Waterflooding Technologies and Field Practices
(N2/CO2/WAG) Training

Course Price

£3050

Course Description

This course concentrates on Reservoir and field operations aspects of waterflooding injection for pressure maintenance and Secondary Recovery. Study in depth of Fractional Displacement theory and all methods available in the oil and gas industry to predict oil recovery. The course is a theoretical-practical course and is designed as a workshop where the participant has to work hard solving a series of projects to apply immediately the concepts, mathematical principles and theories presented and learned during the course. The participants will use a reservoir engineering software designed for water injection. The software will be provided to each participant without additional cost.

Course Objectives

The main goal of the course is the prediction and interpretation of the detailed behavior of oil and gas reservoir under difference known methods of water injection that enable the Petroleum Engineer to select the correct methods at the right time based in the drive mechanisms and production data of specific reservoirs under consideration.

Who Should Attend

This course is designed for Production, Reservoir Engineers and theirs Supervisors, Chemical Engineers associated with refineries and water handling, Geophysical and Technical field personnel and Service Companies representatives to obtain or increase understanding on waterflooding process and problems associated to field operations.

Course Content

I. Introduction

- Definition of Waterflooding Processes
- Historical Background
II. Review of Determination of Oil in Place

- Determination of Primary Recovery
- Material Balance Calculation
  - Solution Gas Drive Reservoirs
  - Water Drive Reservoirs
  - Gas Cap Reservoirs
  - Combination Drive reservoirs
- Volumetric Methods
  - Solution Gas Drive
  - Gas Cap Drive
  - Water Drive Reservoir
- Decline Curve- Determination of Primary Recovery
- Empirical Methods for Estimating Primary recovery

III. Microscopic Efficiency of Immiscible Displacements

- Principles governing Fluid and Rock Interactions
- Wettability
- Capillarity Pressure
- Methods of Inferring Fluid Distribution in Porous Media
- Interpretation of Capillary Pressure data.
- Principle of Multiflow in porous media
- Relative Permeabilities for Drainage and Imbibition Processes
- Validity of Darcy’s Law for Multiple flow
- Exercises and Examples
- Problems to be solve using Computer application by the students.

IV. Assessing the Prospect for Water Injection

- Standard rules to select a Prospect for Water Injection:
  - Oil Saturation
  - Water Saturation at the start of the project
  - Relative Permeability curves: Favorable or unfavorable
  - Permeability Stratification, type Porosity
  - Natural Fractures in the reservoir
  - Initial Gas saturation
  - Mobility ratio and Oil Viscosity
  - Water Supply, treatment and cost
  - Available Wells Conditions
  - Formation Depth
  - Structural Relief
  - Water Compatibility and future problems with Scales
  - Clay Swelling
  - Primary Recovery Mechanism
  - Reservoir Data Available
  - Additional cost for Drilling and Recondition wells
V. **Flood Pattern and Coverage**

- The Basic Flooding Networks
- Injection Beyond Breakthrough and effect of Mobility ratios
- The five-spot well Network
- Pilot Flood
- Directional Permeabilities
- Natural and induced Fractures
- Problem and Solutions

VI. **Immiscible Fluid Disp. Mechanisms**

- The Fractional Flow Equation
- The Rate of Advance Equation
- Stabilized Zone Concept
- Practical Use of Frontal Displacement
- Application of Frontal Displacements
- Problems and Solutions.

VII. **Predicting the Water Injection Performance**

- The Frontal Advance Method- The linear system
- Performance before Breakthrough
- Performance after breakthrough
- Condition for the formation of Oil Bank
- Waterflooding Calculations: Viscous Fingering Method
- Stratified Reservoir- Stiles Method
- Dystra-Parson Method
- Waterflooding Performance Calculation
- Calculation Methods
- Use of Computer Software for Waterflooding Calculations
- Vertical Displacements and Areal Model / Theory
- Problems on Areal Model to be solved using Computers by students

VIII. **Pressure Analysis In Injection Wells**

- Pressure Fall-off Analysis, Liquid filled reservoirs
- Variable Rate Test
- Hall Plots Application and Analysis for Injection well performance
- Water Injection Profiling:
  - Radioactive Surveys
  - Temperature Profiling
- Prediction Injection Rates in Injection Well (Injectivity Index)
- Case Study Discussion

IX. **Water Injection Operations**
• Waterflooding Injection Well Management Control
• Oil Production at the kick, Peak and breakthrough
• Water Treatment Efficiency
• Potential for Scaling Problems in the water Injection System

X. Chemical Water Analysis Pattern and Water Selection, Water treatment for Injection

• Selection of Water Sources
• Estimation of Water requirements
• Source Water Quality
• Analyzing compatibility of the Water
• Chemical Water Analyze Patterns
• Water Treatment for Injection System

XI. Nitrogen/Co2 Injection As Tertiary Recovery After Water Injection Has Finished Or Alternating Wag (Water Alternating Gas)

• Advantage of Nitrogen AND CO2 Injection Gas
• Performance before Gas Breakthrough and After
• Predicting Nitrogen/CO2 Injection Oil recovery
• Laboratory results and discussions

XII. Conclusions and Discussion

XIII. Final Test

CPD Unit

Continuing Professional Development

35 HOURS CPD