Note Title 12/3/2008

EXAM MATERIALS:

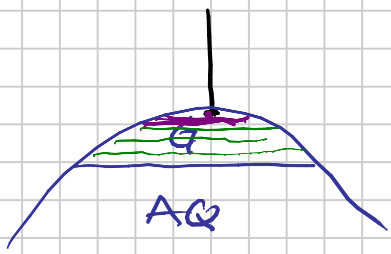
1. Purchased/Stolen SPE Monograph

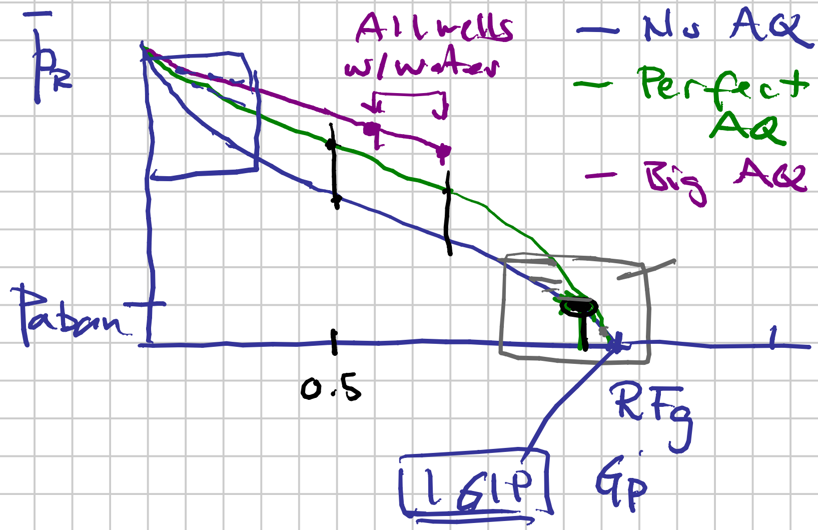
2. Project Report
   - Grading together with the exam problem related to the project
   - To help you on the exam
   - Annotating Project is optional

