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ESP Design and Nodal Analysis for Production Engineers

26 September – 7 October 2027
Sharm El-Sheikh (Egypt)

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ESP Design and Nodal Analysis for Production Engineers

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ESP Design and Nodal Analysis for Production Engineers is a 2-week engineering course for production, reservoir and completion engineers who select, size and redesign electric submersible pump installations. You model inflow and outflow, run nodal systems analysis, size pumps, motors, cables and drives, and diagnose failed units. You take back an ESP Design and Nodal Analysis Workbook. ESP design and nodal analysis training is delivered by Mercury Training Center.

About This Course

Many ESPs run outside their best efficiency range because they were sized on old well data or never checked against inflow. To follow the course you should already read well test results and production reports. You practice on worked well data from onshore and offshore fields, then on one of your own wells.

Who It Is For

- Engineers who choose the lift method and set production targets for oil wells.
- Engineers who model reservoir inflow and forecast well deliverability.
- Engineers who design completions and specify downhole equipment strings.
- Supervisors and staff who monitor lifted wells and act on surveillance alarms.
- Specialists who investigate pump failures and plan workovers.

This course is not for field operators who need hands-on start-up and routine checks, who are better served by a shorter ESP operations course, nor for managers seeking a broad view of oil and gas production, who suit an overview course on upstream operations.

Competencies You Will Build

- Well Performance Modeling: you build inflow and outflow curves from test data and defend the rate a well can deliver.
- Nodal Systems Analysis: you find the operating point and show how tubing size, water cut and pressure shift it.
- ESP Sizing: you specify pump stages, motor, cable and drive for a target rate and fluid.
- Difficult Fluid Design: you adapt a design for free gas, viscosity, solids, heat and corrosion.
- Surveillance and Diagnosis: you read amp charts, gauge data and alarms and name the likely failure cause.
- Installation Redesign: you compare an installed pump with its design and recommend a resize or reconfiguration.

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What You Will Be Able to Do

By the end of the course you will be able to:

- From well test data and a fluid report, build an inflow performance curve and a tubing outflow curve and state the deliverable rate.
- Given a nodal model, run sensitivities on water cut and reservoir pressure and choose the design point.
- Using pump catalog curves, calculate total dynamic head, stage count and motor load for a target rate.
- Given a gassy or viscous well, select gas handling equipment and corrected pump curves and confirm the design still holds.
- From ESP logs, amp charts and teardown findings, write a root cause statement and a corrective action.
- Using variable speed drive settings, plan the frequency changes that keep the pump in range as the reservoir declines.

Course Content

Day 1: Lift Selection and Well Performance

- Comparing Sucker Rod Pumps, Gas Lift and ESP for Changing Well Conditions
- Application Limits of Each Lift Method by Depth, Rate and Fluid
- Productivity Index Calculation from Well Test Data
- Inflow Performance Relationships Using Vogel and Composite Models
- Outflow Performance and Tubing Curves for Producing Wells

Day 2: Nodal Systems Analysis

- Nodal Analysis Solution Points at the Pump Intake and Wellhead
- Multiphase Flow Correlations for Vertical and Deviated Tubing
- Sensitivity Runs on Tubing Size, Water Cut and Reservoir Pressure
- Pump Intake Pressure Curves for ESP Operating Ranges
- Matching a Nodal Model to Measured Rates and Pressures

Day 3: ESP Components and Operating Principles

- Centrifugal Pump Stages, Impellers and Diffusers in Downhole Service
- Motor, Seal Section and Protector Functions in the ESP String
- Gas Separators, Intakes and Downhole Sensor Packages
- Pump Performance Curves: Head, Efficiency and Brake Horsepower
- Electrical and Hydraulic Principles Behind ESP Operation

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Day 4: ESP Sizing Calculations

- Establishing Lift Requirements and Target Rate for a Candidate Well
- Fluid Composition, Free Gas Volume and Gas-Liquid Ratio at the Intake
- Total Dynamic Head from Net Lift, Friction Loss and Wellhead Pressure
- Pump Stage Count and Housing Selection for the Target Rate
- Motor Sizing and Load Checks for the Selected Pump

Day 5: Cable, Drive and Surface Power Design

- Downhole Cable Size, Voltage Drop and Temperature Rating Selection
- Switchboards, Transformers and Surface Power Supply Design
- Variable Speed Drive Frequency Ranges for Changing Inflow
- VSD Design Examples for Declining Reservoir Pressure
- Surface Choke Effects on ESP Efficiency and Operating Point

