ESP Optimisation and Troubleshooting in High-Rate Wells

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ESP performance optimisation is the practice of keeping an electric submersible pump ESP running at its most efficient point, with the fewest failures, in wells where high rates, gas, heat or depth push equipment to its limits. This one-week advanced course is for production, artificial lift and petroleum engineers, and its final deliverable is an ESP well optimisation plan for a high-production case well.

Introduction

The course rests on three references. API RP 11S4 is the recommended practice for sizing and selecting ESP installations. API RP 11S1 sets out how ESP teardown reports are prepared, giving a common language for failure analysis. Nodal analysis is a method that matches a well's inflow performance with the lift system's output to find the operating point. The level is advanced, concentrated in one week on optimisation and troubleshooting rather than the full operation and maintenance syllabus. Teaching uses case studies and troubleshooting exercises built on amp charts, sensor data and teardown findings.

Course Objectives

- Distinguish the pump curve from the system curve and interpret where an ESP operates in a given well
- Apply nodal analysis and API RP 11S4 sizing practice to select pump, motor and cable for a high-production well
- Select design corrections for gas fraction, viscosity and water cut in complex reservoir fluids
- Compare electrical and mechanical failure modes and interpret amp charts to diagnose them
- Apply teardown findings reported under API RP 11S1 to identify root causes and prevent recurring failures
- Justify monitoring triggers and maintenance practices that reduce downtime and extend run life

Target Audience

- Production engineers responsible for artificial lift wells, who must decide when an ESP should be resized, re-speeded or replaced
- Artificial lift and ESP specialists, who must judge the root cause of a failure from field data and teardown findings
- Well site supervisors overseeing ESP installation and start-up, who must assess whether handling and pre-run checks are adequate
- Petroleum engineers planning high-rate or high-gas wells, who must choose design margins for difficult fluids
- Maintenance and reliability engineers supporting production, who must determine which monitoring triggers prevent costly downtime



Course Outline

Day 1: ESP Operating Principles and Performance Indicators

- Pump Curve vs System Curve: Where an ESP Actually Operates in a Well
- ESP Components and Functions: Motor, Seal, Intake, Gas Separator, Pump and Cable
- ESP Performance Indicators: Run Life, Drawdown, Motor Load and Efficiency Explained
- Efficiency Factors in Complex Reservoirs: Gas, Viscosity, Sand and Temperature Effects
- High-Production Well Challenges: Operating Limits Seen in Field Case Studies

Day 2: Design for High-Production and Complex Wells

- Nodal Analysis vs Simple Sizing: Matching Inflow Performance to Pump Selection
- API RP 11S4 Sizing Practice: Selecting Pump, Motor and Cable for a Well
- Fluid Properties in Design: Gas Fraction, Viscosity and Water Cut Corrections
- Design Exercise: Sizing an ESP for a High-Rate, High-Gas Case Well
- Design Case Lessons: What Successful and Failed Designs Reveal About Margins

Day 3: Installation in Deep, Offshore and High-Pressure Wells

- Deep vs Offshore vs High-Pressure Installations: Distinct Handling and Integrity Demands
- Installation Key Considerations: Handling, Splicing, Clearances and Pre-Run Checks
- System Alignment and Integration: Connecting Downhole Equipment with Surface Controls
- Common Installation Mistakes: Cable Damage, Contamination and Preventive Measures
- Installation Scenarios: Field Lessons from Deployments in Demanding Wells

Day 4: Troubleshooting and Failure Analysis

- Electrical vs Mechanical Failures: Insulation, Motor and Cable Faults Compared with Wear
- Amp Chart Interpretation: Reading Current Patterns for Gas Locking, Pump-Off and Overload
- Root Cause Analysis with API RP 11S1: Teardown Reports That Identify Failure Mechanisms
- Troubleshooting Tools and Techniques: Downhole Sensors, Variable Speed Drives and Diagnostics
- Troubleshooting Exercise: Diagnosing Failures from Field Data and Preventing Recurrence

Day 5: Optimisation Practice and the Well Plan

- Reactive vs Proactive Optimisation: Fixing Failures Compared with Monitoring Trends Continuously
- Real-Time Monitoring: Applying Sensor and Amp Chart Data to Operating Targets
- Downtime Reduction: Applying Root-Cause Findings to Maintenance and Restart Practice
- Run-Life Extension Case Studies: Optimisations That Lengthened Pump Life in Demanding Wells
- ESP Well Optimisation Plan: Finalising Operating Targets, Monitoring Triggers and Failure Prevention



Skills You Will Gain

- Pump and System Curve Analysis
- Nodal Analysis
- ESP Sizing
- Gas and Viscosity Correction
- Amp Chart Interpretation
- ESP Failure Analysis
- Installation Quality Checks
- Run-Life Optimisation

Why Attend This Course

- From pulling an ESP after each failure to diagnosing the root cause from amp charts, sensors and teardown evidence
- From catalogue sizing to designs that correct for gas, viscosity and water cut in high-production wells
- From reacting to shutdowns to monitoring triggers that flag gas locking, overload or pump-off early
- From scattered field notes to an ESP well optimisation plan with targets, triggers and failure-prevention actions

Conclusion

Optimising an ESP means keeping the pump near its best operating point while catching the early signs of gas, wear or electrical trouble before they stop production. The course clarifies three distinctions: pump curve versus system curve, electrical versus mechanical failures, and reactive versus proactive optimisation. It suits engineers who already work with ESP wells and want five concentrated days on optimisation and troubleshooting rather than a longer course on ESP operation and maintenance from first principles.

Course FAQs

What is ESP performance optimisation?

ESP performance optimisation is the ongoing adjustment of an electric submersible pump's design, speed and operating limits, guided by monitoring data, so that it delivers the target rate efficiently and runs as long as possible between failures.

What is the difference between electrical and mechanical ESP failures?

Electrical failures involve the motor, cable, splices or insulation, often shown by phase imbalance or ground faults. Mechanical failures involve wear, shaft breakage, seal leaks or abrasion in the pump stages, usually linked to sand, gas or vibration.



Which practices does ESP performance optimisation and troubleshooting training follow?

The course follows API RP 11S4 for sizing and selection, API RP 11S1 for teardown reporting and failure analysis, and nodal analysis for matching well inflow to pump output.

Is ESP performance optimisation and troubleshooting training right for a production engineer?

Yes. A production engineer decides when to resize, re-speed or pull an ESP, and the sessions on pump and system curves, amp chart interpretation, failure analysis and monitoring triggers support those decisions directly.

What do delegates produce in ESP performance optimisation and troubleshooting training?

Delegates produce an ESP well optimisation plan for a high-production case well, setting operating targets, monitoring triggers for gas locking, overload and pump-off, root-cause findings from past failures and actions to extend run life.

