Note Title 4/5/2018

"Cragoe" simple correlation

$C_{og} (M_{\bar{o}}, \rho_{\bar{o}})$ ← BOPVT

PROBLEM 3 Q&A:

$$\boxed{B_{gd}} = \frac{P_{sc}}{T_{sc}} \frac{T_R}{p} \, Z_g \left(\frac{1 + C_{og} \cdot r_s}{f(r_s)} \right)$$

B_{gd}: BOPVT; bracket: "$f(y_{\bar{g}})$"

$Z_{g,d} = 1.08$ (BOPVT)

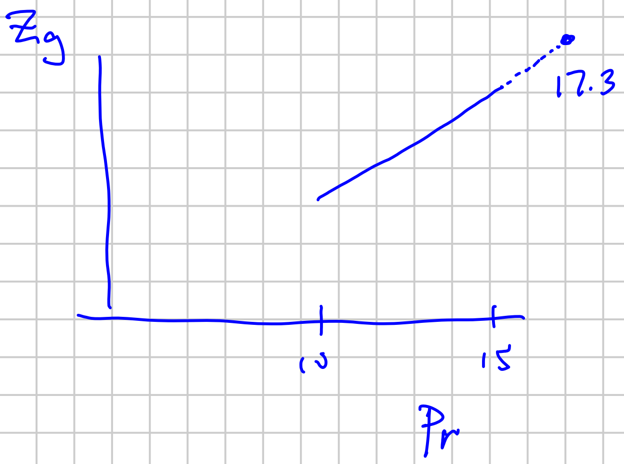
$Z_{g,d} = 1.08$ (Lab report)

$Z_{g,d}$ (y_i, SK Correlation) $= \underline{1.06}$

Hall-Yarborough

$$Z_{g,d} \left(T_{pr} = \frac{T_R}{T_{pc}}, \; p_{pr} = \frac{p_d}{p_{pc}} \right)$$

p_{pr} → 8.8



- Linear Mixing Rule

$T_{pc} = \sum y_i T_{ci}$

$T_{c,C_{7+}}$ (Chart, Eq., Matthews)

- Charts (Z_{gs}) $= f(\gamma_{gR})$ ← reservoir gas

SK Z_g ~ 0–3% errors up to $p_r \sim 15$

Gas Field Performance

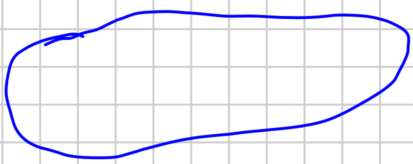
Mike Fetkovich

– Gas Well Performance
  - Reservoir flow eqs.
  - Tubing — " —
  - Pipeline — " —

