N934: PVT

Instructor(s): Bahman Tohidi

3 Days	Competence Level: Skilled
Classroom Course	

Summary

The course covers reservoir fluid composition, phase behaviour and reservoir fluids classification; PVT tests and correlations/modelling; the evaluation and application of PVT reports; Equation of State tuning, PVT analysis by compositional methods using a compositional behaviour model; applications in reservoir simulation. There will be a discussion of potential causes of errors and several case studies.

Learning Outcomes

Participants will learn to:

1. Assess the fundamentals of reservoir fluid composition, phase behaviour, correlations and classification.
2. Construct PVT testing requirements.
3. Appraise PVT analysis by compositional methods.
4. Prepare the results of PVT analysis for use in reservoir modelling and reservoir engineering studies.
5. Characterise sources of error and evaluate case studies.

Duration and Training Method

Three day, classroom course with theory, case studies, exercises, and discussion.

Who Should Attend

The course is designed for Petroleum and Production Engineers as well as Geoscientists who need to understand what types of fluid are available and how the results can be used.

Prerequisites and Linking Courses

A familiarity with basic petrophysical and reservoir engineering principles, such as acquired on N083 (Petrophysics and Formation Evaluation: Principles and Practice) and N006 (An Introduction to Reservoir Engineering for Geoscientists) is expected.

Course Content

The course aims to address a number of key topics in this area, but there is some flexibility in the formal itinerary depending on the groups preferences. The key topics that are covered include:

- Fundamentals - reservoir fluid composition; basic concepts of phase behaviour; classification of reservoir fluids.
- PVT tests and correlations - compositional analysis by gas chromatography and distillation; conventional PVT tests.
- PVT report - its evaluation, quality control, data processing and application of test results.
- Applications in reservoir simulation - pseudo components and grouping; optimum fluid characterisation; tuning equation of state data; generating black oil tables for reservoir simulation.
- Causes of errors in PVT modelling, case studies.

- Specialised topics and current research topics, based on the wealth of knowledge available to the tutor via his links to Heriot-Watt.

Day 1: PVT in hydrocarbon reservoirs

- Pressure-Temperature diagram for pure compounds
- Critical point
- Ideal and real gases
- Corresponding state
- Acentric factor
- Phase behaviour of binary and multicomponent systems
- Phase envelope
- Classifications of hydrocarbon reservoirs
- Retrograde condensation, cricondenbar and cricondentherm
- Effect of composition on phase envelope
- Behaviour of dry/wet gas, volatile/black oil at reservoir and separator conditions
- PVT tests for dry/wet gas, black/volatile oil and gas condensate
- Determining molecular weight of liquid hydrocarbons
- Constant Composition Expansion (CCE) test
- Differential Liberation (DL) test
- Separator test
- Constant Volume Depletion (CVD) test

Day 2: Fundamentals of phase equilibria and Fluid Characterisation

- Equation of state (EoS)
- Van der Waals EoS
- SRK EoS
- PR EoS
- Mixing rules
- Binary Interaction Parameters
- Algorithm for computer calculations
- Distillation
- Gas chromatography
- Single carbon number (SCN)
- Semi-continuous fluid description
- Calculating physical properties of SCN

Day 3: Using data in EoS tuning and reservoir simulation

- Application to reservoir simulation
- PVT reports
- Grouping
- Group Selection, Group Properties
- Tuning of EoS
- Tuning of EoS for an oil using a commercial software

- Tuning of EoS for a gas condensate a commercial software
- Generating black oil tables for exporting to reservoir simulators

This course is also available as a 5-day course with the following additional content:

- Fluid Sampling - well stabilisation and optimum production rate; multi-phase sampling; oil-based mud filtrate contamination sample evaluation.
- PVT tests and correlations - compositional analysis by gas chromatography and distillation; conventional PVT tests; well inflow, pressure build-up and gas recycling; gas injection tests; reservoir fluids properties measurement and predictions.
- PVT analysis by compositional methods - equilibrium ratio correlations and their application; equation of state modelling; simulation of PVT data using fluid composition; evaluation of PVT data using compositional models, fluid characterisation.
- Applications in reservoir simulation - pseudo components and grouping; optimum fluid characterisation; tuning equation of state data; generating black oil tables for reservoir simulation, measurement and prediction of interfacial tension; viscosity correlations and prediction by compositional methods; gas injection and multi-contact miscibility.

PVT in hydrocarbon reservoirs and fluid sampling

- An introduction to reservoir fluid sampling and its importance
- Well preparation for sampling for different reservoir fluids
- Downhole, wellhead and separator sampling

Fluid sampling and PVT tests

- Effect of contamination
- Retrieving the original fluid composition from contaminated samples
- How to use test results on contaminated samples to calculate EOS parameters for uncontaminated fluid
- Application of tracers for retrieving composition of the original fluids in gas condensate reservoirs
- IFT measurement and prediction
- Viscosity measurement and prediction
- Some useful correlations in Petroleum Industry
- Introduction to gas hydrates

Fundamentals of phase equilibria

- K-value calculations
- Raoult's law
- Henry's law
- Flash, bubble point, dew point calculations

Miscible gas injection

- Gas injection

- Ternary diagram
- First contact miscible
- Vaporizing gas drive
- Condensing gas drive
- Limitations of ternary diagram
- Slim tube
- Rising bubble
- Minimum Miscibility Pressure and Minimum Miscibility Enrichment
- Solvent injection

Using data in EoS tuning and reservoir simulation comparison of EoS

- Phase Composition
- Saturation Pressure
- Density
- Gas and Liquid Volumes
- Robustness
- Fluid Characterisation
- Selection of EOS
- Experimental Data
- Selection of Regression Variables
- Limits of Tuned Parameters
- Methodology