Note Title 3/31/2016

$$t_D = \frac{0.000264\ k}{\phi \mu c_{ti} r_w^2} \cdot t_{hr}$$

$$c_g = -\frac{1}{V_g}\left(\frac{dV_g}{dp}\right)_T$$
$$= \frac{1}{Z} - \frac{1}{p}\cdot\frac{dZ}{dp}$$
$$\sim \frac{1}{p}$$

$$c_{ti} = c_p + c_w \bar{S}_{wi} + c_g S_{gi}$$

c_f

c_r

Low-Pressure gas : $c_{ti} \sim c_g \underset{\uparrow}{S_{gi}}$ $\quad c_g >> \underbrace{c_w, c_p}$

0.7 - 0.95

$$c_{ti} \sim c_g \sim \frac{1}{\bar{p}_R}$$

$$p_p = 2 \cdot \int_{p_{ref}}^{p} \frac{p}{\mu Z}\, dp$$

IA

$$q_g = \frac{0.703\ kh\ (p_{pi} - p_{pwf}(t))}{T_R \cdot \left[p_D(t_D) + s_d + Dq_g\right]}$$

Infinite Acting (Pre-PSS Pre-BD)

$\Rightarrow$ A(t) B

BD (PSS)

$$q_g = \frac{0.703\ kh\ (\bar{p}_{pR}(t) - p_{pwf}(t))}{T_R\left[\underbrace{\ln\frac{0.472 r_e}{r_w}}_{= \ln\frac{r_e}{r_w} - \frac{3}{4}} + s_d + Dq_g\right]}$$

A B both constants

Isochronal : Shut-In between each flow

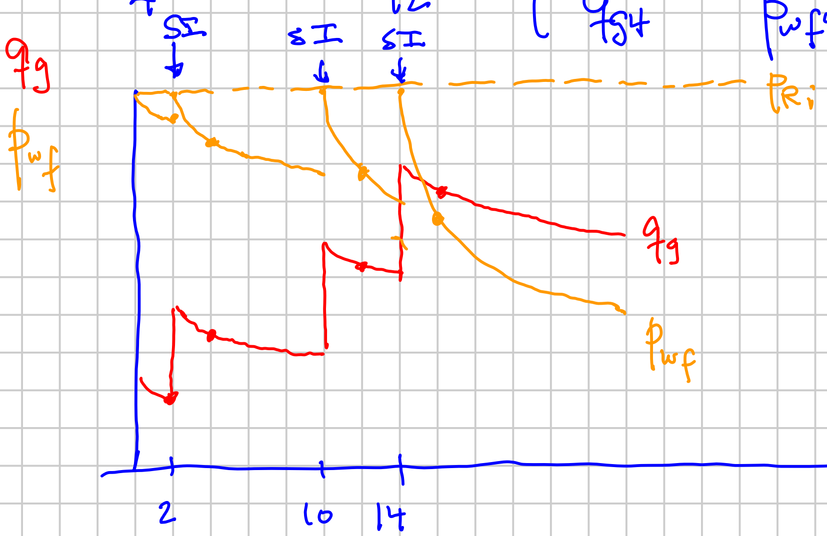
You want to find an $\underbrace{(A \; \& \; B)}$ that should be the SAME for all rates in the multi-rate test.

Test #	Duration (hrs)	q	p_{wf}	Chokes
1	2	q_{g1}	p_{wf1}	4/32"
2	8	q_{g2}	p_{wf2}	8/32"
3	4	q_{g3}	p_{wf3}	10/32"
4	12	q_{g4}	p_{wf4}	16/32"

