Note Title 3/1/2016

# BLACK-OIL PVT (Ch. 7) Mandatory 7.1–7.3 (7.4)

* Two Components: $\bar{g}$ $\bar{o}$

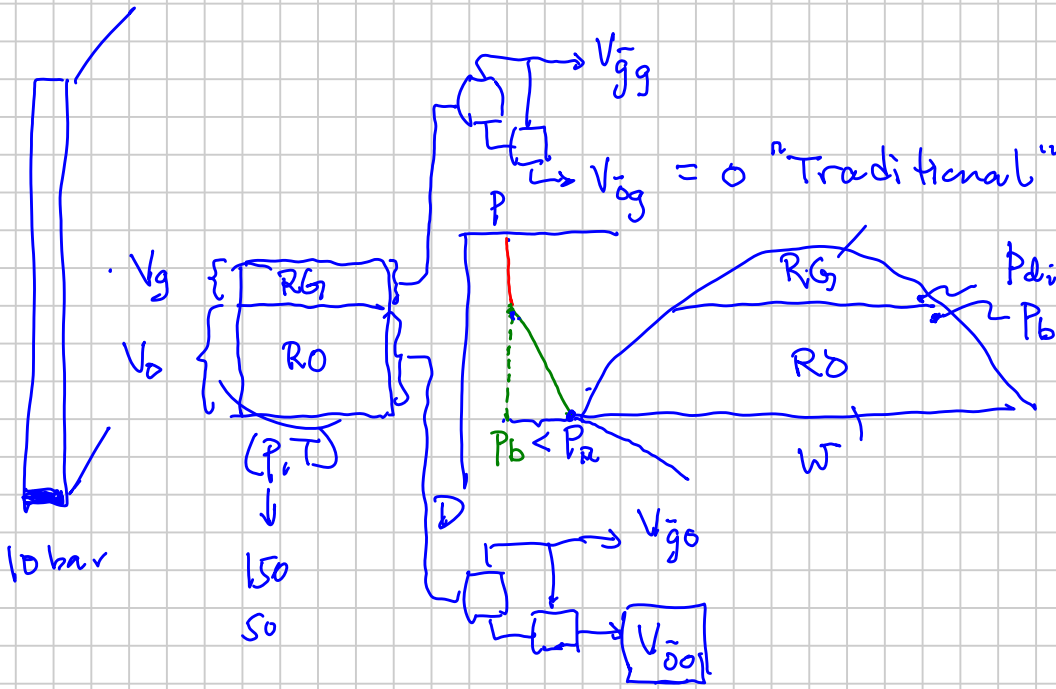
| surface gas | surface oil (STO) |
|---|---|
| SG | SO |

* Quantify amounts in surface-condition volumes (1 atm, 60°F)

* Describe:

Gas Phase @ $(p,T)$ $\rho_g$ $\mu_g$ $y_i$ $\frac{V_{\bar{o}g}}{V_{\bar{g}g}} = r_s$ OGR $\Big|$ $B_g = \frac{V_g(p,T)}{V_{\bar{g}g}}$

Oil Phase @ $(p,T)$ $\rho_o$ $\mu_o$ $x_i$ $\frac{V_{\bar{g}o}}{V_{\bar{o}o}} = R_s$ GOR $\Big|$ $B_o = \frac{V_o(p,T)}{V_{\bar{o}o}}$




