

RECOVERY FUNDAMENTALS

Depletion | EOR
 IOR

DEPLETION

- Initial Reservoir Pressure
- Initial Solution OGR (GOR)
- Initial "OIL FVF" $\left(\frac{B_{oi}}{R_O} \text{ or } \frac{r_{si}}{R_G} \frac{B_{gd}}{B_{di}} \right)$
- Total Water Volume (AQR, NGR, Swc)
- PVT: Oil c_o | Oil Shrinkage
 Gas c_g (B_g) } μ
- LNX (# RFUs) Contrast. in RFU $\underline{\underline{D}} = \left[\frac{(\frac{kh}{B+S}) \frac{\Delta p}{h}}{hCPV} \right]_{RFU}$
- Rock Compressibility ("high" β_{ri}) / Solution Drive
- Gas-Oil Relative Permeabilities (R_O SED) / Gas Drive



EOR

① - Volumetric Sweep ("Conformance") "Macroscopic" Sweep

- Vertical (layering)

$k_h(z)$, gravity ($k_v(z)$)

Orders of magnitude variation $k_h(z)$

- Areal

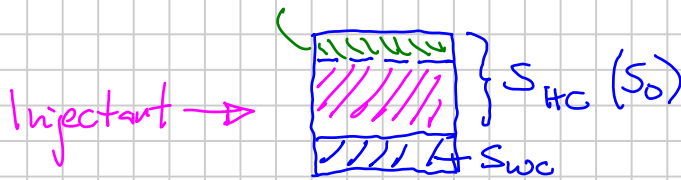
- Well placement ("pattern")
- Well type
- (k_x k_y anisotropy)

② Microscopic Sweep "Pore-level" - "-"

In the volumetrically swept volume

Residual Oil +

S_{or} where $k_{ro} \rightarrow 0$



Buckley-Leverett 80%.
1942

$$S_{oi} = 1 - S_{wc}$$

at BT Inj

S_{oi}

Keep injecting
Many (∞) PVs

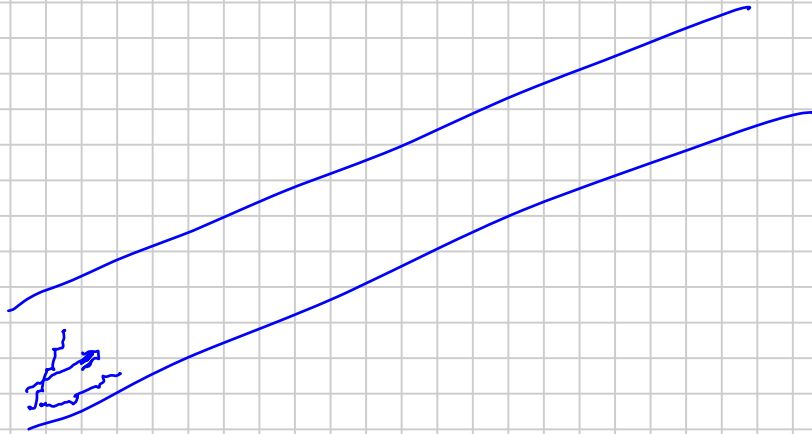
$S_{of} > S_{orw} = 25\%$

S_{orw}

- Oil-Water wettability
- Pore size distribution (k_{rw} & k_{ro})

- Gravity v_z strong

$$S_{oi} \rightarrow S_{or}$$



(a) BL: Immiscible, Equilibrium
O-W O-G

$$S_{oi} \rightarrow S_{of} \rightarrow S_{or}$$

(b) Non-Equilibrium Gas-Oil Displacement (Complex PVT)

- Pore-level $RF_0 = 100\%$
- Develop "Miscibility" $S_{org} \rightarrow 0$ 100% RF ^{microscopic}
 - Vaporizing Gas Drive (VGD)
 - Gas inj in a Gas Condensate R
 - Gas inj in an Oil R, (10%)
 - High p_{inj} , light oils, lean C₁-rich inj gas
 - Condensing/Vaporizing Gas Drive (90%)
Aaron Eick 1986

- Immiscible (Swelling | Vaporizing)

$$S_{org} \text{ from } (S_{org})_{BL} \rightarrow 0\%$$

$\underbrace{\quad\quad\quad}_{BL}$
 25% $\left\{ \begin{array}{l} \text{inj gas} \\ \text{20} \\ \text{10} \end{array} \right.$

Many PVs of gas passing over the oil