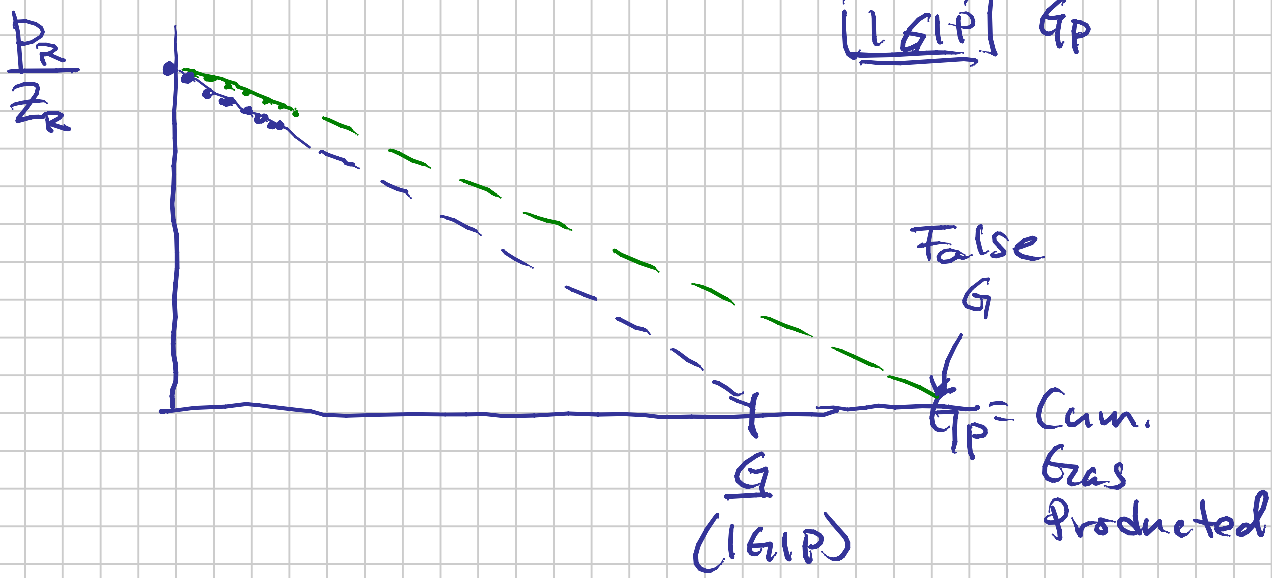
3. Calculator – "Simple" one

Influence of Aquifer / Water Influx on Gas Recovery & Estimation of IGIP

SL







$$\frac{Sm^3}{kg\text{-mole}}$$

$$\frac{scf}{lb\text{-mole}}$$

Ideal Gas Law

$$pV = nRT$$

Always (engineering ±)
OK for ANY gas at
$p_{sc} = 1$ atm, $T_{sc} = 15.56°C$

$$p_{sc} \cdot V_{gsc} = nRT_{sc}$$

$$\frac{V_{gsc}}{n} = \frac{RT_{sc}}{p_{sc}}$$

$$\frac{scf}{lb\text{-mole}} \quad \sim 379 = \frac{10.7315\,(60+459.67)}{14.696 \text{ psia}}$$

$$= \frac{0.08314\ldots(15.56+273.15)}{1.0135}$$

$$\frac{Sm^3}{kg\text{-mole}} \quad = 23.xx$$

$$\frac{V_{\bar{o}}}{n_{\bar{o}}} = \left(\frac{M_{\bar{o}}}{\rho_{\bar{o}}}\right) \qquad \frac{Sm^3}{kg\text{-mole}}$$

$$\frac{\left(\frac{\cancel{kg}}{kg\text{-mole}}\right)}{\left(\frac{\cancel{kg}}{Sm^3}\right)}$$

EOS

$$p = \frac{RT}{v-b} - \frac{a}{v^2}$$

G & L

$$v \equiv \frac{V}{n}$$ molar volume

⇓ Translate to a dimensionless form of the same equation

$$\boxed{Z \equiv \frac{pv}{RT}}$$

→ $Z_L = 0.05$
$p = 300$ bara
$T = 350$ K
$M_L =$

$\Rightarrow v_L \rightarrow \rho_L$

$$Z^3 + uZ^2 + vZ + w = 0$$

Gases & Liq.

u, v, w : $\underbrace{a, b, p, T}$

$\bar{a}_L =$

$\bar{b}_L = \sum x_i b_i$

$$\rho = \frac{M}{v}$$

M

$$b_i = 0.1 \frac{RT_{ci}}{P_{ci}}$$

Surface Liquids : "Ideal Volume Mixing"

@ p_{sc}, T_{sc}

x_i

$$\rho_{\bar{o}} = \frac{\sum m_i}{\sum \tilde{V}_i} = \frac{\sum x_i M_i}{\sum \frac{x_i M_i}{\rho_{Li}}} \qquad m_i = x_i M_i$$

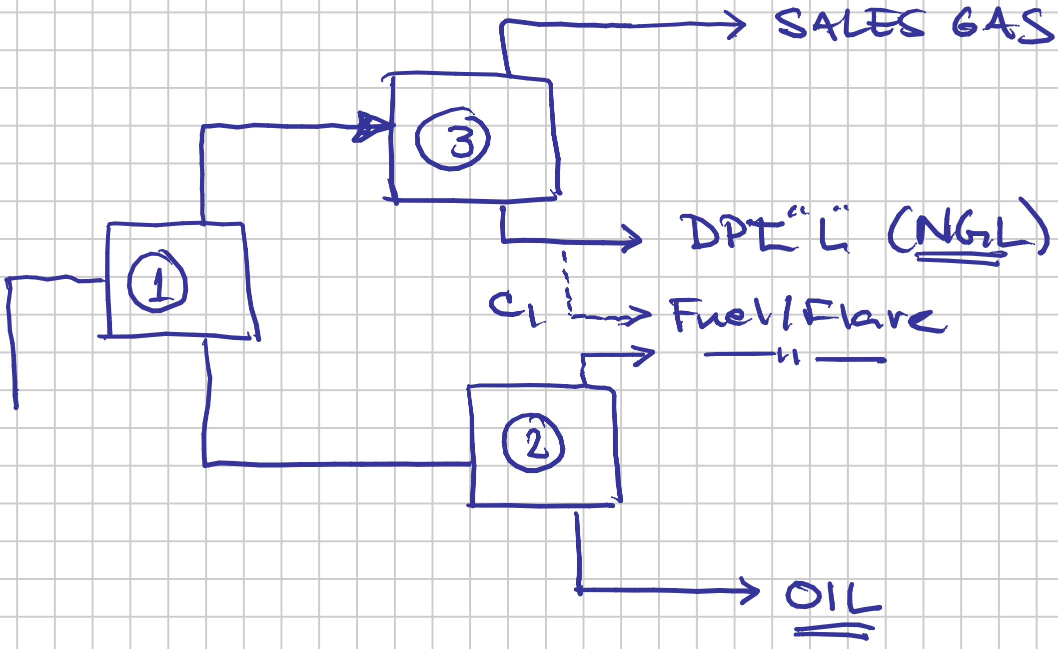
$$\tilde{V}_i = \frac{m_i}{\rho_{Li}}$$

Component "Specific Gravity"

