Note Title 3/13/2017

CONSTANT VOLUME DEPLETION (CVD)

- Ch. 6 | Whitson-Torp SPE paper ~1983

- Introduction to / Method for Calculating "Modified" Black-Oil PVT Tables (standard Today)

  Ch. 7 Black-Oil PVT

$$\underbrace{\frac{v_g}{v_o}} = \frac{k_{rg}/\mu_g}{k_{ro}/\mu_o} = \frac{k_{rg}}{k_{ro}} \frac{\mu_o}{\mu_g}$$

$\frac{\mu_o}{\mu_g}$ — PVT, Rock, PVT

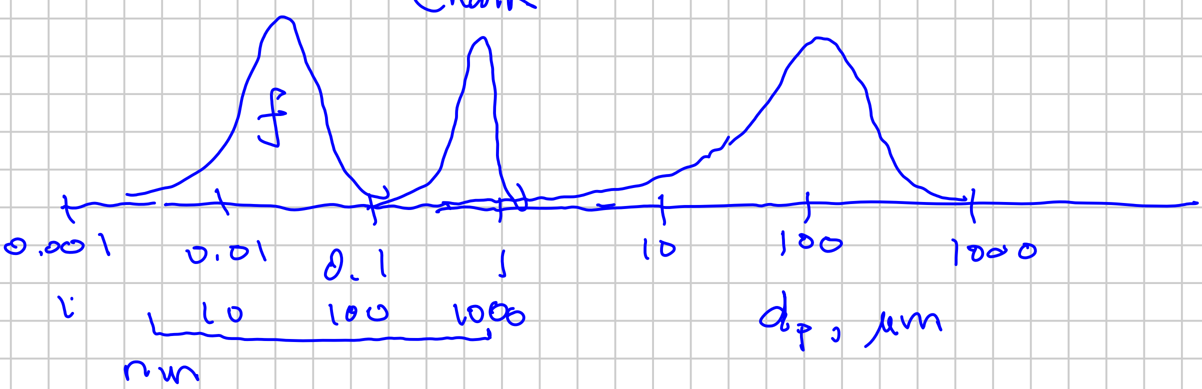
$$S_o = \frac{V_{po}}{V_p} \sim \frac{B_{od}(p)}{B_{od,b}}$$

$$S_g = \frac{V_{pg}}{V_p} \sim (R_{sd,b} - R_{sd}(p)) \cdot B_g(p)$$

$$k_{rg} \simeq S_g^{n_g}, \quad n_g \sim 3\text{-}5 \qquad k_{ro} \sim S_o^{n_o}, \quad n_o \sim 3\text{-}5$$

Corey-Type Equations

saturation
n = exponents } = f (pore size distribution)

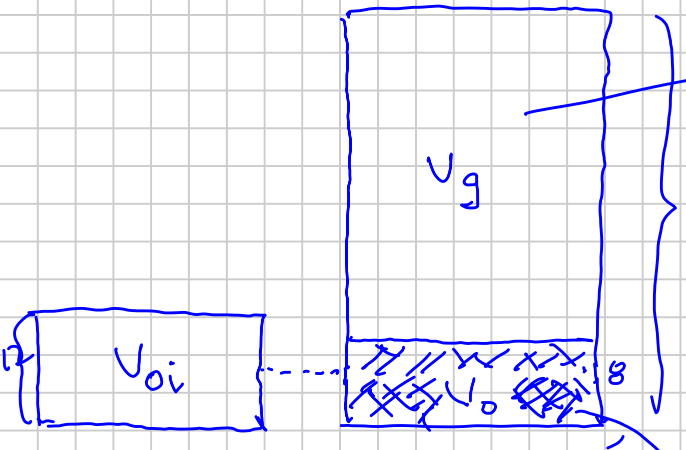


$\rho_o \quad \mu_o \quad \Delta V_{ro}$
$\rho_g \quad \mu_g$ } ~ independent @ p on process of depletion

Reservoir Gas contains STB

$(6-5.3)\cdot 10^9$ STB

$\{\{0.7\cdot 10^9$ STB IN SOLUTION$\}\}$



7000 psia   3500 psia

$V_{oi} = 12\cdot 10^9$ RB

$V_{\bar{o}i} = 6\cdot 10^9$ STB

Surface Oil STO

C_{5+} = STB

$V_{\bar{o}} = 5.3\,10^9$ STB

$V_{\bar{o}} = \underbrace{8.0\cdot 10^9\ RB}_{V_o @ 3500} \cdot / (1.5\ RB/STB)$

