N982: PVT Equation of State Applications to Hydrocarbon Fluids

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4 Days	Competence Level: Skilled
Classroom Course	

Summary

This practical course will provide attendees with a working knowledge of Pressure Volume Temperature Equation of State (PVT EOS) theory and its applications, following a path from field sampling, to the lab and on to the examination of common practices and analyses used in classical and simulated reservoir engineering. It will also address black oil and compositional modeling for simulation.

Learning Outcomes

Participants will learn to:

1. Evaluate fluid types and phase behavior.
2. Explain why and how the Equation of State (EOS) was developed.
3. Select methods of sampling.
4. Assess and quality control PVT lab reports including DLE, CCE, CVD.
5. Set up PVT simulators to tune an EOS to PVT lab report.
6. Manage compositional modeling including vaporization/condensation processes.
7. Construct black oil and compositional simulation models.
8. Assess viscosity and construct tables for simulation.
9. Assess uncertainties in measurements.

Duration and Training Method

This is a four-day classroom-based course that includes theory, worked examples, and a field trip to a reservoir fluid lab.

Who Should Attend

This course is designed for engineers assigned with the responsibility of determining reservoir hydrocarbons originally in place and forecasting produced oil and gas volumes during depletion. Understanding phase behavior and PVT laboratory experiments are essential to the reservoir engineer engaged in primary, secondary and enhanced oil recovery (EOR) operations. Simulation engineers will gain confidence in characterizing reservoir fluids for history matching and predictions. Process and chemical engineers will also benefit from the course.

Prerequisites and Linking Courses

Participants should be familiar with basic reservoir engineering principles including fluid properties, as presented in Nautilus Basic Application level course N980 (Petroleum Reservoir Fluids) and Skilled application level course N900 (Applied Reservoir Engineering).

Course Content

Three and a half days of classroom work will be followed by a half-day field excursion.

1. Basic Thermodynamics

a. Gibb's phase rule
b. Reservoir fluid types and the phase diagram
-Black oil

-Volatile oil
-Near-Critical oil
-Retrograde condensates: lean-rich; low-high dropouts
-Wet and dry gas
c. Single components and development of equation of state (EOS)
d. Two-component systems and binary interaction parameters (BIP)
e. Multi-component systems and ternary-quaternary diagrams

2. Equation of State Phase Behavior Modeling

a. Software applications
b. Data requirements for fluid characterization
c. Experimental data for tuning EOS to fluid characterization
d. Gamma distribution fitting
e. Plus fraction characterization and gamma splitting
f. Pseudoization and component lumping

3. PVT Experiments for Petroleum Fluids

a. Traditional black oil experiments including DLE, CCE, CVD
b. Building black oil tables from directly from PVT data
c. Compositional experiments including:
-Equilibrium phase compositions
-Swelling experiments
-Multi-contact vaporization experiments
-Slim tube displacements

4. EOS Characterization Tuning

a. General guidelines for tuning
b. Initializing the characterization
c. Inputting measured data
d. Guidelines for choosing regression variables
e. Trial and error including:
-Modifying the data weighting
-Modifying the choice of regression variables
-Learning to recognize data outliers and discrepancies
-Learning to recognize good matches from poor matches

5. Estimating Reservoir Fluid Compositions

a. “Equilibrium Contact Mixing” method
b. Mathematical decontamination
c. Gravity induced thermodynamic segregation

6. Using Black Oil Properties from a Tuned EOS

a. Run your own laboratory experiments
b. Simulate depletion experiments
c. Generate results for multi-stage surface conditions
d. Translate results in reservoir simulator format

7. Minimum Miscibility Pressures and Enrichments

a. Mechanisms
-Condensing gas drive
-Vaporizing gas drive
-Condensing/vaporizing gas drive
b. EOS predictions
-Slim tube simulations
-Multi-cell, multi-contact mixing simulations
-Predictions by the method of characteristics

8. Reservoir Fluid Lab Visit

a. How PVT experiments are conducted
b. Understanding limitations and uncertainties