$$q_{\bar{g}} = \frac{2 \pi k h}{\ln\left(\frac{r_e}{r_w} - 0.75\right)} \frac{7.63}{T_R} \underbrace{\int_{p_{wf}}^{p_R} \frac{p}{z \mu_g} dp}$$

LP: $\left(\frac{1}{\mu_g z}\right)_{@ p_R} \frac{(p_R^2 - p_{wf}^2)}{2}$

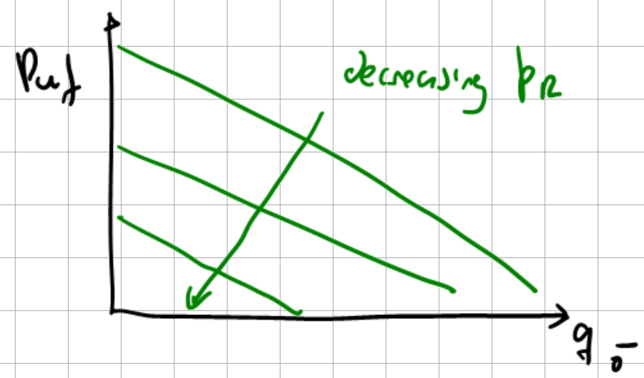
$\frac{\left(m(p_R) - m(p_{wf})\right)}{2}$

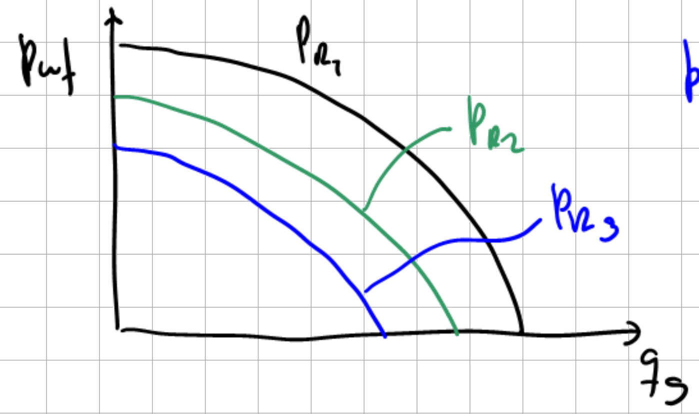
HP: $\frac{p_R}{(\mu_g z)_{@ p_R}} (p_R - p_{wf})$

$$q_{\bar{o}} = \underset{\sim}{J} \left(p_R - p_{wf}\right)$$

geometry →

fluid properties → $(\mu_o B_o)_{@ p_{av}}$



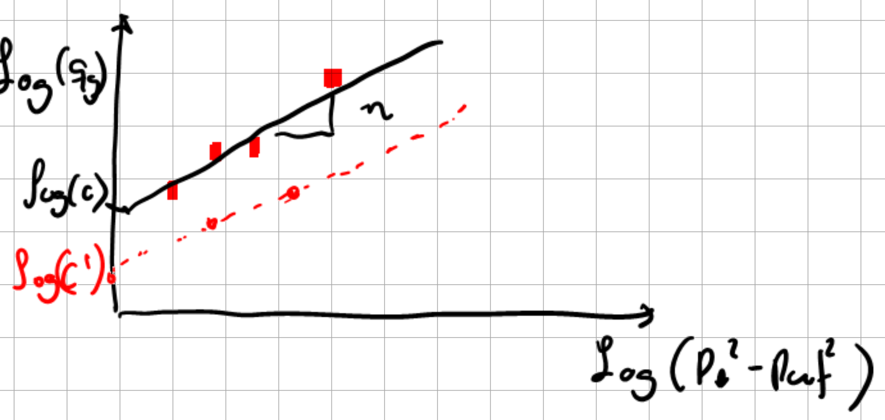


$p_{R_1} > p_{R_2} > p_{R_3}$

Diagnostic of well productivity issues

$$q_{\bar{g}} = C \left(p_R^2 - p_{wf}^2\right)^n$$

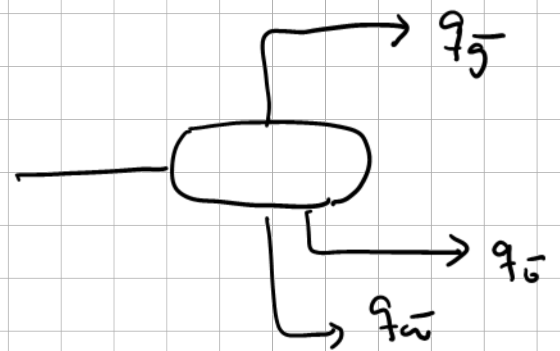
$$\log(q_{\bar{g}}) = \log(C) + n \log\left(p_R^2 - p_{wf}^2\right)$$