$B_o^{3500} = B_{od}^{DLE\ 3500} \cdot \dfrac{B_{ob}^{SEP}}{B_{od,b}^{DLE}} \approx 1.5\ \dfrac{RB}{STB}$

$8\cdot 10^9$ bbl

$= \dfrac{V_o^{3500}}{V_{\bar{o}}} = 1.5$

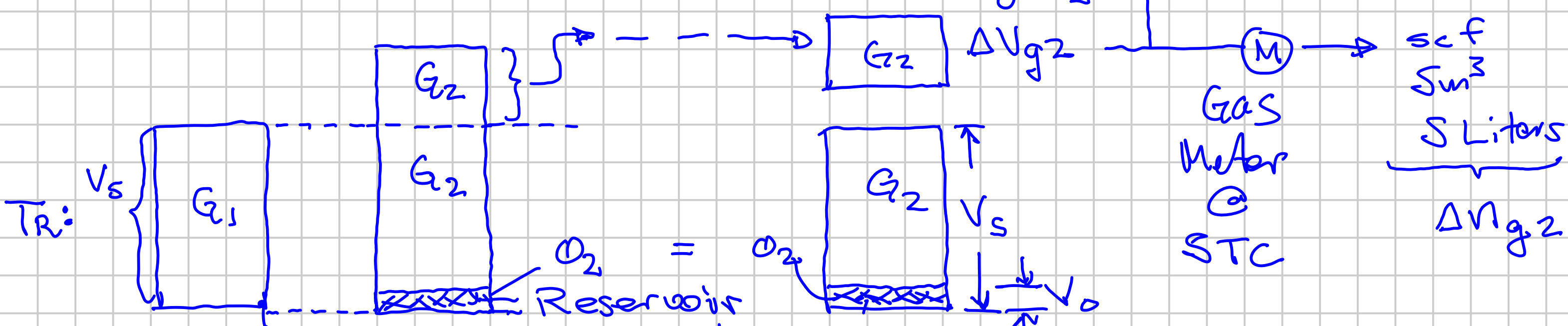
Surface Process of R. Oil @ 3500

$\{T_R, p_2, \Delta V_{g_2}(T_R, p_2), \Delta n_{g2}\} \Rightarrow (Z_g)_2$

CVD Test

(γ_{7+}, M_{7+})

$(y_i)_2$ G.C.



Reservoir Condensate Identical

$G_2 - O_2$

Thermodynamic Equilibrium!

$p_1 = p_s$ > p_2

DP (p_d) 95%   BP (p_b) 5%

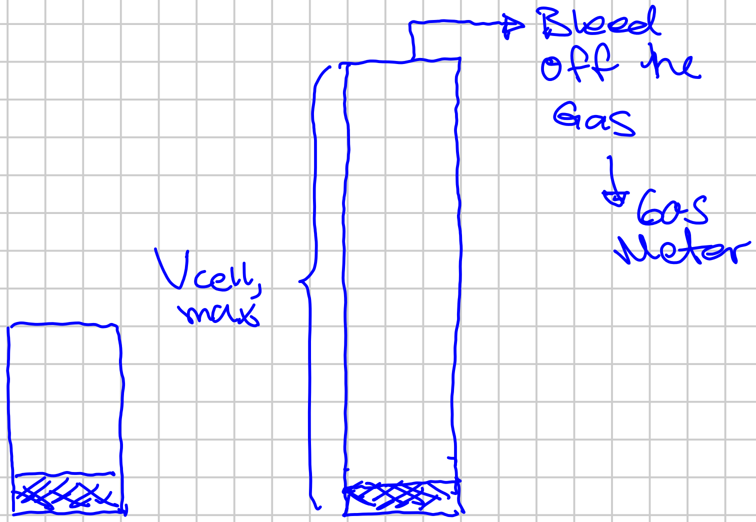
Stage 2

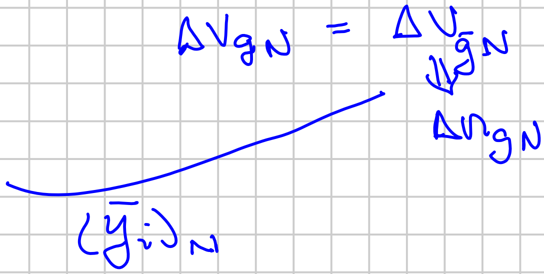
⋮

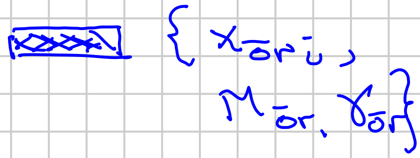
6–8 stages (repeated)

