Intelligent Wells & EOR

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EORI, 10-11/Sep/2012; Jackson Hole, Wyoming
1st Generation

Low-Angle

High-Angle

Multilateral
Natural Gas-Lift*

*Al-Kasim et al (SPE 77660)
*Betancourt et al (SPE 74391)
Commingled Production

*Lucas et al (SPE 71828)
*van Delden et al (SPE 71824)
Commingled Injection

*Gajraj et al (SPE 74392)

With Flow Control

Time (days)

Without Flow Control

Time (days)

80%

20%
Commingled Injection*

Without Flow Control: Two 3½” Tubing Strings

With Flow Control: One 4½” Tubing String

B = High Perm, Low Press

Gajraj et al (SPE 74392)
Commingled Injection – WAG*

WATER Cycle

GAS Cycle

Identical Layers

60%

40%

50 - 50 Split

Identical Layers

45%

55%

55%

45%

Gajraj et al (SPE 74392)
Passive Control

Liner Completion

ICD Completion
Low Pressure Interval

\[ \Delta P = 1200 \text{ psi} \]

Pore Pressure Log

*Frank et al (SPE 87091)
High Mobility Interval

- $k/\mu$ (md/cp)
- Water Sat. ($S_w$)
- Porosity ($\phi$)
- Measured Depth, 1000 ft

Graphs showing mobility and pore pressure (PP) logs.
High Drawdown Intervals

Bed Boundary Log

TVD, ft

Measured Depth, ft

Highest Drawdown

Lowest Drawdown

Pay thickness variability

Relative frequency, %

Reservoir thickness, ft

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

x 1000 x 2000 x 3000 x 4000 x 5000 x 6000 x 7000

0 2 4 6 8 10

Relative frequency
High Injectivity Interval

Water Injector with Fiber Optic Distributed Temperature Sensors (DTS)

Initial temperature

Near-Zero Injectivity!

*Bui et al (SPE 89924)
Importance of Injection Control

Importance of Injection Control

- Primary Recovery
- Secondary Recovery
Importance of Injection Control*

Basic Message

• Injection control remains a key challenge for all assisted recovery operations, EOR included.

• One part of the solution consists in use of controllable wells for injection purposes; the other is in control of injection fluid mobility in the reservoir.