Reservoir Characterization & Simulation

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Introduction:

Naturally fractured reservoirs present unique and specialized challenges to hydrocarbon extraction. This course seeks to confront many of these challenges by providing an introduction to the engineering and geological character of naturally fractured reservoirs. A blend of engineering and geological data and tools are used to optimize our understanding of this class of reservoirs.

Case histories of several naturally fractured reservoirs are presented to show that a range of strategies may be required to successfully address the complexity of this diverse class of reservoirs. It provides the candidates with the skills and understanding required to naturally fractured reservoirs. Natural fractured reservoirs hold both conventional and unconventional hydrocarbon resources. It provides different approaches for evaluation and characterization of heterogeneous naturally fractured reservoirs by wire-line log, core analysis and well testing. Different methods for Modeling and dynamic simulation of naturally fractured reservoirs and case histories will be reviewed including multiple porosity model with structured grids and single porosity with unstructured grids. Production data analysis of unconventional reservoirs will also be reviewed.

Objectives

By the end of this course delegates will be able to:

- Understand fractures in a reservoir
- Determine whether fractures are important to hydrocarbon producibility
- Analyze the fracture system for the purpose of improved reservoir management
- Learn about the geological character of fracture systems
- Recognize and describe geological character of fracture systems
- Learn their effect on reservoir performance
- Distribute geological character of fracture systems in a reservoir model
- Know the different approaches to flow simulation

Who should attend?

Asset managers and reservoir and production engineers, Oil & Gas Engineers, reservoir operators, geologists, geophysicists, anyone who work in an integrated asset team in the upstream of petroleum industry, those who desire to obtain an overall picture of oil and gas field, development and desire to obtain knowledge and skills of reservoir and the design and interpretation of well tests.

Course Outline:

Geologic Aspects

- Fracture definition, Reasons for generation of fractures
- Storage capacity of matrix and fractures, Classification
- Migration and accumulation of hydrocarbons in fractured reservoirs

Petro physics and Rock Properties

- Use of sonic amplitude, variable density, dual-induction, later log, spontaneous potential
- Density correction curve, combination of sonic-neutron, combination of sonic density
- Combination of neutron core porosity, borehole televiewer
- Combination sonic- neutron-density, short and long normal
- Dip meter, production index, temperature.
- NMR and FMS/FMI/EMI logs in the evaluation of naturally fractured reservoirs.
- Cross-plotting techniques.
- Porosity exponent, m, in naturally fractured reservoirs.
- Water saturation exponent, n, in naturally fractured reservoirs.

- Water saturation in matrix, fractures and the composite system.
- P1/2 statistical analysis for calculating water saturation.
- Total, matrix, and fracture porosity.
- The uncertainty of calculating hydrocarbons-in-place.

- Fracture and effective system compressibility.
- Capillary Pressure for fractured system.
- Relative permeability for fractures, matrix and composite system.

Well Testing

- Naturally fractured reservoirs interpretation.
- Parameters lambda and omega.
- Fracture permeability and fracture-matrix average permeability.
- Fracture and total porosity.
- Size of matrix blocks, effect of matrix block shape and effect of partial secondary mineralization on pressure data
- Skin due to formation damage and pseudo-skin due to partial secondary mineralization within natural fractures

- Radius of investigation equation for fractured reservoirs
- Variable-rate build-up and drawdown
- Effect of a single sealing fault and faults intersecting at any angle on pressure data
- Bounded reservoirs
- Horizontal wells, effect of x, y, z anisotropy

- Type Curves : Obtaining a good match
- Uniform flux vertical fracture
- infinite conductivity vertical fractures
- Finite conductivity vertical fractures, Horizontal fractures
- Effective reservoir permeability and fracture half-length
- Dual porosity systems without and with hydraulic fractures
- Dual porosity systems: Outer boundaries with or without pressure maintenance
- Dual porosity systems: Pressure Interference, Gas Wells

Primary and Secondary Recovery

- Saturated and under-saturated reservoirs, Material balance
- Gas-oil ratio and oil saturation equations
- Water-drive reservoirs, Well spacing
- Water and gas coning through fractures
- Production decline type curves
- Horizontal wells, Gas injection, Water injection.

Simulation of Naturally Fractured Reservoirs

- Grid Generation, Double porosity model
- Double porosity double permeability model
- CBM Model, Multiple porosity model, Discrete fracture model
- Case Studies of shale gas reservoirs, Automatic history matching