(N−1) th Stage ~ 15–50 bar

T_R

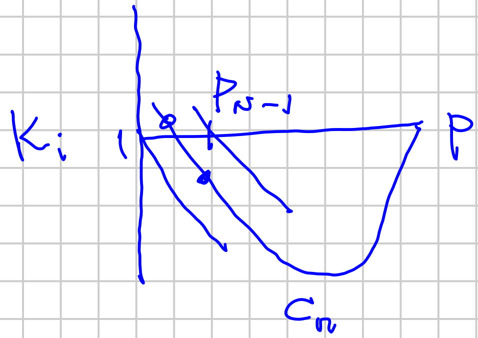


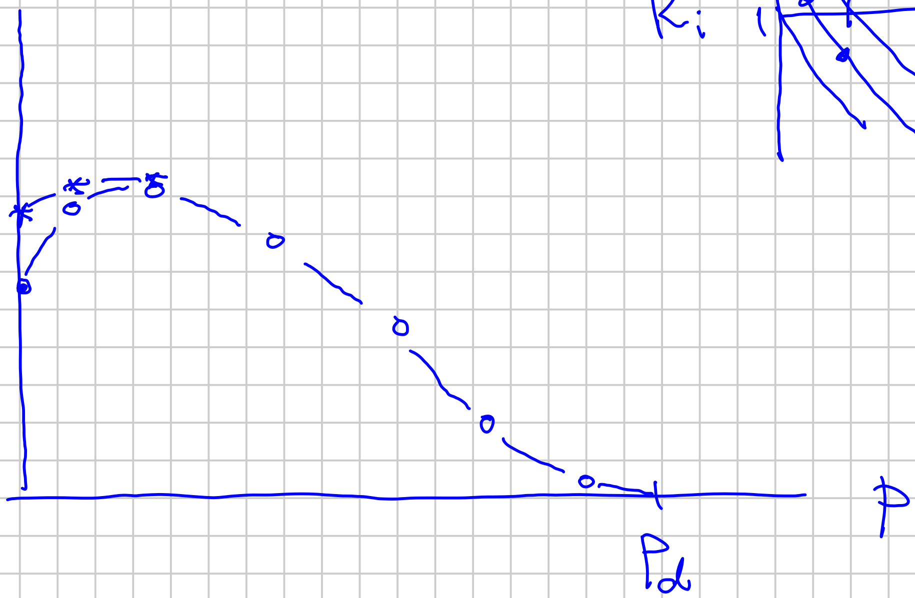




p_{N-1} $p^* > p_N$ $p_N = 1$ atm

50   32 bara





Modified Black-Oil PVT

GAS PHASE

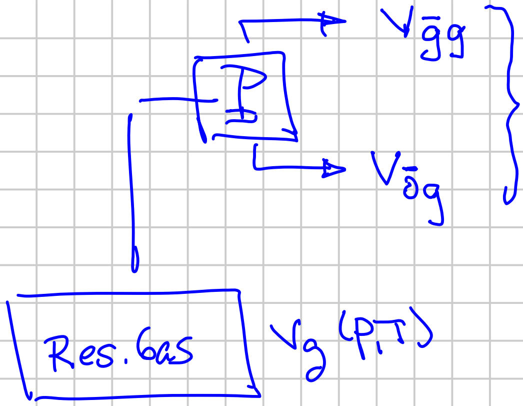
p	B_{gd}	r_s
	Dry Gas FVF	

B_{gd}

↑

"dry"

Reservoir Gas that has been processed



$$r_s = \frac{V_{\bar{o}g}}{V_{\bar{g}g}}$$

OGR

into Surface Condensate (STB)

and Surface Gas, "dry gas"

$$B_{gd} = \frac{V_g(p,T)}{V_{\bar{g}g}}$$

Difference

1% – 20%

≠

$$\frac{p_{sc}}{T_{sc}} \frac{T_R Z_s}{p} = B_g \quad \text{text books}$$

$n_{\bar{g}} = n_{gR}$

$n_{\bar{o}g} = 0$