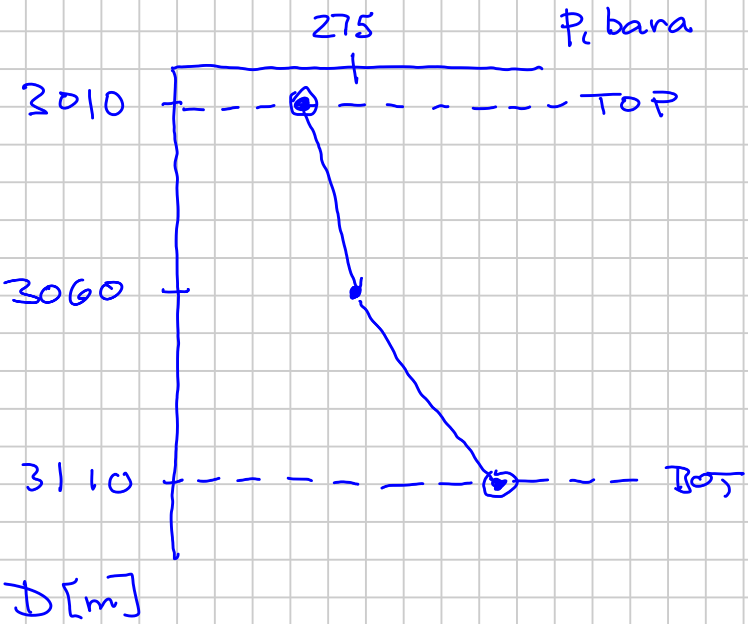


$$\rho_g \rightarrow p_g(D)$$

$$\rho_o \rightarrow p_o(D)$$

$$p_o^{BOT} = p_{GOC} + \underset{\sim \rho_{ob}}{\rho_o}\, g\, (D_{BOT} - D_{GOC})$$

$$p_g^{TOP} = p_{GOC} + \underset{\rho_{gd}}{\rho_g}\, g\, (D_{TOP} - D_{GOC})$$

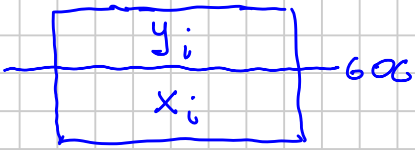
$$\rho_{ob} = \frac{\rho_{\bar{o}} + \rho_{\bar{g}} R_{sb}}{B_{ob}}$$

$$\rho_{gd} = \frac{\rho_{\bar{g}} + \rho_{\bar{o}} r_{sd}}{B_{gd,d}}$$

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

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

D. Assume the reservoir fluids consist of two “components”, *surface gas (SG)* and *surface oil (SO)*. If the SG composition in the reservoir oil is 60 mol-%, it’s K-value is 1.662, calculate the molar compositions (mol-% SG and mol-% SO) of the GOC reservoir gas and reservoir oil, and the K-value of the surface oil.



$$x_{\bar{g}} \approx x_{SG} = 0.6 \qquad x_{SO} = x_{\bar{o}} = 1 - 0.6 = 0.4$$

$$K_{SG} = K_{\bar{g}} = \frac{y_{\bar{g}}}{x_{\bar{g}}} = \frac{y_{\bar{g}}}{0.6} = 1.662 \text{ @ } T_R, P_R$$

$$y_{\bar{g}} = 1.662 \cdot 0.6 = 0.9972$$

$$y_{\bar{o}} = 1 - y_{\bar{g}} = 0.0028$$

$$K_{\bar{o}} = \frac{y_{\bar{o}}}{x_{\bar{o}}} = \frac{0.0028}{0.4} = 0.007$$

$$z_i = f_{RG}\, y_i + (1 - f_{RG})\, x_i \Leftarrow$$

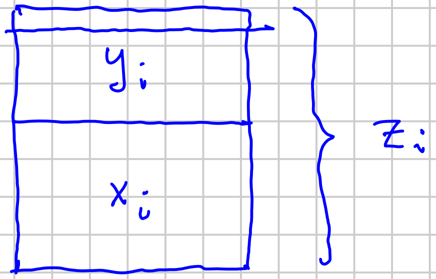
$$f_{RG} = \frac{n_{RG}}{n_{RG} + n_{RO}}$$

$$n_{RG} = V_{RG} \cdot \rho_g / M_g \quad (y_i)$$

Likewise for RO

$$M_g = y_{\bar{g}} M_{\bar{g}} + (1 - y_{\bar{g}}) M_{\bar{o}}$$

$$\text{Cragoe: } M_{\bar{o}} \approx \frac{6084}{API - 5.9}$$



$$x_i < z_i < y_i$$

CVD Test:

