Note Title 4/26/2018

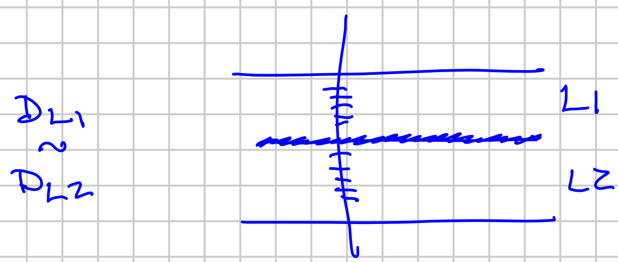
DECLINE CURVE ANALYSIS (DCA) <=> Mat. Bal. & Rate Eqs. (IPR | BPE)

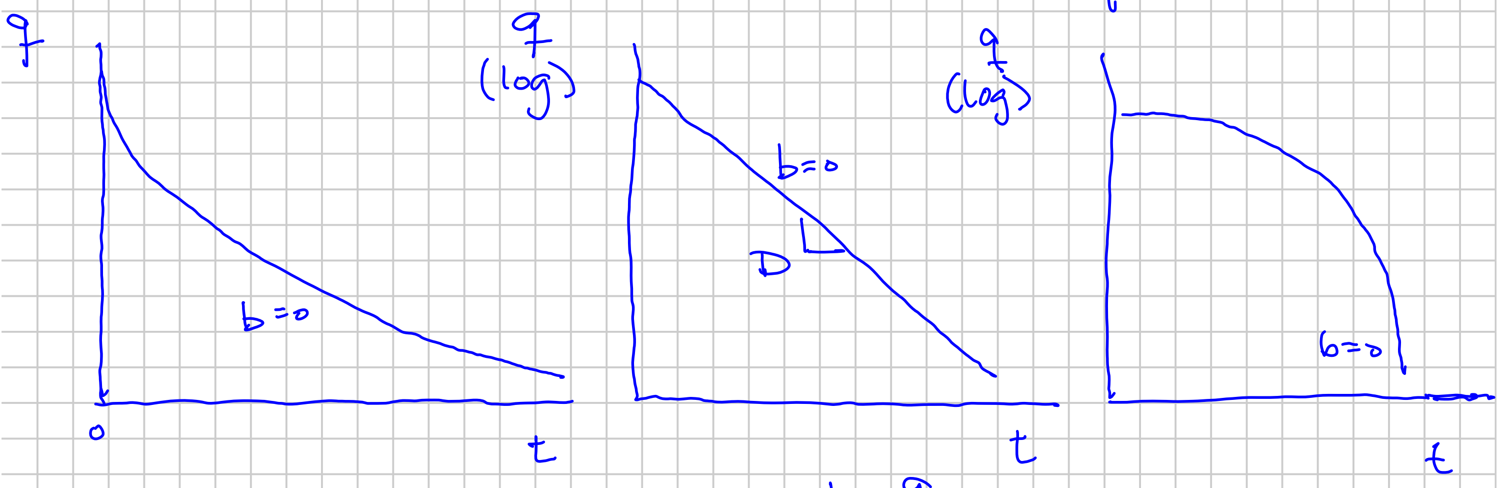
Production Forecasting Tool

- Arps Eq. (Empirical) 1945.
- Fetkovich 1973 (1980 JPT)
  - Defines Arps parameters in terms of reservoir/production variables
  - Ties Arps PSS | BD (pseudosteady state | boundary dominated) to "Infinite-Acting" (IA) flow behavior — "RTA"

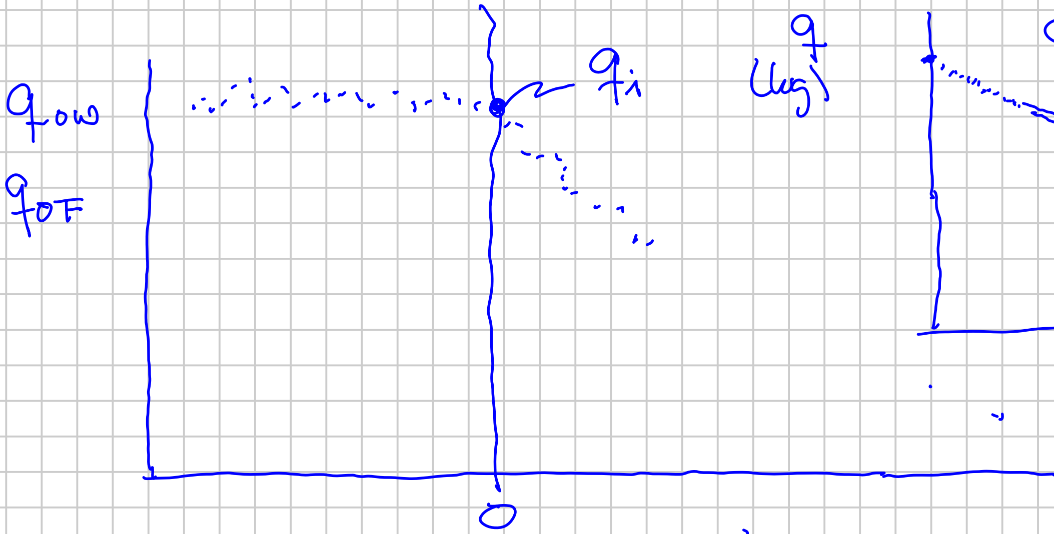
"RTA" → Rate Time Analysis (IA | BD | Superposition etc) Normalization

