ROUTINE AND SPECIAL CORE ANALYSIS

RSE006

COURSE OVERVIEW

This 5-day course presents the Routine Core Analysis (RCA) and Special Core Analysis (SCAL) concepts and experiment that are required in the execution of reservoir engineering studies, reservoir simulation models and Enhanced Oil Recovery (EOR) studies. It describes the different laboratory experimental methods and techniques to develop representative reservoir properties to be used in classical reservoir engineering and numerical simulation reservoir models. The lectures include the coring and transport procedures, native state analysis, cleaning procedures, aging the cores to restore original conditions, describing the best practices for quality control, core description, plugs selection, experimental procedures, and limitations of the results. Field cases of core capture, RCA and SCAL programs for implementation of Enhanced Oil Recovery projects.

COURSE OBJECTIVES

By the end of this course, participant will be able to:

- Understand the principles and techniques of Routine Core Analysis (RCA) and Special Core Analysis (SCAL).
- Gain knowledge of laboratory experimental methods for developing representative reservoir properties.
- Learn about coring and transport procedures, native state analysis, and core cleaning techniques.
- Understand the importance of core preservation, imaging, and drying.
- Acquire skills to perform saturation, porosity, and permeability measurements.
- Gain insights into capillary pressure, electrical properties, and wettability measurements.
- Learn about relative permeability and its significance in reservoir engineering.
- Understand the concept of hysteresis and its impact on fluid flow in porous media.
- Gain knowledge of applied core analysis techniques for rock typing and quantifying heterogeneity.
- Learn how to interpret and apply core analysis results in reservoir engineering and Enhanced Oil Recovery (EOR) projects.
- Develop an understanding of Enhanced Oil Recovery (EOR) techniques and mechanisms.
- Assess the limitations and challenges associated with core analysis and apply best practices for quality control.
- Apply the acquired knowledge and skills in the design and construction of reservoir static and dynamic models.

- Evaluate the potential net pay, sweeping efficiency, and displacement efficiency based on fractional flow and mobility ratio.
- Learn basic statistical techniques, such as histograms and cumulative distribution function (CDF), for data analysis in core analysis.
- Gain awareness of the latest advancements and field cases in core capture, RCA, and SCAL programs for EOR projects.

WHO SHOULD ATTEND

- Reservoir Engineers
- Geologist
- Geophysicist
- Petrophysicists
- Geo-modelers
- Subsurface managers and professionals involved in the design of conventional and special core analysis programs and applying results from laboratory experiments for the construction of reservoir static and dynamic models.

COURSE DURATION

5 Working Days

COURSE OUTLINES

1. **Pre course evaluation**

2. **Introduction and Routine Core Analysis in Lab.**
   - Fundamentals:
     - Wettability Origin
     - Driving Mechanisms vs. Driving Forces
   - Core Planning
     - Scope and Objectives of the Core Analysis
     - Core Measurements
     - Coring Considerations
     - In the Wellsite
     - Core Handling
   - Sampling
     - Sampling Protocol
     - Whole core vs. Core Plugs

- Core Preservation

- Core Preparation
  - Core Objectives (Why do we need cores?)
  - Core Definitions (Fresh core, preserved core, cleaned core, restored core...)
  - Core Imaging (Photography, X-ray techniques, NMR...)
  - Examples of Core Plans (based on Objectives)
  - Precautions and Best Practice
- Core Cleaning
  - Why to clean the core?
  - How to clean the core? / Types of Solvents
  - Problems and Challenges related to Core Cleaning
  - RCAL Methods for Cleaning Core Samples
    - Retort Cleaner – CO2 Extractor – CO2 Centrifugal Extractors
    - Soxlet Extractor – Dean-Stark Extractor – Flow-Through Cleaner
  - Comparisons between Key Cleaning Methods
  - Key Design Issues (Which Cleaning Method is Optimum?)
- Core Drying
  - Why Core Drying is needed?
  - Methods of Core Crying
  - Key Design and Precautions
  - Recommended Practice
- Saturation Measurements
  - Determining Initial Water Saturation
  - Retort System – Dean-Stark System
  - Precautions and Recommended Practice
- Porosity Measurements
  - Porosity Definition
  - Different Methods to Calculate/Measure Porosity
  - Screens and Wraps (for poorly unconsolidated sample)
  - Direct Measurements of Bulk Volume
  - Grain Volume Estimation (from gas expansion method)
- Permeability Measurements
  - Permeability Definition
  - Basic Darcy Law
  - Bedding Plane and Permeability