Gas Volumetric Material Balance (traditional)

YouTube video 27 min

$$\frac{p_R}{Z_{gR}} = \left(\frac{p_{Ri}}{Z_{gRi}}\right) \cdot \left[1 - \frac{G_p}{G}\right]$$

G_p = cum. surface gas prod.

G = initial surface gas in place

$$HCPV_g = \text{constant}$$

⇒ Define in CVD report "Z_2" (not physical quantity)

Two-Phase Z-factor

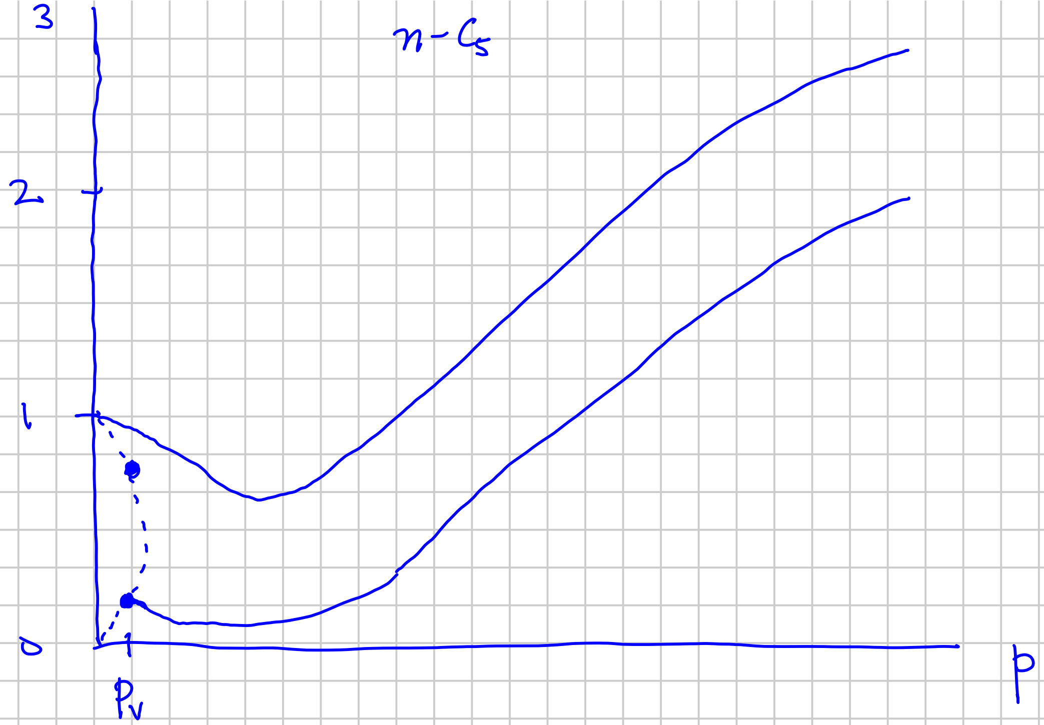
$$p < p_d$$

$$Z \equiv \frac{pv}{RT} = \frac{pV}{nRT}$$

Ideal Gas Law: $Z = 1$

$$\rho = \frac{m}{V} = \frac{pM}{RTZ}$$

$T = 15°C$



Z_g in gas condensate

$Z_g(y_i, p, T)$

$\downarrow$

<u>Best Est.</u> $\underline{\underline{P_{pc}}}$, $\underline{\underline{T_{pc}}}$

