IPG 415 Exam Solution. 2011

Problem I

A. $\gamma_g = 0.6$. $M_g = \sum_{i=1}^{n} y_i M_i$

$M_g = 28.97\,\gamma_g = 17.38$ kg/k-mol

$C_1 \hat{=} 0.9$. $C_3 \hat{=} 0.1$

B. $T_{pc} = 168 + 325\gamma_g - 12.5\gamma_g^2 = 358.5\ ^\circ R$

$P_{pc} = 667 + 15\gamma_g - 37.5\gamma_g^2 = 662.5$ psia

$P_i = 3030$ psia. $T_i = 114^\circ F = 574\ ^\circ R$

$P_r = 3030/662.5 = 4.57$ $T_r = 574/358.5 = 1.6$

$\Rightarrow z_i = 0.83$.

$\rho_g = 28.97\,P\cdot\gamma_g/zRT = 0.165$ g/cm³ $= 10.3$ lbm/ft³

$dp/dh = \rho_g/144$ psi/ft $= 0.072$ psi/ft

C. $IGIP = [A\cdot h\cdot\phi(1-S_w)]/B_g = 1.08\times10^9$ m³

$= 3.81\times10^{10}$ scf

$B_g = 0.0282\,zT/P = 4.45\times10^{-3}$ ft³/scf

D. $n = m/M$. $M = 17.38$ kg/k-mol

$m = \rho\cdot V_R = 7.93\times10^8$ kg

$n = m/M = 4.56\times10^7$ kg-moles.

E. $Q_p = 0.5\times IGIP = 5.4\times10^8$ sm³

$T = Q_p/q = 3814$ days ≈ 10.45 years.

F. $P/z = P_i/z_i\,(1 - R_F)$ $P \hat{=} \hat{z}\,(P_i/z_i)(1-R_F)$

$\hat{z} = 0.85$. $P = 1551.5$ psia

G. $q_g = C_R (P_c^2 - P_w^2)$

$C_R = 0.703 kh / T_R (N_2) [\ln \frac{r_e}{r_w} - \frac{3}{4} + S]$

Assume: $S = 0$, $r_w = 0.3$ ft

$r_e = \sqrt{A/\pi} = 2979$ ft

$C_R = [0.703 \times 50 \times 30] / [574 * 0.015 \times 985 \times (\ln \frac{2979}{0.3} - \frac{3}{4})]$

$= 17.045$ Scf/D.psia^2

$P_w^2 = P_c^2 - q_g / C_R$

$P_w = 1453.9$ psia

Problem 2 A.

A. Dead oil: Eqs 3.117 $\Rightarrow$ $\mu_{OD} = 1.84$ cp

Chart $\Rightarrow$ $\mu_{OD} = 2$ cp

Bubblepoint oil: Eqs 3.123 $\Rightarrow$ $\mu_{OB} = 0.58$ cp

Chart $\Rightarrow$ $\mu_{OB} = 0.72$ cp

μ_{oi} Eqs 3.130 $\Rightarrow$ $\mu_{oi} = 0.65$ cp

$\mu_{oi} = 1.12 \mu_{ob} = 0.8$ cp

Data from report: $\mu_{OD} = 1.241$ cp

$\mu_{OB} = 0.624$ cp

$\mu_{oi} = 0.73$ cp

B. μ_o @ 650 psig $= 0.816$ cp

μ_g: Eqs 3.65 $\Rightarrow$ $\mu_g = 0.02$ cp

Chart $\Rightarrow$ $\mu_g = 0.013$ cp.

$\mu_o / \mu_g = 63$ or 41

C. Choose the lowest B_o

100 psig, 130°F

D. $IOIP = A \cdot h \cdot \phi (1 - S_W) / B_{oi}$

$= 3.97 \times 10^5 \ Sm^3$

$= 2.497 \times 10^6 \ STB$

E. $G = IOIP \cdot R_s = 2.497 \times 10^6 \ STB \times 471 \ SCF/STB$

$= 1.18 \times 10^9 \ Scf$

$= 3.34 \times 10^7 \ Sm^3$

F. $HCPV = A \cdot h \cdot \phi (1 - S_W) = 494088 \ m^3$

$m_o = \rho \cdot V = \rho_o \cdot HCPV = 494088 \ m^3 \times 0.7245 \times 1.221 \times 10^3 \ kg/m^3$

$= 4.37 \times 10^8 \ kg$

$n = m_o / M_o = 4.37 \times 10^8 / 106.03 = 4.12 \times 10^6$ kg-mole.

Problem 3

A. $n_{gi} = 4.56 \times 10^7$ kg-mole $\quad n_{oi} = 4.12 \times 10^6$ kg-mole

$f_{gi} = n_{gi} / (n_{gi} + n_{oi})$

$\cong 92\%$

B. $n_i = n_{gs} y_i + n_{os} \cdot x_i$

$n_{C1} = 4.56 \times 10^7 \times 0.9 + 4.12 \times 10^6 \times 0.25 = 4.21 \times 10^7$ kg-moles

$n_{C2} = 4.56 \times 10^7 \times 0.1 + 4.12 \times 10^6 \times 0.065 = 4.83 \times 10^6$ kg-mole

$n_{C7+} = 4.56 \times 10^7 \times 0 + 4.12 \times 10^6 \times 0.5184 = 2.14 \times 10^6$ kg-moles

$Z_{C1} = n_{C1} / n_{total} = 84.6\%$

$Z_{C2} = n_{C2} / n_{total} = 9.7\%$

$Z_{C3} = n_{C7+} / n_{total} = 4.3\%$

C. $k_i = y_i / x_i \qquad K_{C1} = 2. \qquad K_{C2} = 0.75$

C1: $z_i = f_v y_i + (1 - f_v) x_i$

$x_{C1} = z_{C1} / (f_v + 1) = 0.64$

$y_{C1} = 2 \cdot x_{C1} = 0.88$

C2: $z_i = f_v y_i + (1 - f_v) x_i$

$x_{C2} = z_{C2} / (1 - 0.25 f_v) = 0.126. \qquad y_{C2} = 0.094.$

D. $V_{ro} \cong HCPV_{os} / [HCPV_{os} + HCPV_{gs}]$

$= 4.94 \times 10^5 / [4.94 \times 10^5 + 4.81 \times 10^6]$

$= 9.3\%$

also.

$$V_{ro} = \frac{n_o M_o / \rho_o}{n_o M_o / \rho_o + n_g M_g / \rho_g}$$