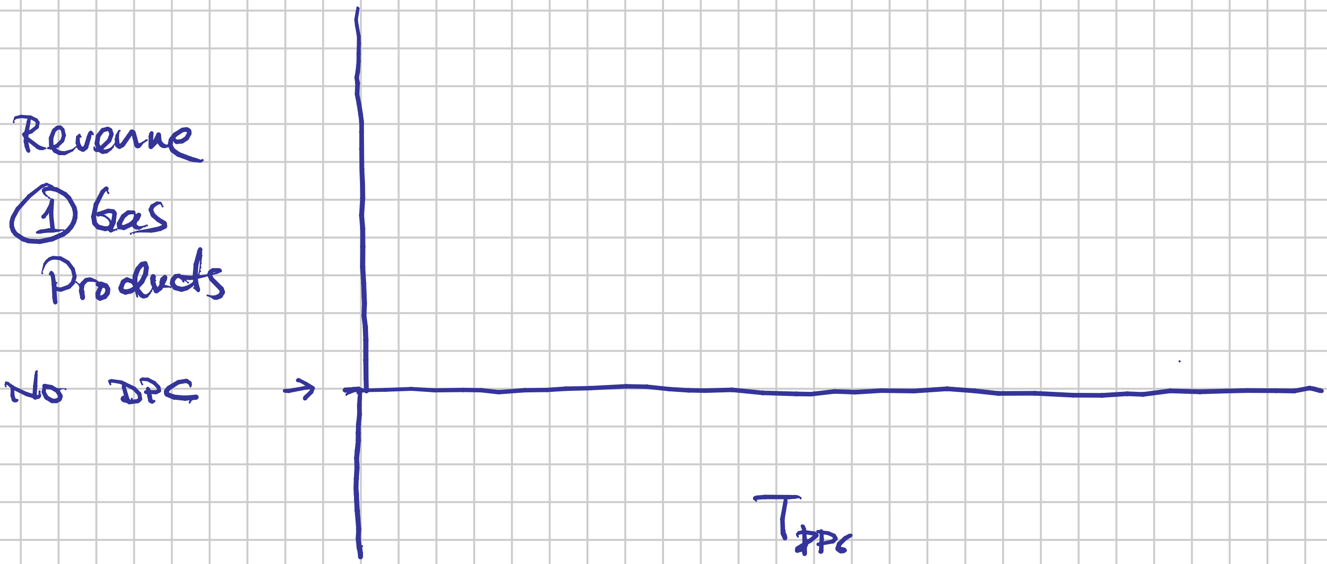
Density @ p_{sc}, T_{sc} (App. A)

Ch. 5 . Table 5.2

C_{7+}



Amount INDEPENDENT of T_{DPC}



Problem 1 2008

R: $$q_g = \frac{2\pi kh\,(P_R^2 - P_{wf}^2)}{(\quad)\left[\ln \frac{r_e}{r_w} + s + Dq_g\right]}$$

Assume: $\underset{\sim 0}{Dq_g} << \left[\ln r_e/r_w + s\right]$

$$q_g = C_R\,(P_R^2 - P_{wf}^2)$$

$$q_g = C_R' \left(p_c^2 - p_w^2\right) \Rightarrow p_c^2 - p_w^2 = \frac{1}{C_R'} q_g$$

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

R+T (=WH) $$p_c^2 - p_t^2 = \left(p_c^2 - p_w^2\right) + \left(p_w^2 - p_t^2\right)$$

$$\frac{1}{C_R'} q_g + \frac{1}{C_T^2} q_g^2$$

WH (s=0) $$\left[\, A\, q_g + B\, q_g^2 - \Delta p^2 = 0 \,\right]$$

A_{Test} (s≠0) $\quad A_{Development}$ (s=0)

$$C_{R\,test} = \frac{q_g}{\left(p_c^2 - p_w^2\right)} = \frac{kh}{\ln\frac{r_e}{r_w} + s}$$

$$C_{R\,s=0} = \frac{q_g}{\underbrace{\left(p_c^2 - p_w^2\right)}_{\text{measured } s\neq 0} + \underbrace{\left(p_w^2 - p_w^{*2}\right)}_{s=0}} = \frac{q_g}{\left(p_c^2 - p_w^{*2}\right)_{s=0}}$$

