# N956: Enhanced Oil Recovery using CO2: Techniques, Practices and Simulation

Format and Duration
Classroom - 3 Days

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## Summary

This course provides clear, concise and practical information for understanding, simulating and implementing carbon dioxide recovery projects. Case studies are used to demonstrate a variety of evaluation and predictive techniques using experimental, analytical and numerical methods. Operational aspects including transportation, injection, separation, reinjection and corrosion are discussed.

## Learning Outcomes

Participants will learn to:

1. Judge the technical reasons for the recent increase in gas injection operations in the US.
2. Implement EOR screening.
3. Assess the merits of lean-gas and enriched-gas injection operations.
4. Characterize the nature of miscible and immiscible flooding.
5. Select laboratory tests and screening for pilot design.
6. Assess minimum miscibility and injection pressure of a CO2 injection operation.
7. Predict the effects of hydrodynamic instabilities on the oil displacement front.
8. Estimate recovery efficiency of a CO2 injection using analytical viscous fingering models.
9. Create a compositional equation of state model for simulation of CO2 injection.
10. Optimize a CO2 injection operation using simulations.
11. Evaluate and address operational aspects of CO2 projects.

## Training Method

A three-day classroom course, with time equally divided among lectures, case studies and computer-based practical exercises.

## Who Should Attend

The course is designed for mid to senior level engineers as well as engineering managers looking for a detailed understanding of CO2 processes.

## Course Content

The course will help engineers understand, simulate and practice the major enhanced oil recovery techniques. The course involves projects that are designed to practice the oil recovery techniques using analytical, statistical and numerical simulation models. The numerical approaches are using CMG GEM (equation-of-state compositional simulator), and STARS (three-phase multi-component thermal simulator).

### Topics Covered

#### 1. Introduction

- Review of Enhanced Oil Recovery (EOR) Techniques

- EOR Screening and identification of candidate reservoirs for CO2 injection
- Current Status of EOR Projects in the US

### 2. CO2 Process Facilities

- Oil production and processing facilities
- Corrosion management in oil production and processing operations
- Gas gathering systems
- CO2 surface facilities

### 3. CO2 Injection Considerations

- Locating the source
- Sub-critical and super-critical CO2
- Completion design
- Conformance control
- Gravity control
- Well testing

### Fundamentals - Immiscible Oil and Gas Displacement

- Recovery efficiency concept
- Microscopic displacement efficiency
- Macroscopic displacement efficiency

### 4. Fundamentals - Miscible Oil and Gas Displacement

- First-contact and multiple-contact (dynamic) miscibility; ternary-diagrams; condensing and vaporizing gas drive processes
- Miscible fluids and dispersive mixing; mixing cell theory
- Viscous fingering: initiation, growth and modeling

### 5. Miscible Gas Injection Methods

- Hydrocarbon gas (lean and enriched)
- Inert gas (air, nitrogen and CO2)
- Acid gas

### CO2 Injection Methods

- Single-well cyclic stimulation
- Injector-producer well patterns and flooding
- Water-alternating-gas (WAG)

### 6. Laboratory Tests for Gas Injection

- Hele-Shaw experiments
- PVT analysis and CO2-hydrocarbon phase behavior predictions
- Slim-tube experiments
- Flooding experiments

### 7. Reservoir Simulation CO2 Enhanced Oil Recovery

- Introduction to Petroleum Reservoir Flow Simulation
- Five-spot well pattern simulation projects:
  -CO2 flooding
  -Conversion into enriched gas using hydrocarbons
  -Conversion into thermal/solvent injection
  -Economic Evaluation

### 8. CO2 Injection into Unconventional Resources

- CO2-enhanced coalbed methane recovery
- CO2-enhanced organic-rich shale gas and oil recovery
- CO2 injection into natural gas hydrate resources

### 9. Environmental Considerations into CO2 Injection

- EOR as a CO2 sequestration method

### 10. Future of EOR and CO2 Applications