- Lab. Methods to Determine Permeability
- Basic Permeameter

3. SCAL Measurements in the Lab.

- Capillary Pressure Measurements
  - Porous Plate/Pressure Equilibrium – Centrifugal Method – Air/brine or Oil/Brine
  - Drainage and/or Imbibition – Mercury Injection
- Electrical Properties Measurements
  - Applications
  - Overview
  - Measurements techniques
- Wettability Measurements
  - Definitions – Background – Why it is important?
  - Lab experiments (Contact Angle, Amott test, and USBM)
  - Alteration of Original Wettability
  - A Few Considerations in SCAL Wettability Measurements
- Relative Permeability Measurements
  - Definitions – What controls relative permeability?
  - Analysis/Measurements Considerations:
    - Steady State / Unsteady State
    - Flow rate
    - Reservoir/Ambient/Elevated Condition
    - Wetting Conditions – Fluids IFT
  - Core Flooding Tests
  - Experimental Factors
  - Centrifugal Method
  - Analysis Conditions
  - Guidelines for Planning a Lab Relative Permeability Test Program

4. Relative Permeability Topics

- Darcy Law
- Sources of Permeability
- Viscosity Effect
- Effective Permeability
- Relative Permeability Definition

- Fundamental Concepts
- Uses of Relative Permeability
- Kr Example
- Common Multi-phase Flow System
- Importance of Relative Permeability Data
- Factors Affecting Relative Permeability Data
- Selecting the Relevant Kr Data
- Averaging Relative Permeability Data
- When you have to care more about Gas-Oil Relative Permeability
- When you have to care more about Water-Gas Relative Permeability
- When you have to care more about Gas-Oil Relative Permeability

5. **Capillary Pressure & Hysteresis Topics**
   - Capillary Pressure
     - Surface Tension effect on Fluid Flow
     - Wettability1
     - Uses of Capillary Pressure
     - Capillary Pressure Concept and Definition
     - Relation between Pc and Sw
     - Fluid Distribution in Petroleum Reservoirs
     - Height vs. Sw relationship
     - Converting Lab Data to Reservoir Conditions
     - Drainage and Imbibition Process
     - Parameters Affecting Pc
     - Effect of Reservoir Rock Types
     - Effect of Layered Reservoir
     - Effect of Interfacial Tension
     - Effect of Reservoir Fluids Density
     - Effect of Pore Geometry
     - Sw Distribution by Capillary Pressure Model
     - High Perm vs. Low Perm Pc
   - Hysteresis
     - Definition
     - Saturation History
     - Drainage Effect

- Imbibition Effect
- Hysteresis Effect
- Scanning Curves

6. **Applied Core Analysis**
   - Overview about Rock Typing Techniques
   - Rock Quality Index (RQI)
   - Flow Zone Indicator (FZI)

7. **Applications of RCAL and SCAL: Important Concepts**
   - Applied SCAL: Potential Net Pay Determination Based on Fractional Flow
   - Applied SCAL: Mobility Ratio Effect on Sweeping Efficiency (Waterflooding)
   - Applied SCAL: Interfacial Tension (IFT)/Wettability Effect of Displacement Efficiency (Waterflooding)
   - Heterogeneity Quantification (Dykstra Parson and Lorenz Coefficient)
   - Averaging technique (arithmetic, geometric and harmonic averaging)
   - Basics of Histograms and Cumulative Distribution Function (CDF)
   - Basics of Enhanced Oil Recovery Techniques & Mechanisms

8. **Post course evaluation**