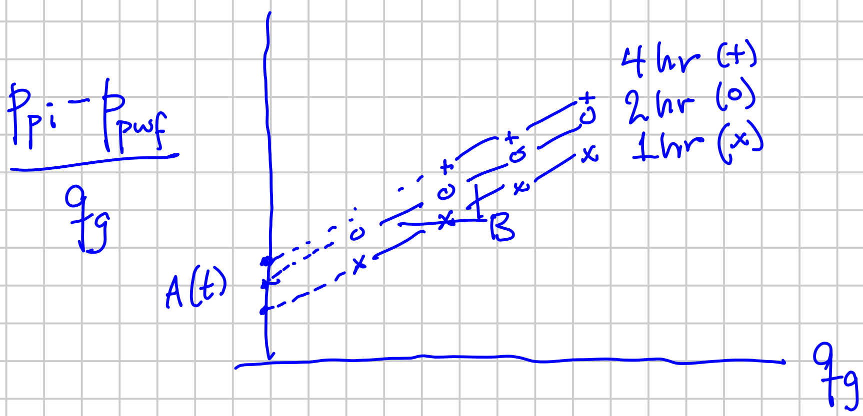
Choose the data (q, p_{wf}) @ the same period of production – e.g. @ 2 hr

↳ p_D same for each rate

$p_{D\,2hr}$



$p_D \propto t$



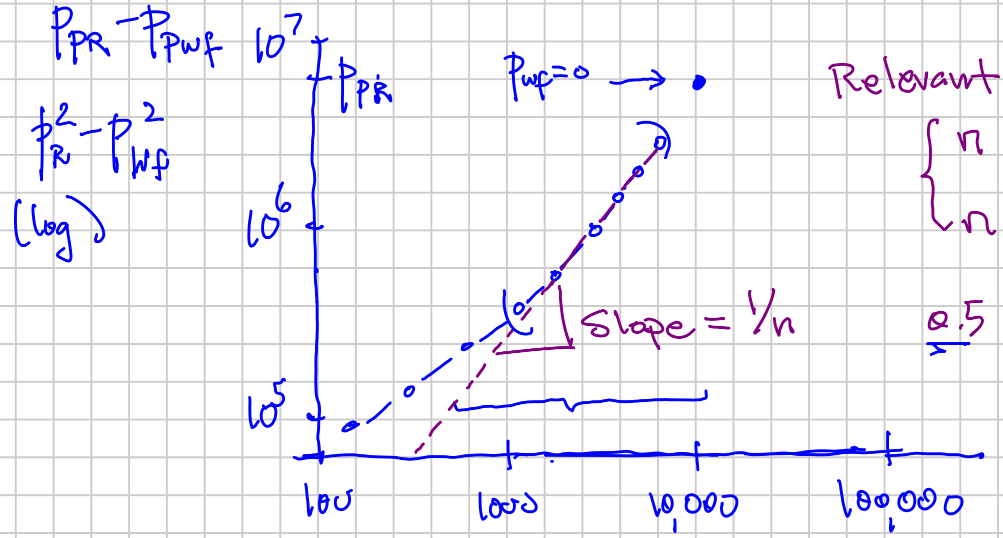
PTA : $A(t)$: match to $B(t_D)$ ⇒ k, s, ...

Approximating Quadratic (Forchheimer) Eq by Reservoir "Backpressure" Eq.

$$* \quad q_g = C \cdot \left(\bar{p}_{pR} - p_{pwf}\right)^n \quad \sim$$

$$\circ \quad A q_g + B q_g^2 - \left(\bar{p}_{pR} - p_{pwf}\right) = 0 \quad \checkmark$$

Graphical log-log plotting was available, not Excel



Relevant

$$\begin{cases} n \sim 1 & \text{: Laminar } B \sim 0 \\ n \sim 0.5 & \text{: Turbulent } A \sim 0 \end{cases}$$

