TETRA TECH RPS ENERGY | TRAINING

N998: Well Completion Design

Instructor(s): Jonathan Bellarby

Format and Duration

Classroom - 5 Days
Virtual - 5 Sessions

Summary

The course expands on a basic awareness of wells and completions to cover how completions can affect production and how completion design is used to optimise production. Some of the key subject areas that are covered include completions types, inflow performance, perforating, stimulation, tubing performance and artificial lift, production chemistry, materials, stress analysis and corrosion and completion equipment / installation.

Learning Outcomes

Participants will learn to:

1. Characterise the causes of skin including formation damage.
2. Examine different type of perforation designs and devise an appropriate perforation strategy.
3. Predict the types of well completion that benefit from matrix and fracture stimulation and the types of fluids and completion techniques that are used including in unconventional resources.
4. Integrate vertical lift performance into reservoir performance analysis. Examine unstable flow behaviour including liquid loading and lazy well phenomena and determine potential solutions.
5. Decide on the optimum artificial lift strategy (gas lift, ESPs, HSPs, jet pumps, PCPs and sucker rod pumps) including up-front installation or retrofit.
6. Assess where production chemistry problems can pose a threat to productivity and propose mitigations in terms of the completion design or routine well interventions.
7. Perform an outline stress analysis with an awareness of the issues to be considered.
8. Evaluate risks to well integrity such as corrosion in order to ensure the threat to safety and productivity is managed. Be able to choose (as a first-pass) an appropriate material for the completion.
9. Review the types of completion equipment commonly used and where/why they are used.
10. Produce an outline installation program and identify the main steps.

Training Method

This is a five-day virtual course which includes, a mixture of informal lectures, course handouts, videos and discussions. One client specific case study is used and integrated into the sessions.

Who Should Attend

This course is primarily aimed at intermediate level petroleum, completion and reservoir engineers. The course will also benefit geologists, petrophysicists and production engineers who need to deepen their understanding of completion and production enhancement techniques.

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Course Content

The course is practical in nature and uses two possible case studies and practical exercises throughout the week to demonstrate the effects of the design and operation of the completion on well and reservoir management. Some of these key themes that are covered during this week include:

Completion scope and types

This session serves as introduction to the subject and covers basic types of completion.

- Discuss the role of a "double barrier policy" and how this is achieved. Be aware of the issues and mitigations required where a true double barrier approach is not used.
- Discuss what is meant by the reservoir completion and identify the advantages and disadvantages of the main types (barefoot, open-hole, cased and perforated and sand control).
- Explain what is meant by the upper completion and identify the different types (tubing less, packerless, with packer, dual completions) along with their advantages and disadvantages. Explain how to interface the reservoir with the upper completion and define and identify advantages (and disadvantages) of monobore completions.

Inflow performance

This session focuses on the principals in determining the reservoir inflow potential from knowledge about the reservoir, drilling and the completion. It covers basic and advanced inflow performance equations for both oil and gas wells.

- Define the radial inflow performance and use it for practical purposes. Be aware of when the steady state radial flow equation is not valid and what is does to correct it.
- Define the skin factor and convert it to flow efficiency.
- Characterise the causes of formation damage including particulate invasion, wettability changes, relative permeability, emulsions, fines migration and clay swelling.
- Explain non-Darcy flow and identify where these effects are critical.
- Evaluate productivity in deviated, partially completed and horizontal wells.

Perforating

This session is primarily aimed at subsurface engineers involved in perforating decisions.

- Identify the basic principles of perforating.
- Define the factors that influence the productivity of a cased and perforated well with an analysis of the Karakas and Tariq relationship.
- List the main methods of perforating along with the associated depth control.
- Analyse the benefit of underbalance and the techniques used to generate it.
- Determine what to do if sufficient underbalance cannot be achieved (dynamic underbalance and

propellants).
- Assess the optimum perforating interval.

Stimulation (proppant and acidisation)

This session is in less detail than the perforating session as the subject is broader and more specialised. It is primarily aimed at cross-disciplinary understanding and interactions with stimulation design and execution.