FVF / $(T_R)$ Formation Volume Factors

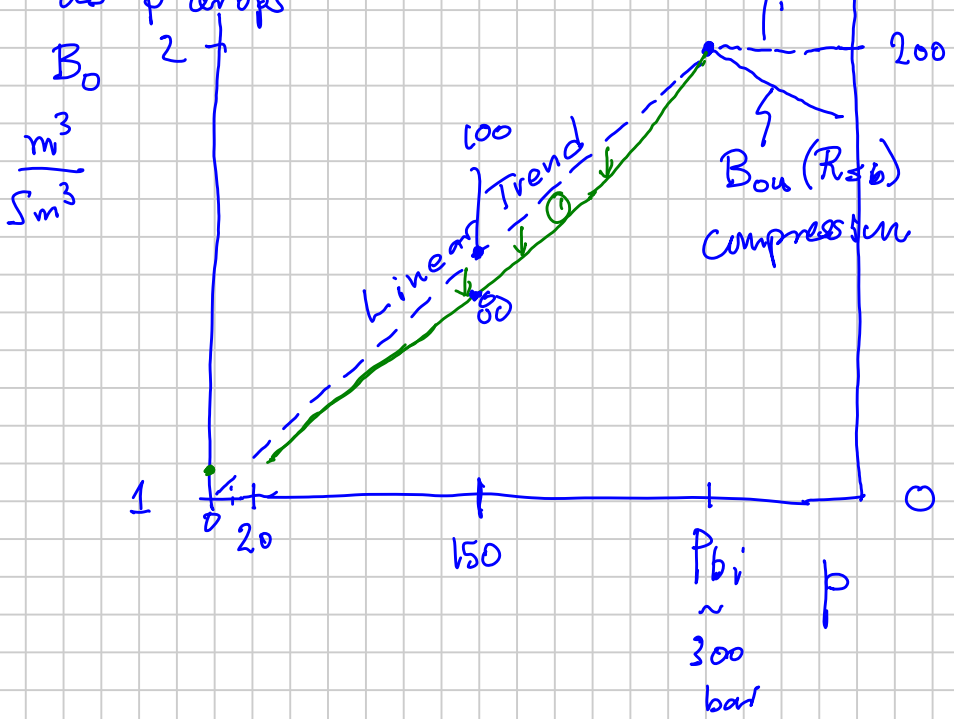
What is a Black-Oil PVT Table?

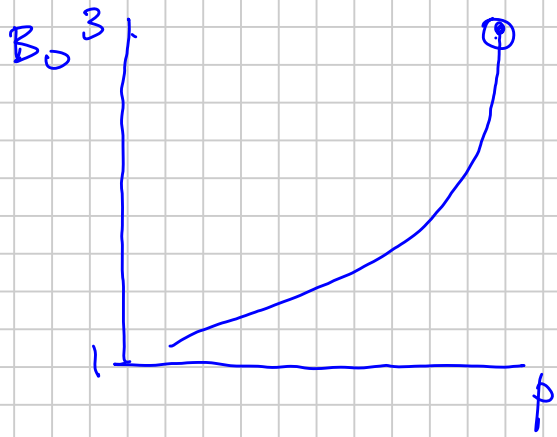
T

| Oil Phase | | | | | Gas Phase | | |
|---|---|---|---|---|---|---|---|
| $p_{bara}$ | $\mu_o$ cp | $B_o \frac{m^3}{Sm^3}$ | $R_s \frac{Sm^3}{Sm^3}$ | p | $\mu_g$ cp | $B_g \frac{m^3}{Sm^3}$ | $r_s$ [$Sm^3/Sm^3$] |
| $P_{bi}$ | 0.2 | 2.0 | (200) | $P_i$ | 0.025 | 1/250 | $500 \cdot 10^{-6}$ |
| Saturated | | | | | Saturated | | |
| $p_b = 150$ | | | | | | | |
| 10 | | (?) | (?) | | | | (1/10) |

The Shrinkage @T of the oil because gas is coming out of solution as p drops

Remaining Gas in Solution in the Oil @ (p, T)