- Gas wells produce condensate $q_{\bar{o}}$, water $q_{\bar{w}}$

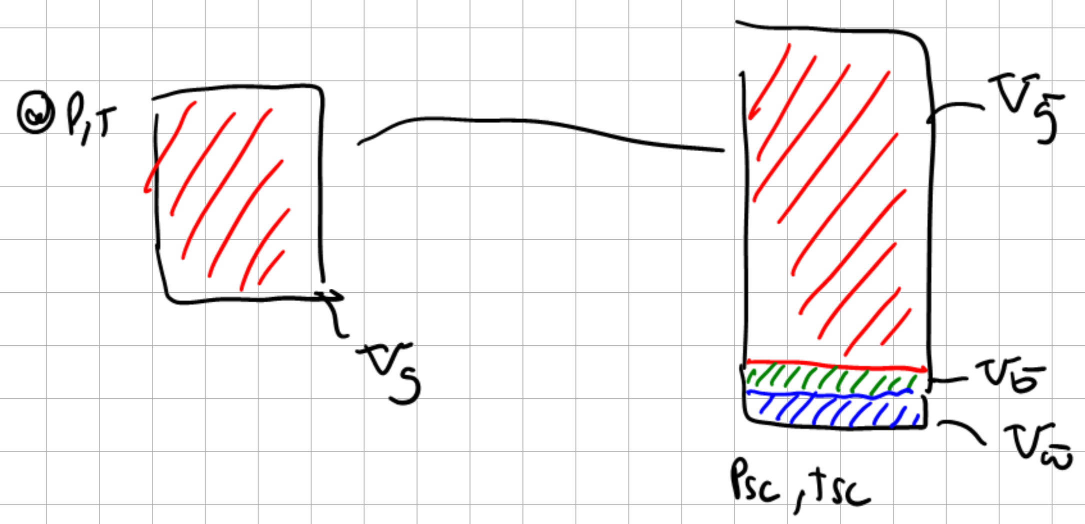
$CGR = \frac{q_{\bar{o}}}{q_{\bar{g}}}$

$WGR = \frac{q_{\bar{w}}}{q_{\bar{g}}}$



- the same IPR equations can be used as long as flow $p_R \rightarrow p_{wf}$ is single phase

B_g



$$B_{gd} = \frac{V_g}{V_{\bar g}}$$

$$B_{gw} = \frac{V_g}{V_{\bar g} + V_{\bar o} + V_{\bar w}}$$

$$\frac{p}{\rho} = z R T$$ → assumes single-phase gas

$$\int_{p_{wf}}^{p_R} \frac{p}{z \mu_g} dp$$ → neglects the dropout of condensate / water

If there is dropout of condensate and water → generate a table of B_{gd} {e.g. EOS}

$$\int_{p_{wf}}^{p_R} \frac{1}{\mu_g B_{gd}} dp$$ ← integrate B_{gd} directly

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Expressions are available for horizontal wells:

SPE 99712

Generalized Horizontal Well Inflow Relationships for Liquid, Gas, or Two-Phase Flow

R. Kamkom and D. Zhu, Texas A&M U.

base pressure. The IPR equation for horizontal gas wells in term of the real gas pseudo-pressure is

$$q_g = \frac{kL\left(m(\bar{p}) - m(p_{wf})\right)}{1424T\left(\ln\left[\frac{hI_{ani}}{r_w(I_{ani}+1)}\right] + \frac{\pi y_b}{hI_{ani}} - 1.224 + s\right)} \quad (13)$$

$$I_{ani} = \sqrt{\frac{k_H}{k_V}}$$

IPR:

$$q_g = \underbrace{C}_{\text{geometry}} \int_{p_{wf}}^{p_R} \underbrace{F(p)}_{\text{function of fluid properties}} dp$$