N512: PVT Analysis for Unconventional Hydrocarbon Fluids

Tutor(s): Yucel Akkutlu

2 Days	Competence Level: Skilled Application
Classroom Course	

Summary

Pressure-volume-temperature (PVT) analysis is the process of determining fluid behavior and properties of the produced oil and gas samples from an existing well. PVT analysis has been well-established for the unconventional reservoirs. However, the unconventional resources such as source rocks bring in new uncertainties into the analysis. These are mainly due to presence of a large range of pore size distribution from fractures and micro-cracks, down to nanometer-scale pores. The fluid PVT is influenced by strong interactions with the organic (kerogen) matrix walls and, at the lower end of the pore size distribution, by the so-called nano-confinement effects. Currently, the industry lacks predictive fluid models that can be used with the existing reservoir tools such as the flow simulation models for production forecast and optimization. Also, it is not clear whether the nano-confined fluid behavior has the potential to impact the production trends. For example the release of nano-confined fluids from the formation have been proposed as the source of erratic produced GOR values experienced in the field. This course is a treatise on PVT analysis for the unconventional fluids. Prediction of the changes in fluid properties and phase behavior of the nano-confined fluids and the deviations from the conventional (or bulk) fluids is the main interest. An in-house multi-scale compositional simulation model (including nano-pores and large-pores) will be used to forecast the production trends and to show the impact of nano-confinement effects.

Learning Outcomes

Paticipants will learn to:

1. Quantify the nano-confinement effect during the fluids in-place calculations.
2. Learn to predict recovery from kerogen.
3. Learn to use equation of State for fluid under confinement.
4. Learn to consider the capillary pressure during the flash calculations.
5. Develop compositional flow simulation models for shale gas/oil reservoirs.

Prerequisites and Linking Courses

Related Publications for Reading

* Bui, K. and Akkutlu, I. Y. 2017. Hydrocarbons Recovery from Model-Kerogen Nanopores. SPE Journal 22 (3) 854-862

** Baek, S and Akkutlu, I.Y. 2019. Produced Fluid Composition Re-Distribution in Source Rocks for Hydrocarbon in-Place and Thermodynamic
Recovery Calculations. SPE Journal 24 (3) 1395-1414

† Baek, S. and Akkutlu, I.Y. 2019. CO2-Stripping of Kerogen Condensates in Source Rocks. SPE Journal 24 (3) 1414-1434.

†† Baek, S. and Akkutlu, I.Y. 2019. Recovery Mechanisms for Nano-confined Oil in Source Rocks using Lean Gas

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Injection. SPE-195272 to be presented at the SPE Western Regional Meeting, April 23-26, San Jose, California, USA

Course Content

Day 1 – Conventional Wisdom– PVT for Bulk Fluids

1. Phase Behavior of Bulk Hydrocarbon Fluids
2. Equations of State
3. Properties of Five Reservoir Fluids
4. Recombination of Surface Fluids
5. Gas-liquid Equilibria
6. Flash Vaporization and Differential Vaporization
7. Surface Separator Calculations for Oil and other fluids
8. K-factors for Separator Calculations
9. Equilibrium Ratio Correlations and Convergence Pressure Estimation
10. Gas-liquid Equilibria Calculations with Equation of State
11. Atomistic modeling of Recombined Surface Fluid mixtures and Validation using PVTSim

Day 2- Unconventional Fluids- The State of the Art

1. Phase Behavior of Nano-confined Hydrocarbon Fluids
2. Equations of State for Nano-confined Hydrocarbon Fluids*
3. Re-distribution of Recombined Surface Fluid Mixtures using Membrane Model*
4. Occurrences of Five Reservoir Fluids as Redistributed Fluid Mixtures in Nano-pores based on molecular simulations
5. Capillary Condensation** of Re-distributed Fluid Mixtures in Nano-pores
6. Hydrocarbon in-place calculations for dry gas, wet gas, condensate and oil formations using a new volumetric method** in presence of nano-confined fluids
7. Thermodynamic Recovery from Nanopores during pressure depletion using membrane model *
8. Vaporization†of Capillary Condensed Fluid Mixtures using Lean Gas Injection and enhanced oil-gas recovery from nanopores
9. In-house Multi-scale Compositional EOS Reservoir Flow Simulator coupled with Molecular simulations of Nano-confined Fluids Release
10. Simulated Production Trends in the Presence of Nano-confined Fluids

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