" $p_{wf}^* - p_{wf} = 15$ bar "

$$p_w^* = p_w + 15 \cdot \exp(\quad)$$

F_v : RR

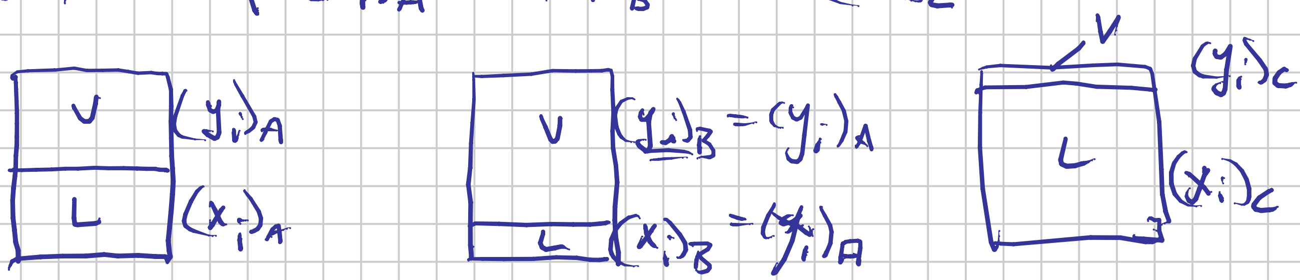
If RR $F_v < 0$ or $F_v > 1$

✓ then single phase, NO phase split

but RR gives y_i ✓ physically OK
x_i ✓

What do y_i & x_i represent when $F_v < 0$?
$F_v > 1$?

Lab: Make up $(z_i)_A$ ... $(z_i)_B$ ... $(z_i)_C$



P, T　　　P, T　　　P, T

$F_{vA} = 0.5$　　　$F_{vB} = 0.9$　　　$F_{vC} = 0.1$

$$(z_i)_B = 0.9\,(y_i)_A + 0.1\,(x_i)_A$$

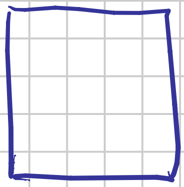
↑

F_{vB}

(z_i) Fall on the same "Tie Line"

$F_{vx} = -0.1$

(y_i) (x_i)



$$(z_i)_x = -0.1\,(y_i)_A + 1.1\,(x_i)_A$$

P, T

$$\Rightarrow (y_i)_x = (y_i)_A$$
$$(x_i)_x = (x_i)_A$$

$F_{vx} = -0.1$

$$\frac{dp}{dr} = \frac{\mu}{K} v + \beta \rho v^2$$

$$q = v \cdot 2\pi r h$$

$$v = \frac{q_R}{2\pi r h}$$

$$q_g \longleftrightarrow q_{gR}$$

$$B_g \propto \frac{1}{p}$$

$$\frac{dp}{dr} = \frac{\mu}{K} \cdot \frac{q}{2\pi h} \frac{1}{r} + \beta \rho \left(\frac{1}{2\pi h}\right)^2 \frac{1}{r^2} q^2$$

$$= \underbrace{\frac{q\mu}{2\pi K h}}_{\text{const}} \left[\frac{1}{r} + \beta \rho \frac{K}{2\pi h} \cdot \frac{1}{r^2} q\right]$$

$$\frac{2\pi K h}{q\mu} \int_{p_{wf}}^{p_e} dp = \int_{r_w}^{r_e} \left[\frac{1}{r}\right] dr + \beta \rho \frac{K q}{2\pi h} \int_{r_w}^{r_e} \frac{1}{r^2} dr$$

$$= \ln r_e/r_w + \beta \rho \frac{K}{2\pi h} q \left(\frac{1}{r_w} - \frac{1}{r_e}\right)$$

$$\frac{1}{r_w} \gg \frac{1}{r_e}$$

$$\frac{2\pi K h \Delta p}{q\mu} = \ln \frac{r_e}{r_w} + Dq$$

$$D = \beta \bar{\rho} \frac{K}{2\pi h r_w}$$

$$q = \frac{2\pi K h \Delta p}{\mu \left[\ln \frac{r_e}{r_w} + Dq\right]}$$