N006: An Introduction to Reservoir Engineering for Geoscientists

Instructor(s): Mark Cook/ Richard Oxlade/ John Gallivan

4 Days	Competence Level: Foundation
Classroom Course	

Summary

Business Impact: By building a greater awareness of **reservoir engineering principles**, participants will be able to **communicate more effectively** with their Reservoir Engineering colleagues, ensuring **better integration** between disciplines, thereby improving the efficiency, effectiveness, and quality of business activities.

This course examines the standard reservoir engineering processes and techniques, particularly their interface with geoscience activities. This course illustrates, with examples, the use of subsurface data in the construction of a reservoir model. It covers three related main themes: static reservoir models; developing dynamic reservoir simulation models; and reservoir management during the producing life of a field. This course covers the fundamentals of fluid flow in porous media, from a rock and fluid perspective.

Learning Outcomes

Participants will learn how to:

1. Operate more effectively, and work more collaboratively, with their Reservoir Engineering colleagues.
2. Interpret original fluid contacts, through analysis of logs and pressure vs. depth profiles, prior to production start-up; understand saturation vs height relationships and estimate original hydrocarbon in place volumes, for both oil and gas reservoirs.
3. Employ fluid sampling techniques. Differentiate the physical and chemical properties of hydrocarbons and their description through phase diagrams.
4. Examine the uses and importance of well tests and appraise how analysis is conducted.
5. Examine the controls on fluid flow in the reservoir, the balance of viscous, capillary and gravity forces and the impact of reservoir drive mechanisms including depletion, water and gas drive.
6. Analyse production performance in the wellbore and debate artificial lift techniques. Compare production enhancement through stimulation, horizontal wells, and completion techniques.
7. Examine the processes and interfaces of building both static and dynamic reservoir models. Show awareness of the principles, objectives, demands, and uses of reservoir numerical simulation techniques and its validation.
8. Analyse the importance of continued reservoir management for forecasting future production profiles and maximising economic hydrocarbon recovery from a producing field over the complete life cycle.
9. Compare the Enhanced Recovery techniques: steam and fire flooding; miscible and immiscible gas displacement.

Duration and Training Method

This is a four-day classroom course, comprising a mixture of lectures and case studies with many worked examples to be completed by participants.

Who Should Attend

This course is aimed at Geoscientists and other subsurface professionals who interface with Reservoir

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Engineers in their regular work, or who wish to obtain a broad grounding in reservoir engineering principles. This course will also benefit new team leaders tasked with managing multi-disciplinary teams.

Prerequisites and Linking Courses

There are no prerequisites for this course. Participants seeking to build and expand upon the learnings for this course could follow up with N012 (Reservoir Modelling Field Class (Utah, USA)), N033 (Characterisation, Modelling, Simulation and Development Planning in Deepwater Clastic Reservoirs (Tabernas, Spain)), N412 (A Critical Guide to Reservoir Appraisal and Development)
and N386 (Reservoir Model Design (Pembrokshire, UK)).

Course Content

The material covered in this course is built around the reservoir model, which can be constructed using analytical (calculator) or numerical (simulation) processes. The process is in three parts:

1. Building a static reservoir model
2. Developing a dynamic model
3. Reservoir management during the producing life of a field

The **static reservoir model** refers to the description of the reservoir in terms of reservoir and fluid distribution, volumetrics and reservoir zonation to identify the main potential flow units.

The **dynamic model** builds on the static model to include the consideration of fluid flow in the reservoir, near the wellbore and through the production tubing to the wellhead. The dynamic model is often constructed using a numerical reservoir simulator, but there are analytical techniques which can be used to predict fluid flow in the reservoir.

Reservoir management is a key activity for a producing field, performed with the general objective of maximising economic recovery. Monitoring is performed by measuring production and pressures in the reservoir and the results drive the forward activity programme and production forecasts.

Throughout the course, the use of complex mathematics has been avoided in order not to perturb creative geologists and the material concentrates on the principles rather than the detailed work of the reservoir engineer.

The following topics will be covered:

Introduction

Basic Reservoir Rock And Fluid Description

Controls on fluid flow in the reservoir

- Rock permeability, and relationship with porosity
- Reservoir zonation; Darcy's Law and impact of permeability contrasts

Defining fluid contacts and estimating volumetrics

- Basic reservoir volumetrics
- Defining fluid contacts; RFT pressure measurements and Pressure vs Depth relationships
- Capillary pressures and saturation-height relationships

Reservoir fluid properties

- Fluid sampling
- Analysis of fluid samples
  - Chemical properties of hydrocarbons
  - Physical properties of hydrocarbons
  - Phase diagrams
- Making use of the PVT report

Well test analysis

- Uses of well testing
- Planning a well test
- Well testing operations
- Well test analysis – determining kh, skin, PI, boundary effects
  - Analysis principles
  - Analysis techniques – semi-log and log-log analysis
  - The components of total skin
  - Special test types

Dynamic Behaviour of Reservoir Fluids

Material balance and fluid displacement

- Drive mechanisms; depletion, gas cap drive, water drive
- Material balance for oil reservoirs
- Material balance for gas reservoirs
- Fluid displacement on a macroscopic scale; sweep efficiency
- Fluid displacement on a microscopic scale; relative permeability
- Estimating recovery factors
- Diffuse and segregated flow regimes
- Buckley-Leverett displacement theory

Dynamic well performance

- The inflow performance relationship
- Tubing performance curves
- Artificial lift
- Coning and cusping
- Well completions

- Horizontal wells
- Well stimulation; fracturing and acidisation

Reservoir simulation

- Gridding
- Simulation principles
- Input, output and visualisation
- Upscaling static and dynamic model properties

Measuring Reservoir Performance And Reservoir Management

Reservoir monitoring

- Overview of reservoir management
- Monitoring tools: pressure, PLT, TDT, RFT, MDT, XPT pressure data, production and injection data
- Well interventions and workovers

Production

- Field analogues
- Decline curve analysis
- Analytical models
- Reservoir simulation and history matching
- Probabilistic production forecasting
- Reserves reporting

Enhanced oil recovery techniques

- Defining the target oil
- EOR techniques
- Steam and fire flooding
- Miscible gas displacement
- Immiscible gas displacement
- Novel techniques