- Define the basic theory of proppant stimulation (fraccing).
- Understand the role of geomechanics in fracturing and type of data required.
- Identify (in outline) the equipment and procedures used for proppant stimulation.
- Calculate the productivity for a fractured well and optimise a fracture for length and width and be able to quantify the benefit of tip screen fracturing.
- Be aware of the basic types of fluids used for stimulation and how the fluid choice is made.
- Examine the different types of horizontal completion techniques used for stimulation (plug n' perf, open hole sleeves and cased hole sleeves).
- Predict which types of reservoirs will benefit from matrix and fracture acidisation and the types of fluids and additives that should be used along with an appropriate completion technique.
- List the techniques used for diversion and leak off-control.

Open hole completions

Open hole completions have specific challenges and advantages, so this session ensures an awareness for subsurface and production engineers.

- Relate the specific issue of formation damage with an openhole completion and define the methods for how to mitigate it.
- Determine how water and gas influx is managed with the use of ECPs, openhole packers and swellable elastomers.
- List the 3 methods for how to remove the drilling mud and the role of drill-in fluids especially with relation to open hole sand control completions.

Tubing performance

Many engineers (especially production and reservoir engineers) are involved in simulations that require an understanding or prediction of tubing performance. This session covers how to generate and integrate these predictions.

- Define the critical role of PVT data in tubing sizing and explain how it differs from the data required by reservoir engineers.
- Define the basics behind multiphase flow and how correlations are used to determine the tubing performance.

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- Quantify the influence in changing reservoir parameters (water cut, GOR) in vertical lift performance.
- Incorporate inflow performance (nodal analysis) and select an appropriate tubing size.
- Determine the onset of unstable flow in both oil wells and gas wells and explain it is mitigated (plungers for example).
- Examine lazy wells and the methods used to restart such wells.

Artificial lift

Artificial lift profoundly affects productivity and this session deals with how artificial lift must be integrated into the production engineering (e.g. surface facilities) and the subsurface development plan.

- Describe how artificial lift is integrated into well performance assessments.
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- Explain how gas lift works and is designed and provide outline gas lift designs. Can troubleshoot gas lifted wells.
- Describe how Electrical Submersible Pumps (ESPs) work and how they are designed and optimised. Can create a basic ESP design including pump and motor selection.
- Describe the basics behind jet pumps, PCPs, HSP and rod pumped wells and provide examples of where they are best suited for application.

Production chemistry

Production chemistry problems can pose a major threat to productivity, so this session covers how it must be assessed and mitigated.

- Provide examples indicating the criticality of proper fluid samples (oil and water) for production chemistry assessment and can identify where the data comes from and the underlying uncertainties.
- Describe the common types of oilfield scales, how they are predicted, removed or prevented.
- Explain wax and asphaltene deposition and describe how they influence productivity and are removed or prevented.
- Identify the role of hydrates in tubing blockages and the occurrence and production of naturally occurring hydrate deposits.
- Describe how reservoir souring occurs and its influence and mitigation.

Overview of Tubing Stress Analysis

- The main issues for burst, collapse, axial and triaxial loads.

Well integrity and material selection

Well integrity poses a threat to safety and productivity and must be managed. The emphasis in this session is on understanding and evaluating the risks and on the correct choice of completion materials.

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- Provide a brief overview of corrosion and erosion mechanisms and identify how they are mitigated.
- Be able to provide a first-pass assessment of both tubing metallurgy and seals (elastomers and plastics).

Completion equipment

Although drilling and completion engineers will likely select the equipment, a well-designed completion must integrate subsurface and production engineering needs, for example well surveillance and well interventions. This session focuses on these interactions.

- Identify the main types of completion equipment and how they work and are applied with an emphasis on their role in reservoir management. Covers trees, safety valves, packers, mandrels, gauges, reservoir isolation valves and nipple profiles.

Non-conventional wells

Whilst all these issues cannot be covered in details, this session addresses some of the more unusual completions which can provide significant benefits in terms of the field development plan.

- Identify the broad issues with HPHT completions.
- Explain how the different types of downhole flow control (sometimes called smart or intelligent wells) systems work and how they can be integrated into the reservoir management e.g. variable vs. on/off valves, the integration of gauges.
- Explain the complexities and limitations of multilateral and multipurpose wells and their impact on reservoir management. Can identify the types of application where their uses can be beneficial.
- Can describe the issues involved with CO2 sequestration from a completion and near wellbore perspective.