Approx Est $P_{pc}\ T_{pc} = f(M_g)$

y_i @ Res. Cond. $\longrightarrow$ $\boxed{P}$ $\rightarrow \bar{g}$, $\rightarrow \bar{o}$

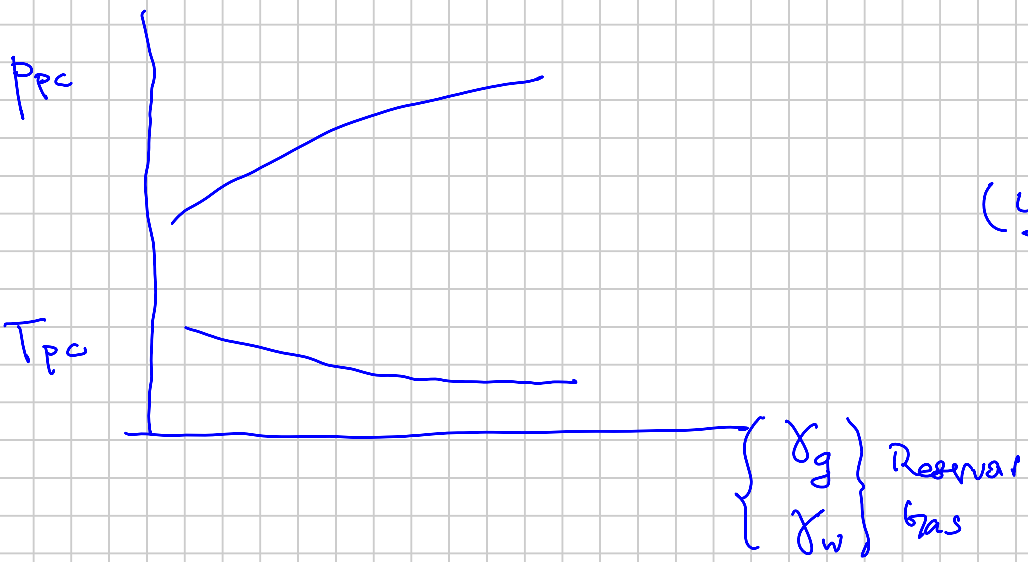
$\left\{ \gamma_{\bar{g}},\ GOR,\ \gamma_{\bar{o}} \right\}$

$\Downarrow$

$(y_i) \longleftrightarrow \boxed{M_g}$

$\Rightarrow \gamma_w$

$\Rightarrow \gamma_g$



$$M_g = \frac{M_{\bar{g}}\, y_{\bar{g}} + M_{\bar{o}}^{*} (1 - y_{\bar{g}})}{1}$$

* Cragoe

$$y_{\bar{g}} = \frac{GOR/(RT_{sc}/p_{sc})}{GOR/(RT_{sc}/p_{sc}) + (\rho/M)_{\bar{o}}}$$

$$\underbrace{\gamma_w = \gamma_g}_{\text{Reservoir Gas}} = \frac{M_g}{M_{air}}$$

$Z_g(y_i, p, T)$

$Z_g(\gamma_g, p, T)$

↑ Res. Gas "Gravity" $\sim y_i$

2013

5. When reservoir pressure, p_R, is 75 bara in RO and producing gas-oil ratio, R_p, is 1000 Sm^3/Sm^3,

- find R_s, B_o, μ_o, r_s, B_{gd} at p_R;
- calculate oil density at p_R;
- calculate % of stock tank oil rate that produces from flowing reservoir gas.

$$q_{\bar{o}} = q_{\bar{o}o} + q_{\bar{o}g}$$

$$\frac{q_{\bar{o}g}}{q_{\bar{o}}} \; ?$$

$$\frac{q_{\bar{o}g}}{q_g} \overset{?}{=} \frac{r_s}{B_{gd}}$$

Basis: $q_g = 1 \ m^3/d$

$$B_{gd} = \frac{q_g}{q_{\bar{g}g}}$$

$$q_{\bar{g}g} = q_g / B_{gd}$$

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

$$q_{\bar{o}g} = r_s \, q_{\bar{g}g}$$

$$q_{\bar{o}g} = r_s \cdot \frac{q_g}{B_{gd}} \Rightarrow \boxed{\frac{q_{\bar{o}g}}{q_g} = \frac{r_s}{B_{gd}}}$$