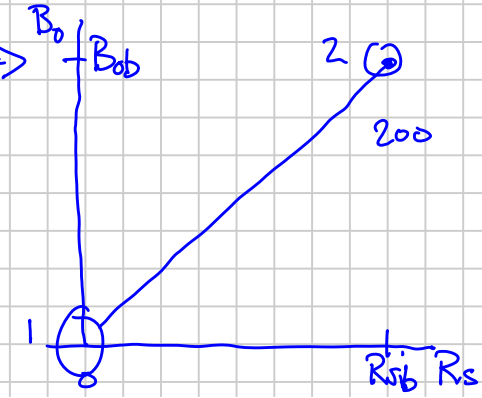


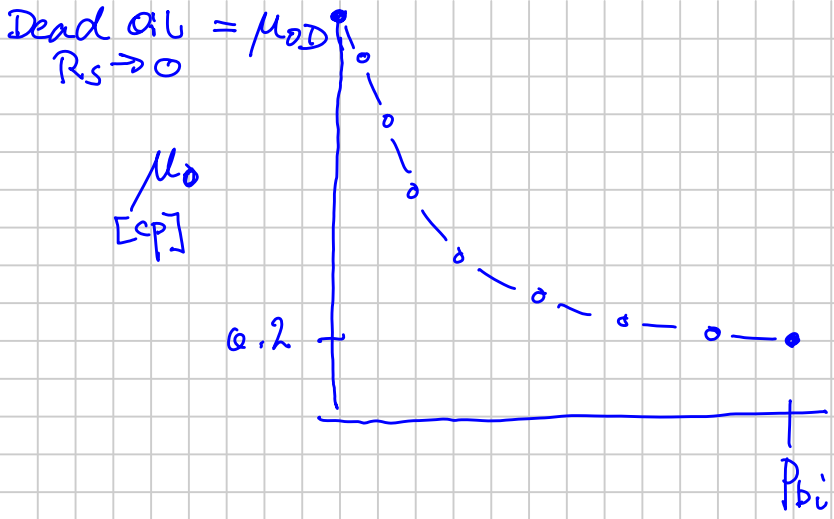




① Downward trend in $B_o(p)$ due to gas coming out of solution

② Larger deviation below the linear trend,
⇒ "Volatile" oil, i.e. the faster gas comes out of solution per bar pressure drop

③ Shape of $B_o(p) \equiv R_s(p)$ ⇒






How to get oil density $\rho_o$?

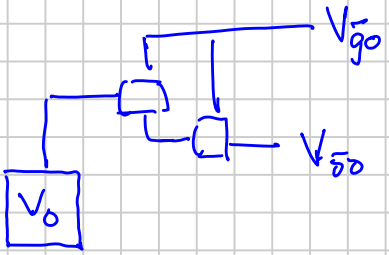
From $R_s$, $B_o$

$V_{\bar{g}o} / V_{\bar{o}o}$ ; $\frac{V_o(P,T)}{V_{\bar{o}o}}$

$$\rho_o(P,T) = \frac{m_o}{V_o(P,T)} = \frac{m_{\bar{g}o} + m_{\bar{o}o}}{V_o(P,T)} = \frac{\frac{V_{\bar{o}o}}{V_{\bar{o}o}} R_s \rho_{\bar{g}o} + \frac{V_{\bar{o}o}}{V_{\bar{o}o}} \cdot \rho_{\bar{o}o} \cdot \frac{1}{V_{\bar{o}o}}}{\frac{V_o}{V_{\bar{o}o}}}$$

$$= \frac{R_s \rho_{\bar{g}o} + \rho_{\bar{o}o}}{(V_o / V_{\bar{o}o})}$$

$$\rho_o = \frac{R_s \rho_{\bar{g}o} + \rho_{\bar{o}o}}{B_o}$$




$$B_o \equiv \frac{V_o}{V_{\bar{o}o}}$$

$$R_s \equiv \frac{V_{\bar{g}o}}{V_{\bar{o}o}}$$

BO PVT Table

$\rho_{\bar{o}o}$ = const

$\rho_{\bar{g}o}$ = const

needed ↑ $\rho_o$

$$m_{\bar{o}o} = V_{\bar{o}o} \cdot \rho_{\bar{o}o}$$

@ S.C. @ S.C.

$$m_{\bar{g}o} = V_{\bar{g}o} \cdot \rho_{\bar{g}o} = V_{\bar{o}o} \cdot R_s \cdot \rho_{\bar{g}o}$$

Ch. 7 $\rho_{\bar{o}o}(p)$ igured $\rho_{\bar{o}o}$ = const

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Saturated Oil Phase $B_o(p)$ $R_s(p)$ $\mu_o(p)$.

Undersaturated Oil Phase

① Know what is the oil $p_b$ (or $R_s$ value)

② At $p > p_b$, $R_s$ = constant

③ $m_{ou} = m_{os}$

$V_{ou} < V_{os}$ $V_o$

$(V_{\bar{o}\bar{o}})_u = (V_{\bar{o}\bar{o}})_s = V_{\bar{o}\bar{o}}$

$$B_{ou} = \frac{V_{ou}}{V_{\bar{o}\bar{o}}} < \frac{V_{os}}{V_{\bar{o}\bar{o}}}$$

1.9x 2