} Phillips Heritage (60s) + MJF application

– High-Pressure Gas Material Balance

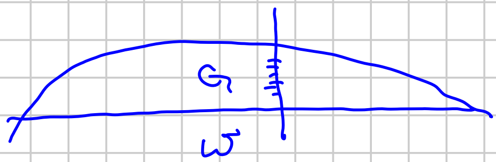
Top

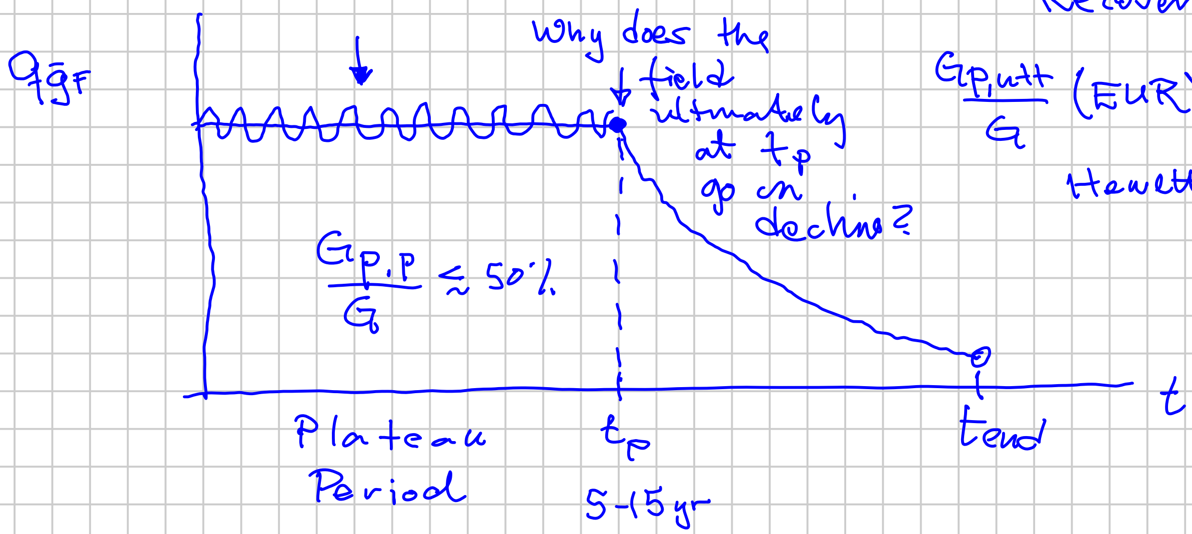


$\phi \pm$ $\bar{S}_w \pm$

$\boxed{G \pm}$

side





Expected Ultimate Recovery

$\frac{G_{p,ult}}{G}$ (EUR) ~ 50-(95%) 70%

Hewett : > 98%

G : IGIP OGIP scf Sm^3 of initial surface gas in place

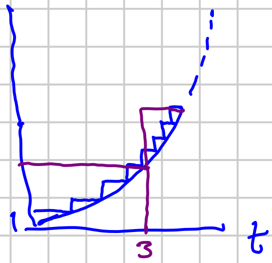
$$G_{p_F} \equiv \int_0^t q_{g_F} d\tau$$

Wells go on decline when p_t : flowing pressure at the wellhead reaches the ~ "pipeline pressure" (or "intake pressure" to the compressor delivering to the pipeline).