2. Calculate gas rate for the flowing parameters given below, including skin in the rate equation:
kh =1000 md·m,
r_e=1000 m,
r_w=0.1 m,
p_R = 200 bara,
p_{wf} = 175 bara,
p_{sc}=1.0135 bara,
T_{sc}=15.56 °C
Skin s=-3

Missing: $T_R = 100°C$ assume

$(\mu_g Z)_i$

Low-p Assumption $\tilde{\le}$ 200 bar

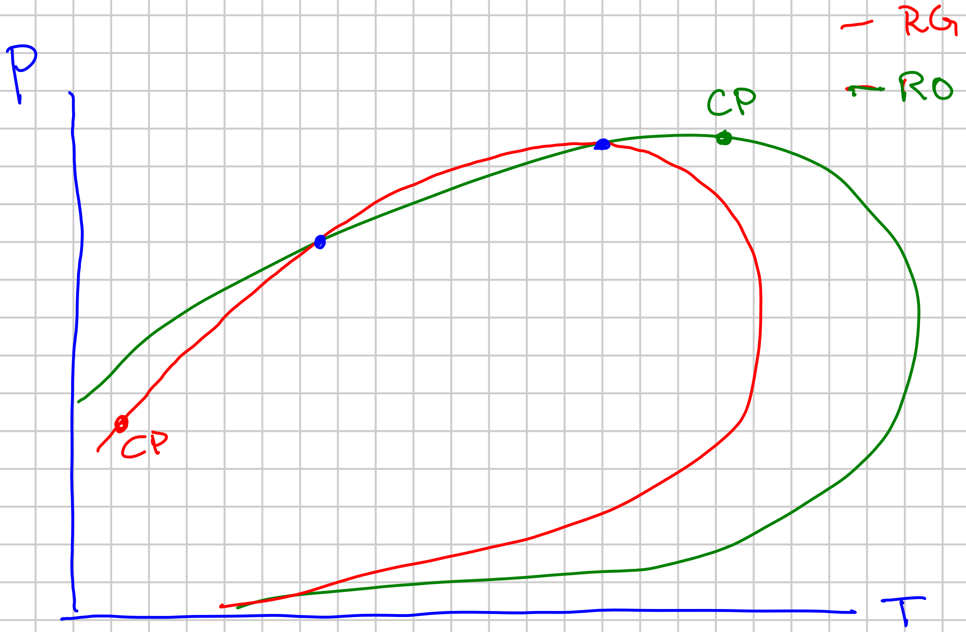
$\mu_g Z = \text{const}$

$(\mu_g Z)_i = (\mu_g Z)_{atm}$

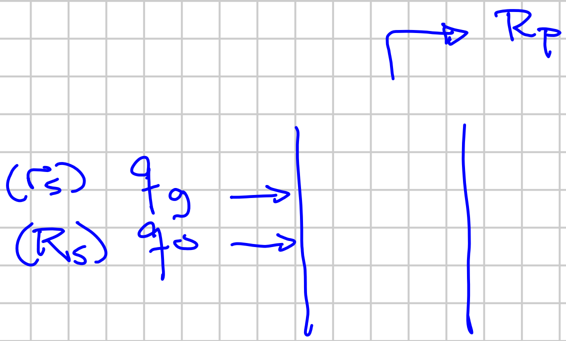
$\mu_g^o(T, \gamma_g)$ ✓ ~0.02cp

$Z = 1$

p_R : $\ln \frac{r_e}{r_w} - \frac{3}{4}$



• Saturated Gas-Oil System (Gas Cap + Oil Zone)



$$p_{wf} > p_s$$

$$1/r_s > R_p > R_s$$

$$R_p = \frac{1}{r_s} \quad \text{if } q_o = 0$$

$$R_p = R_s \quad \text{if } q_g = 0$$