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## N954: Practical Approaches to Increased Recovery

Instructor(s): Andy Woods, Pete Smith and Guest

Format and Duration

Classroom - 3 Days

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### Summary

Alongside conventional techniques such as drilling additional wells and water and gas flooding there are many other recovery methods that need to be evaluated. The physics governing the effectiveness of various recovery methods (e.g. polymer flooding and microbial enhanced oil recovery) is illustrated in relation to experiments and simple modelling. The applicable conditions (simple screening criteria) are presented together with field examples to give a staged approach to understand the potential of Advanced Recovery methods in various situations.

### Learning Outcomes

Participants will learn to:

1. Evaluate the physics governing the effectiveness of various recovery methods.
2. Develop a framework where conventional increased recovery methods can be compared with novel enhanced recovery methods from the standpoints of economics and increased reserves.
3. Appraise simple laboratory scale experiments to understand the physics of fluid flow through various types of heterogeneities.
4. Evaluate the impact of various geological settings by reference to first order modelling assumptions.
5. Screen out non-viable Advanced Recovery schemes using the binary indicator method.
6. Assemble and perform analytical performance indicator screening tools.
7. Evaluate the uncertainty of potential methods due to geological variability.
8. Design and evaluate the economic benefit of a potential Advanced Recovery scheme.

Participants will also have gained a fundamental understanding of the physical processes of fluid-flow that underpins the approach.

### Training Method

This is a three-day classroom-based course with worked examples, case studies, exercises and discussion. The course includes micro-scale examples to see practical illustrations of the important physical processes.

### Who Should Attend

The course is designed for mid to senior level engineers, production geoscientists and subsurface managers.

### Course Content

#### 1. Introduction

- What are the challenges of recovering Oil and Gas?
- The need to understand the physics of fluid-flow
- The impact of the geological setting
- The economics of the various schemes

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### 2. Physics of Enhanced Oil and Gas Recovery schemes

- Using 1st order modelling tools to understand fluid-flow in heterogeneous reservoirs
- Impact of low permeability barriers and high permeability thief zones
- What happens when fluids come into contact with baffles that disperse flow; acid formation and dissolution and precipitation
- Motion of a buoyant plume of CO<sub>2</sub>

### 3. Preliminary Screening

- Reservoir properties, e.g., the Depth, Net Thickness, Dip, Lithology, Fracture Intensity, Vertical Heterogeneity, Lateral Heterogeneity
- Fluid/reservoir properties, e.g., Horizontal Permeability, Porosity, Temperature, Oil Gravity, Oil Viscosity, Acid number
- Development properties, e.g., initial and current pressure, Oil Saturation, Well Spacing, Aquifer strength, Gas cap size
- Determine whether the potential scheme, e.g., polymer flooding, microbial enhanced oil recovery, deep diversion technology (gels of different kinds), surfactant flooding, low salinity water flooding, gas injection, water-alternating-gas (WAG) and Foam-Assisted-WAG, can immediately be excluded

### 4. Screening: estimated performance based upon:

- Classical reservoir engineering techniques
- Layer cake model
- Gravity viscous balance
- Sweep efficiencies
- Miscibility pressures

### 5. Field Examples (depending upon availability)

- Polymer injection test at Heidrun field (Statoil)
- Sodium silicate system for water diverging at the Snorre field (Statoil)
- Dukhan Arab – C multiple tracer test (BP/QGPC)
- CO<sub>2</sub> Injection Screening of Abu Dhabi Onshore Oil Reservoirs (ADNOC)
- JPT studies on the efficacy of EOR methods

### 6. Uncertainty Analysis

- Analysis of the performance indicators given distributions for reservoir properties
- The use of tracer and pilot tests to examine the geological heterogeneity prior to going ahead with field-scale implementation
- Techniques to estimate the probability and impact of the potential of Enhanced Oil and Gas Recovery schemes

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### 7. Cost/Benefit Analysis

- Economic benefit of Advanced Recovery schemes illustrated with worked examples