Day 6: Difficult Fluids and Alternative Configurations

- Gas Handling Devices and Gas Lock Prevention in Gassy Wells
- Viscosity Correction of Pump Curves for Heavy Oil
- Abrasion, Scale and Corrosion Resistant Materials Selection
- High-Temperature Motor and Cable Choices for Hot Wells
- Inverted, Bottom-Intake, Dual and POD ESP Configurations

Day 7: Installation, Commissioning and Surveillance

- Installation Practices for Running the ESP String
- Surface Equipment Commissioning and Start-Up Checks
- Downhole Gauge and Surface Sensor Data for Real-Time Surveillance
- SCADA Integration and Alarm Settings for Abnormal Operation
- Trend Review of Flow Rate, Pressure, Temperature and Motor Current

Day 8: Failure Analysis and Reliability

- ESP Log and Amp Chart Interpretation for Diagnosing Problems
- Dismantle Inspection and Root Cause Analysis of Failed Units
- Condition Monitoring with Vibration and Oil Analysis
- Reliability-Centered Maintenance for Seals, Bearings and Cables
- Working with OEMs and Service Providers on Run-Life Improvement

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Day 9: Redesigning Installed Pumps

- Performance Analysis of an Installed ESP Against Its Design
- Redesign Options for Rising Water Cut and Declining Pressure
- Smart Sensors and Machine Learning for Predictive Maintenance
- Environmental Impact of Produced Fluid Disposal and Emissions
- Environmental Management System Practices in ESP Operations

Day 10: Applying Nodal Design to Your Own Well

- Exercise: Building the Nodal Model of Your Candidate Well
- Exercise: Sizing the Pump, Motor and Cable for Your Well
- Exercise: Testing the Design Against Gas, Viscosity and Decline Cases
- Exercise: Reviewing a Failed Installation and Proposing a Redesign
- Completing the ESP Design and Nodal Analysis Workbook

Case Studies and Exercises

The items below are suggested activities that the trainer fits to the group.

- Case study: A mature onshore heavy-oil field where ESPs fail early from gas lock and sand; you rank the causes and choose design changes.
- Case study: An offshore platform well with rising water cut; you rerun the nodal model and decide whether to resize the pump or adjust the drive.
- Exercise: A water supply well feeding a waterflood; you size a high-rate ESP and its cable for the required injection volume.
- Exercise: A teardown report from a failed unit; you write the root cause analysis and the redesign brief.

What You Take Back

The ESP Design and Nodal Analysis Workbook holds the calculations, curves and checks for one of your own wells. In your first month back you use it to confirm or correct a current installation, to brief the next workover, and to set surveillance limits for the operations team.

- A nodal model with inflow, outflow and sensitivity runs.
- A sizing sheet for pump, motor, cable and drive.
- A difficult-fluid check for gas, viscosity, solids and temperature.
- A surveillance and failure review checklist.

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Quick Answers FAQ

What should you know before ESP design and nodal analysis training?

You should read well test results, know basic reservoir and fluid properties, and use a spreadsheet. Prior ESP design work is not needed, but daily contact with lifted wells helps you apply the calculations to real cases.

How does ESP design and nodal analysis differ from a basic ESP operations course?

A basic operations course explains components, start-up and troubleshooting over one week. ESP design and nodal analysis adds, over 2 weeks, inflow and outflow modeling, nodal analysis, full sizing calculations and the redesign of installed pumps.

Why do ESPs fail early in gassy or sandy wells?

Free gas lowers pump head and can cause gas lock, while sand erodes stages and bearings. Early failures usually follow designs that ignored intake gas fraction, solids or temperature, which nodal analysis and correct material choices expose before installation.

What do you take back from ESP design and nodal analysis training?

You take back the ESP Design and Nodal Analysis Workbook for one of your wells: nodal model, sizing sheet, difficult-fluid check and failure review checklist, ready to use at the next workover review.

For Your Manager

After the course, the engineer will be able to model well inflow and outflow, run nodal analysis, size an ESP string with its drive and diagnose failed units from field data. They return with the ESP Design and Nodal Analysis Workbook for one of the team's own wells, first used at the next workover or pump replacement review to confirm or correct the design.