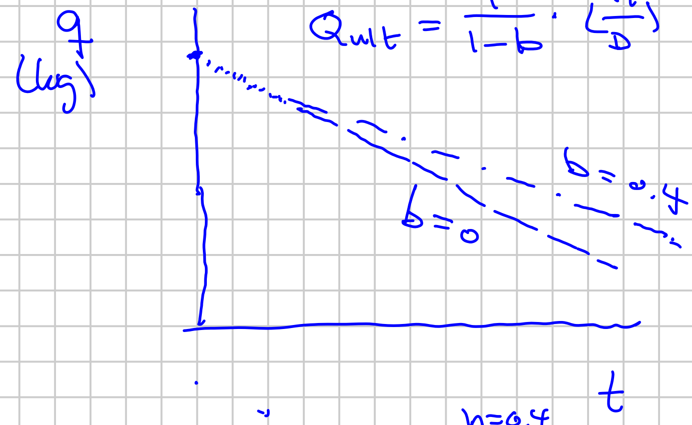
- Others
- Fetkovich et al. - Layered No-Crossflow (LNX) 1990s





$$D = \frac{1}{1-b}\frac{q_i}{Q_{ult}}$$





$$Q_{ult} = \frac{1}{1-b} \cdot \left(\frac{q_i}{D}\right)$$

$$\frac{Q_{ult}^{b=0.4}}{Q_{ult}^{b=0}} = \frac{1}{1-0.4} = \frac{1}{0.6}$$

t ↑ since the start of decline (yr)

Arps:

$$q = \frac{q_i}{(1 + bDt)^{1/b}}$$

q_i = rate at start of decline

b = empirical constant ($0 < b < 0.5$)

$b > 0.5$ – Single Reservoir Unit

D = "decline constant"

~ % decrease each year

= if $b = 0$

$b = 0$

$$q = q_i \cdot e^{-Dt}$$

decline EUR

$$Q_{p,ult} \equiv \int_0^\infty q \, dt \Rightarrow D = \frac{1}{1-b} \frac{q_i}{Q_{p,ult}}$$

single reservoir unit $b \lesssim 0.5$

Q_p = cum. production

$$Q_{pult} = \frac{1}{1-0} \frac{1000 \text{ STBD} \cdot 365 \text{ d}}{0.1 \left(\frac{\text{STBD}}{\text{STBD}}\right) / \text{yr} \cdot \text{yr}} \quad \text{STB}$$

$$= 10{,}000 \text{ STB} \times 365$$

$3.65 \cdot 10^6$ STB by calculation

$$D \left[\frac{1}{[t]}\right] \qquad \left[\frac{1}{yr}\right]$$

~1990 : Phillips Monteray Basin

Wells & Reservoirs $b \sim 0.6 - 0.9$

⇒ Single wells produce from multiple, non-communicating reservoir units (LNX)

where

Voidage Ratio "D" $\left(\frac{q_i}{Q_{ult}}\right)$ & ϕ layers are different > 2 → 10

⇓

Differential Depletion

$$q_w(t) = q_{\ell_1}(t) + q_{\ell_2}(t)$$

$$D_1 > D_2$$

$b_1 = 0.3$ $b_2 = 0.3$

b 0.5 → 0.9 (1)

~1970 PTA (Well Testing) Course

Hank Ramey (Henry)

$q = \text{const.} \Rightarrow p_D(t_D)$

PSS: $p_D(t) \propto t_D$

Analytical solution for $p_{wf} = \text{const}$ B.C.

