Fundamentals Enhanced Oil Recovery, a Holistic Approach

Course Description

The Fundamentals of Enhanced Oil Recovery course builds your competence, confidence, and credibility through a strong theorical framework as well as examples, exercises, and case studies discussions designed to consolidate and reinforce learning and identify solutions to specific challenges associated with oil recovery process.

It is well known that large amount oil is still underground after primary recovery and implementation of waterflooding operations. Petroleum companies are looking for techniques to improve volumetric sweep efficiency, minimize the effect of reservoir heterogeneities and mobility ratio to increase final recovery factor and maximize economics.

The EOR methods can grouped into four main categories: chemical, miscible, thermal, and others. This course will provide detailed explanations of the drive mechanisms of each EOR method as well as critical success factors and expected recovery. This Enhanced Oil Recovery training covers the screening criteria required to select the EOR method that best fit the reservoir parameters, geological complexity and recovery expectations.

The expected recovery factor, EOR process maturity, project economics, as well as pro and cons for each EOR method will be discussed during the training. Main reservoir monitoring techniques, well completions strategies, and key performance indicators will be analyzed as a part of the reservoir management of EOR processes. This course covers conventional reservoirs.

Finally, a field development plan approach will be presented as an example of integration of technical, environmental, and economical aspects of EOR methods to increase oil recovery.

The course will be supplemented by practical examples, case studies analyses, group exercises, and interactive group discussion designed to consolidate and reinforce learning and identify and offer solutions to specific problems associated with waterflooding and EOR of oil fields.

Who Should Attend?

This course is designed for professionals with background in Engineering (Petroleum, production, or Chemical), geologist, team leaders, facilities engineers concerned with

waterflooding and EOR processes, and other professionals whom are responsible for maintaining or increasing oil production.

1. Attendants should be familiar with Waterflooding processes

2. Preferably, attendants should have some basic knowledge of reservoir characterization and simulation.

What are the Goals?

By the end of this Enhanced Oil Recovery training course, participants will:

- Understand the importance of reservoir characterization and geologic features on the EOR project success.
- Apply the screening criteria guidelines for selecting candidate's reservoir for EOR projects
- Understand the drive mechanisms related to chemical, miscible, and thermal EOR methods
- Learn how the vertical, areal, and volumetric sweep efficiency can be estimated and how they can be optimized to maximize oil recovery
- Learn key concepts of EOR pilot design based on best practices and lessons learned
- Learn how to estimate fluids injection requirements, incremental oil cost, and fluid treatment before injection
- Understand the Reservoir Management concepts for EOR projects
- Understand the environmental and economic aspects of EOR Methods

What You Will Gain:

1. Understand the screening criteria for gas, thermal, and chemical EOR methods
2. Understand the importance of reservoir characterization and geologic features on the EOR project success
3. Understand the drive mechanisms related to chemical, miscible, and thermal EOR methods
4. Learn how the vertical, areal, and volumetric sweep efficiency are estimated and how they can be optimized to improve oil recovery
5. Learn key concepts of EOR pilot design based on best practices and lessons learned.
6. Identify major risks in EOR implementation and plans for mitigation
7. Prepare reservoir surveillance and monitoring plans, completion technologies and key performance indicators to measure reservoir performance.
8. Learn how to estimate fluids injection requirements, incremental oil cost, and fluid treatment before injection
9. Understand the environmental and economic aspects of EOR Methods
10. Learn best practices and lessons learned from case studies

Training Methodology

The training course will combine lectures (30%) with workshop/work presentations (30%), interactive practical exercises and case studies (20%), supported by video material, software and general discussions (20%)

Course Content

Day 1. Introduction to Enhanced Oil Recovery (EOR)

- History of EOR
- Definitions of Primary, Secondary Recovery and IOR/EOR
- Target of EOR
- Key definitions related to EOR
    - Incremental Oil
    - Vertical, Areal, and Volumetric Sweep Efficiency
    - Mobility Ratio, Residual Oil Saturation and Recovery Factor
- Effect of Reservoir Heterogeneities on EOR processes
    - Dykstra Parson, And Lorenz Coefficients, Koval Factor
    - Injection Patterns, Mobility Control
    - Factors affecting recovery factor

Day 2. Screening Criteria, overview of waterflooding and chemical flooding processes

- Review of EOR screening criteria
- Secondary recovery overview
    - Injection – production patterns
    - Fractional flow, oil Saturation calculation after Water Flooding
    - Displacement efficiency, Buckley – Leverett theory, Welge Method
    - Recovery efficiency of waterflood, worldwide statistics
    - Case studies and best practices
- Chemical Flooding processes
    - Polymer Flooding
        - Physics of Polymer Flooding
        - Dimensionless numbers
        - RF, RRF, Salinity, Effect of Adsorption on Polymer Flooding processes
    - Surfactant flooding
        - Physics of Surfactant Flooding
        - Relative Permeability Curve Considerations
        - Capillary Number, Effect of adsorption on surfactant flooding processes
    - Alkali, Surfactant, Polymer flooding (ASP)
        - Physics of ASP Flooding
        - Guidelines for Designing P, S, and ASP Projects
    - Case studies and best practices

Day 3. Miscible and Thermal Flooding Methods

- Miscible gas injection EOR
    - Phase Behavior overview
    - Minimum Miscibility Pressure
    - Dimensionless numbers
    - Kr and Pc considerations for Miscible Process
    - CO2, N2 , gas injection process overview
    - Miscible WAG overview
    - Guidelines for Designing Miscible Processes
- Thermal EOR
    - Steam Injection overview
    - Thermal properties of water, oil, gas, and reservoir rock
    - Continuous Steam Injection, Cyclic Steam Injection
    - SAGD
    - In Situ Combustion
    - Case studies and best practices

Day 4: Pilot projects, Injection surveillance and monitoring.

- EOR Pilots
  - Pilot objective
  - Pilot design
  - Monitoring plan
  - Consideration for full field implementation
- Data gathering and interpretation
  - Injector and Producer monitoring variables
  - Monitoring dashboards: Hall Plot, Voidage Replacement Factor (VRF), and other Key Performance Indicators
- Saturation measurements, tracers
- 3D and 4D Seismic for Reservoir Monitoring
- Magnetotellurics Methods
- Data Acquisition Plan
- Tunning reservoir simulation models using production, pressure and saturation data

Day 5: Reservoir management of EOR projects. Case Studies

- Reservoir management framework
- Production scenarios definition, criteria for selecting optimum scenario for full field implementation
- FDP uncertainties and decisions analysis overview
  - Risk of implementing EOR processes
  - Mitigation plan of identified risks
  - EOR Planning, from pilot to full field
- Fluid Injection System
  - Injection source analysis, fluid treatment and injection fluid quality control
  - Transport of injection fluids, surface facilities considerations
  - Incremental oil cost analysis
- Environmental and Economic Aspects of EOR Methods
- EOR Variables for Optimization
- NPV Optimization of EOR Processes
- Case Studies Analysis and Discussion