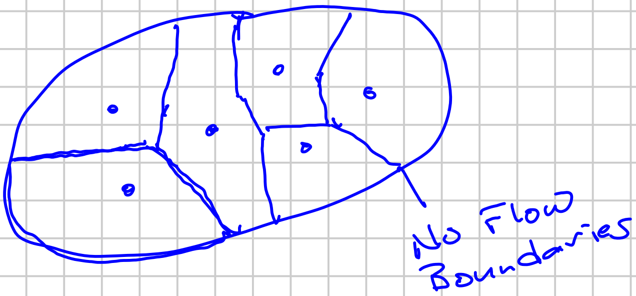
Average well concept

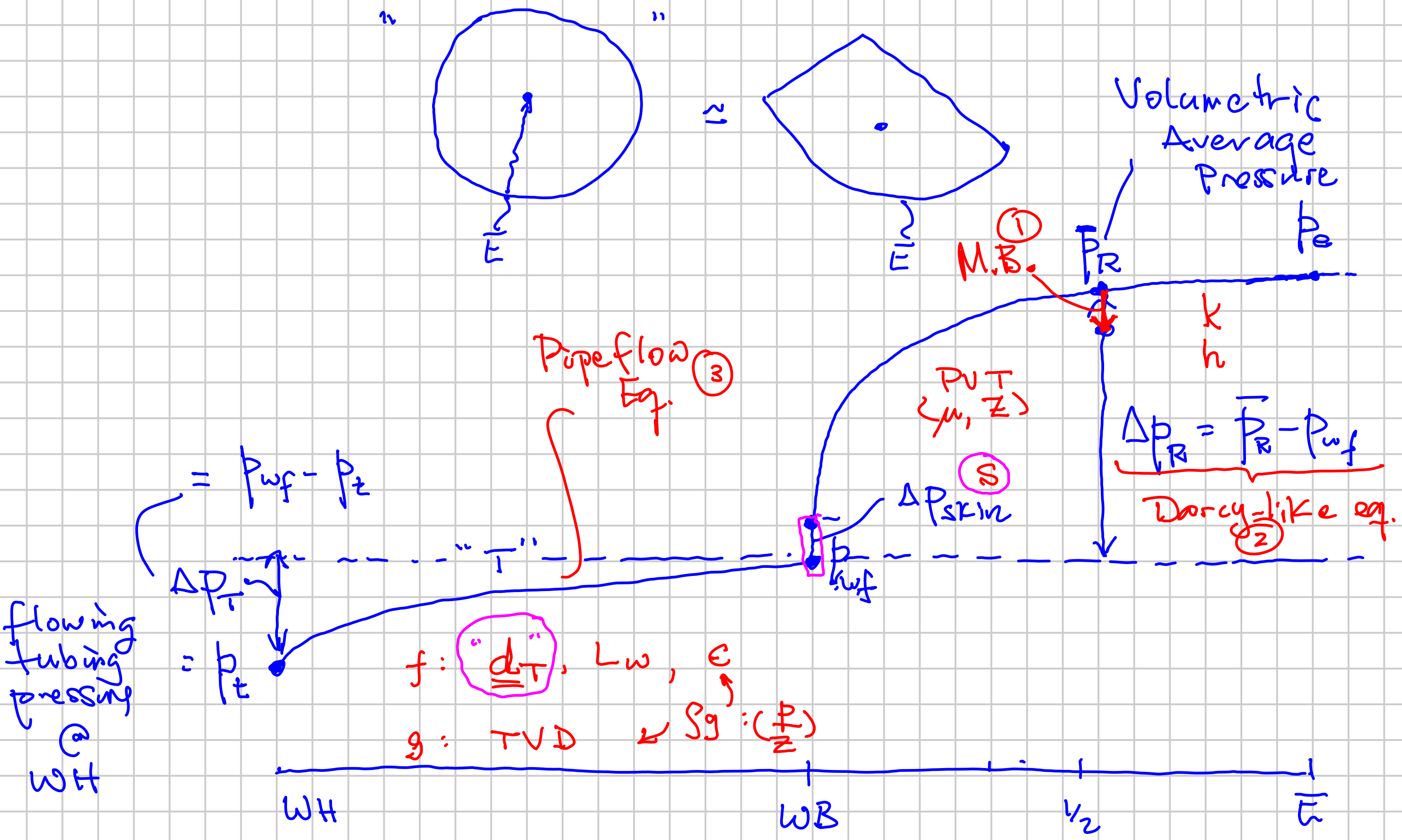
$$\text{const.} = q_{gF} = \sum_w q_{gw} = \underbrace{N_w(t)}_{\text{Drilling Queue}} \cdot \underbrace{\bar{q}_{gw}(t)}$$

(w: wells)



We must understand and (optimally) engineer INDIVIDUAL well performance — i.e. "well deliverability".





Well Deliverability:

At a given time when $\bar{p}_R$ is known

SET p_t

what rate will flow from the well

i.e., can be sold (delivered for sale)

$(q_g)_{delivery}(t)$ at fixed p_t

$p_R(G_p(t))$

$\boxed{p_R(G_p)}$ ≡ "Material Balance"

$$q_{gw} \propto (p_R - p_{wf})$$

p_t = const.

p_{wf} ~ const

Delivery $q_{gw}(t) = C\,(p_R(G_p(t)) - p_{wf})$

① M.B.

$$\frac{\bar{p}_R}{Z_{gR}}\left[1 - c_e\,(p_{Ri} - \bar{p}_R)\right] = \left(\frac{p_{Ri}}{Z_{gi}}\right)\left(1 - \underbrace{\frac{G_p}{G}}_{RF_g}\right)$$

c_e: Total system Compressibility (water + rock)

② Reservoir Rate Eq.

$$q_g = C_R \cdot \int_{p_{wf}}^{\bar{p}_R} \frac{p}{\mu_g Z_g}\,dp$$

$C_R\,(k, h, s, \ldots)$

③ Tubing Rate Eq.

$$q_g = C_T\,\left(p_w^2 - p_t^2\right)^{0.5}$$

$p_w \sim p_{wf}$

$C_T(d_T, L_T, TVD, PVT)$