$0.5 < n < 1$

q_g Mscf/STB

$A q_g$ vs $B q_g^2$

relative importance

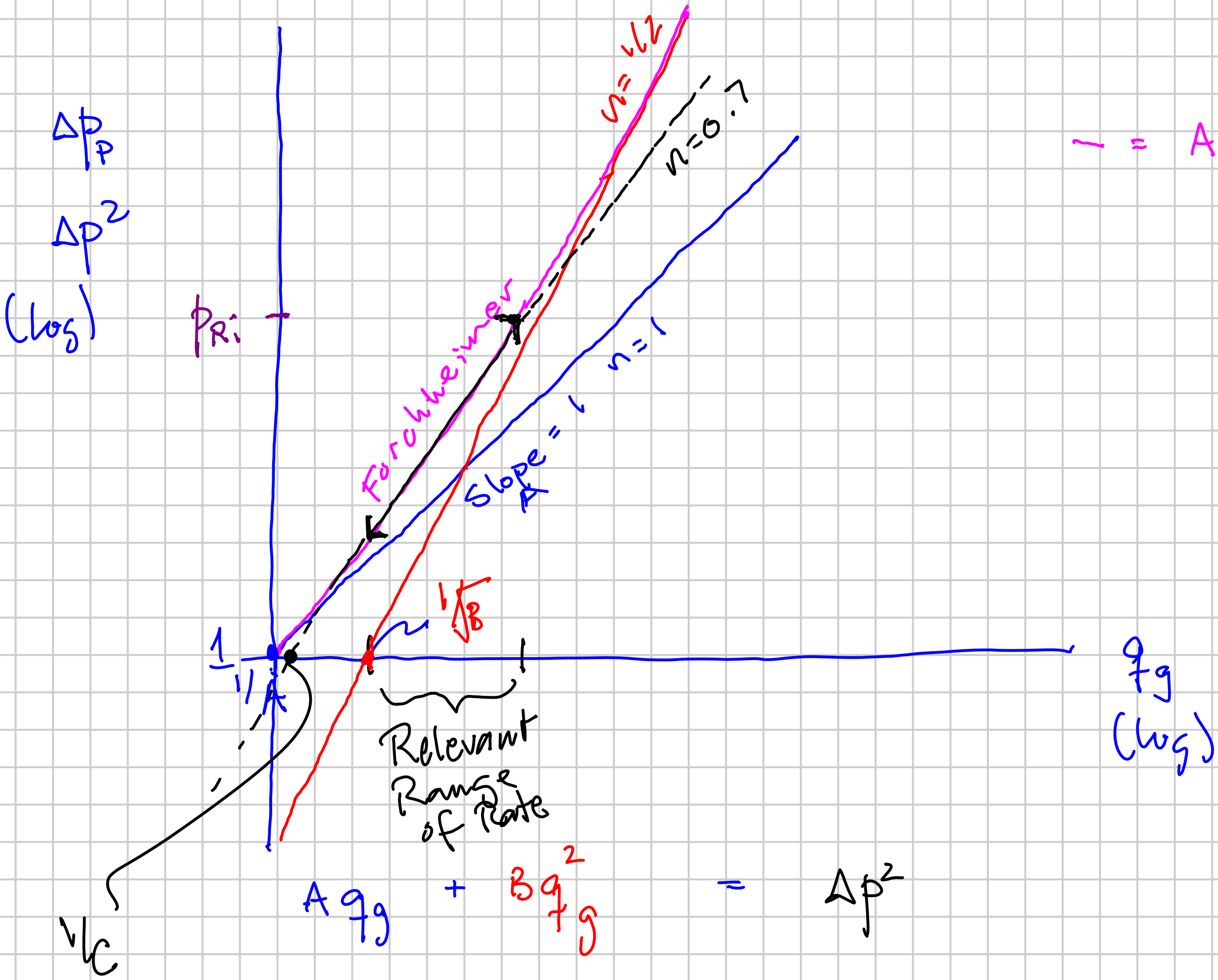
$$\frac{\Delta p}{\Delta x} = \frac{\mu}{k} v + \rho \beta v^2$$

Darcy "Turbulent" (HVF)

$$\beta \propto \frac{1}{k} \qquad f(\underline{\underline{k}}, \phi, \dots)$$

Roar Tessem

$- = Aq + Bq^2$



$$A q_g + B q_g^2 = \Delta p^2$$