$\Rightarrow q_D(t_D)$

PSS: $q_D \propto e^{t_D}$

Same as Arps $b=0$

$$q_i = \frac{kh\,(p_R - p_{wf})}{\left[\ln \frac{r_e}{r_w} - \frac{3}{4} + s\right] \mu B}$$

(kh, s)

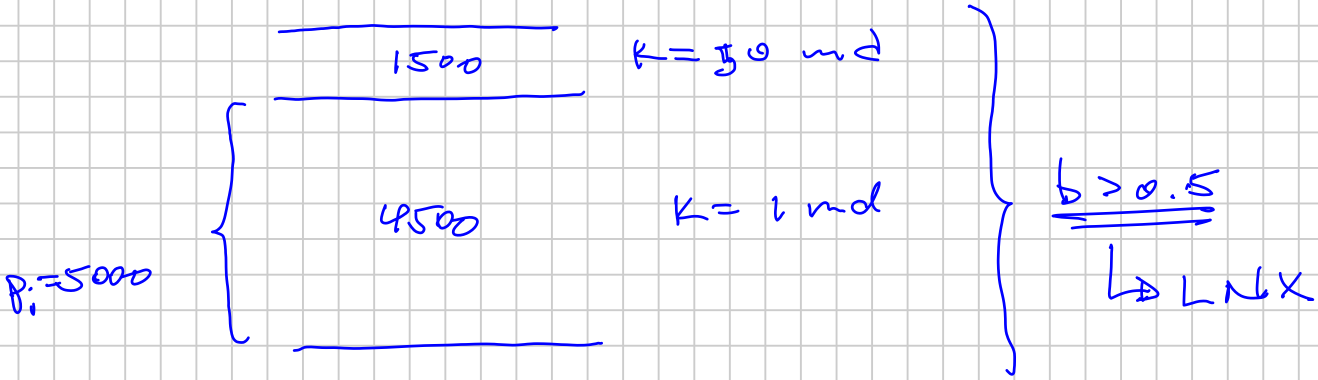
101P 1601P

$$D = \frac{1}{1-b} \frac{q_i}{[Q_{pult}]}$$

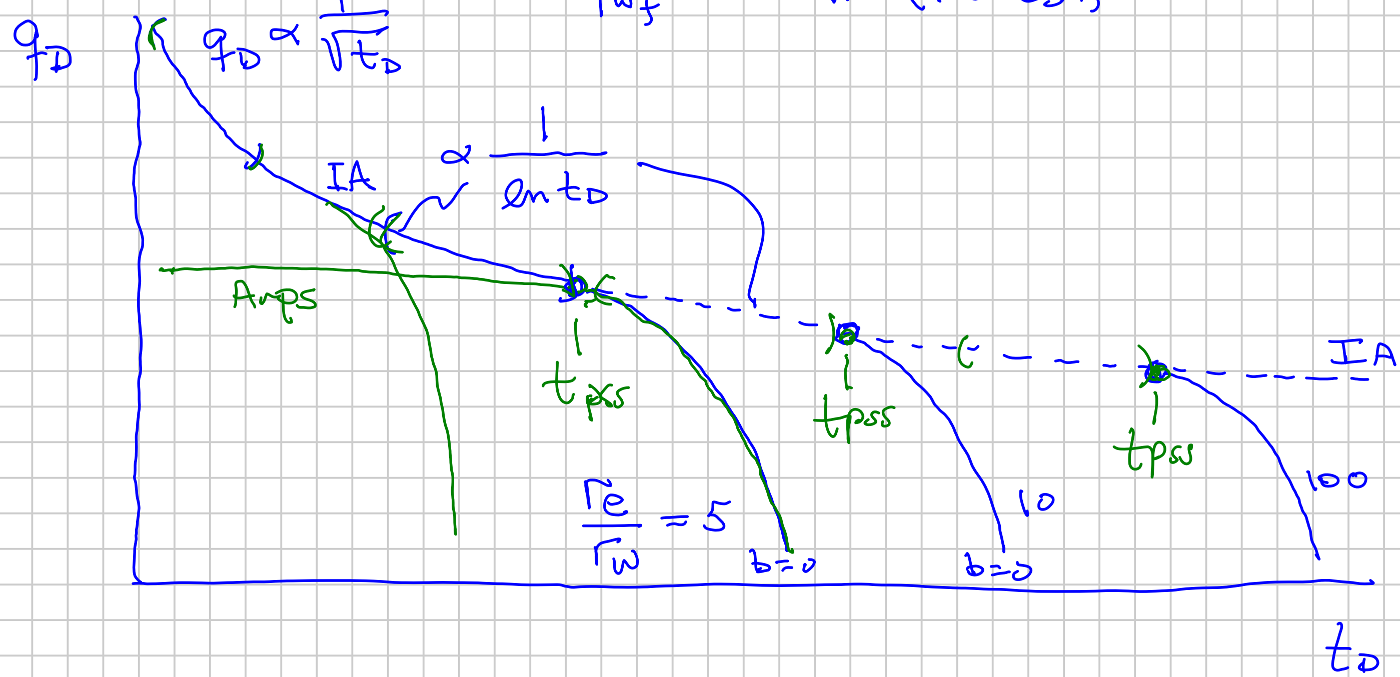
Q: RF$_{ult}$, decline period — M.B.

b: 0 / 0.5

- shape $q(p_{wf})$
- shape $p_R(Q_p)$
- Both linear: $b = 0$
- Non-Linear (Realistic) → 0.5



P_{wf} = const. (Tables)



Arps: b = 0 ⇒ Exponential