ratio and GOR Trends
- Well Performance KPIs: Deferred Production, Lift Efficiency and Uptime
- Exception-Based Well Review Dashboard and Review Cadence

Day 10: Capstone: Well Performance Optimisation Plan

- Field Case Study: Multi-Well Candidate Ranking by Incremental Rate
- Opportunity Screening Across Lift, Stimulation and Completion Options
- Well Performance Optimisation Plan Drafting
- Implementation Sequence and Post-Job Evaluation Criteria
- Plan Presentation and Peer Panel Challenge

Skills You Will Gain:

- Inflow Performance Modelling
- Multiphase Pressure Traverse Calculation
- Nodal Model Calibration
- Artificial Lift Design
- Dynamometer Card Diagnosis
- Stimulation Candidate Selection
- Pressure Buildup Interpretation
- Well Opportunity Ranking

Why Attend This Course:

- Return with a Well Performance Optimisation Plan that ranks your wells by incremental rate and names the lift, stimulation or completion action for each
- Recover deferred oil and gas by finding wells producing below their inflow potential from calibrated models rather than rules of thumb
- Extend lift run life and reduce workover frequency through failure diagnosis on dynamometer cards, ESP data and gas lift surveys
- Compare well performance practice with engineers from national oil companies, independents and service companies working onshore and offshore

Conclusion:

A well produces at the point where reservoir inflow meets the pressure that the completion, tubing and surface system demand. Week one builds that picture from inflow relationships, skin, completion choices and multiphase flow into a calibrated nodal model. Week two adds what a shorter course leaves out: gas lift, ESP, rod pump and PCP design, formation damage, acidizing, fracturing and sand control decisions, and buildup test and surveillance interpretation. The capstone turns this work into a Well Performance Optimisation Plan ranked by incremental production.