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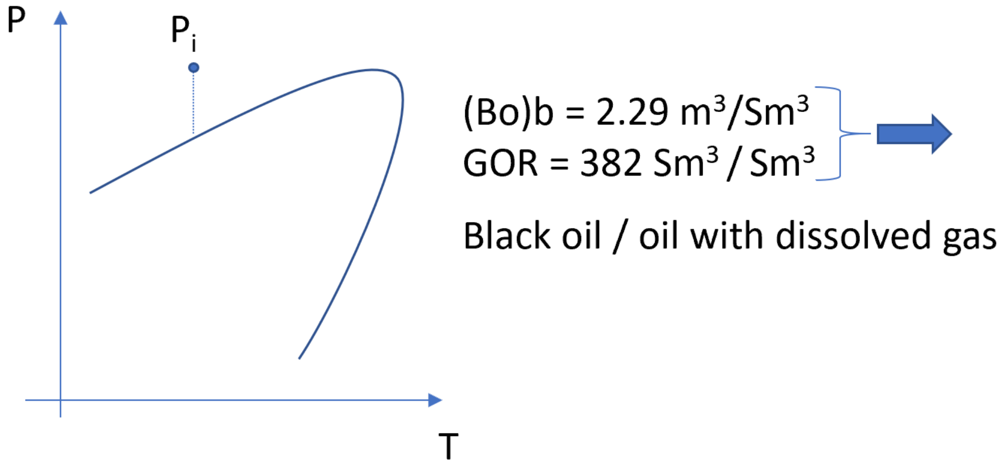
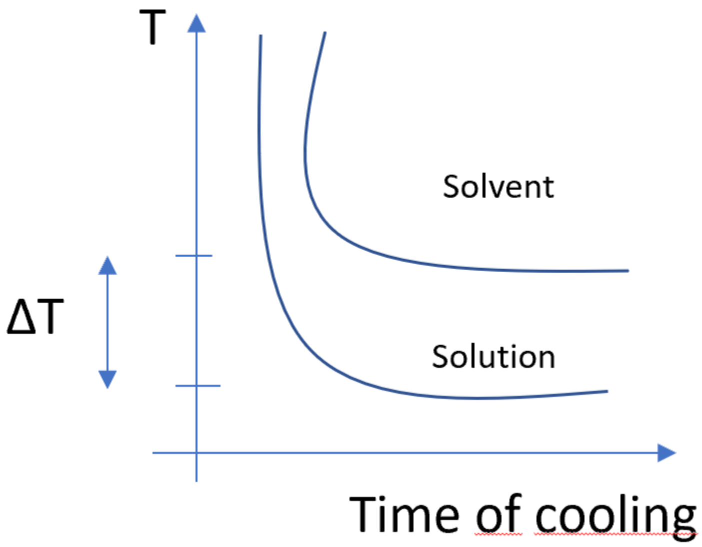
Part 2: PVT of fluids

1 PT-diagram



2 Freezing point depression



Mix mass of STO and measure ΔT

$$\Delta T = k_f \frac{\frac{m_o}{M_o}}{\frac{m_b}{1000}} \Rightarrow k_f \frac{m_o \cdot 1000}{m_b \cdot M_o} \Rightarrow$$

$$M_o = k_f \frac{m_o \cdot 1000}{m_b \cdot \Delta T}$$

3 Formula based on 100g STO

$$\frac{100}{M_{STO}} = \sum_{C_1}^{C_9} \frac{(wt\%)_i}{M_i} + \frac{(wt\%)_{C_{10+}}}{M_{C_{10+}}} \Rightarrow$$

$$\frac{(wt\%)_{C_{10+}}}{M_{C_{10+}}} = \frac{100}{M_{STO}} - \sum_{C_1}^{C_9} \frac{(wt\%)_i}{M_i} \Rightarrow$$

$$M_{C_{10+}} = \frac{(wt\%)_{C_{10+}}}{\frac{100}{M_{STO}} - \frac{(wt\%)_{C_{10+}}}{M_{C_{10+}}}} | \cdot \frac{M_{STO}}{M_{STO}}$$

$M_{STO} = 187 \Rightarrow$

$$M_{C_{10+}} = \frac{187 \cdot (wt\%)_{C_{10+}}}{100 - 187 \cdot \sum_{C_1}^{C_9} \frac{(wt\%)_i}{M_i}}$$

4 Basis on 1.0 Sm^3 STO:

$$z_i = n_{STO} x_i + n_g y_i = \frac{m_{STO}}{M_{STO}} x_i + \frac{GOR}{V_m} y_i$$

$$= \frac{\rho_{STO} \cdot \overbrace{V_{STO}}^{=1}}{M_{STO}} x_i + \frac{GOR}{V_m} y_i = \frac{\rho_{STO}}{M_{STO}} x_i + \frac{GOR}{V_m} y_i$$

$$= \frac{839.4}{187} x_i + \frac{382}{23.6447} y_i = 4.489 x_i + 16.15 y_i$$

5 e).

Plot Y vs. P, when P < P$_b$, $\frac{P_b - P}{P\left(\frac{V_t}{V_b} - 1\right)}$.

Straight line means that we have the correct value for P_b. When we plot the values for P and Y, we get very close to a straight line (easy to do, so wil not be shown here...) $\Rightarrow$ P_b is correctly determined.

6 Based on 1.0 Sm^3 STO

$(B_o)_b = \frac{(V_o)_b}{\underbrace{V_{STO}}_{=1}}$

$$M_{STO} = \rho_{STO} \cdot V_{STO} = 839.4 \cdot 1 = 839.4 \text{ kg}$$

$$m_g = n_g M_g = \frac{GOR}{V_m} \cdot \gamma_g \cdot M_{air} = \frac{382}{23.6447} \cdot 0.837 \cdot 28.96 = 391.60 \text{ kg}$$

$$(\rho_o)_b = \frac{m}{(V_o)_b} = \frac{m_{STO} + m_g}{(B_o)_b} = \frac{839.4 + 391.60}{2.29} = 537.55 kg/m^3$$

$$(\rho_o)_i = \frac{(\rho_o)_b}{(V/V_b)_{P=P_i}} = \frac{537.55}{0.9439} = 569.5 kg/m^3$$

7 g).

All gases will exhibit the same behavior when viewed in terms of reduced values for P, V and T:

$pP_c = \sum y_i P_{C_i}$, $pT_c = \sum y_i T_{C_i}$

For C_{7+} and C_{10+} fractions, pP_C and pT_C can be found from chart if you have the molecular weight, and the specific gravity for the fractions.

$pP_r = \frac{P}{pP_c}$, $pT_r = \frac{T}{pT_c}$

The Z-factor can be determined from a chart (Standing) based on pPr and pT_r: $Z = f(pP_r, pT_r)$. In the chart, the values for pP_r and pT_r **must** be in oil field units:

$[P]$ = psia, $[T]$ = °R

8 h).

$V_g = n_g V_m$, $V_{STO} = \frac{m_{STO}}{\rho_{STO}} = \frac{n_{STO} M_{STO}}{\rho_{STO}}$

$n_{STO} = \sum_{i=1}^{3} L_i$, $n_g = 1 - n_{STO}$

1. $GOR = \frac{V_g}{V_{STO}} = \frac{n_g V_m}{\frac{n_{STO} M_{STO}}{\rho_{STO}}} = \frac{n_g V_m \rho_{STO}}{n_{STO} M_{STO}}$

$$n_{STO} = \sum_{i=1}^{3} = L_i = 0.4784 \cdot 0.6746 \cdot 0.7483 = 0.2415$$

$$n_g = 1 - n_{STO} = 1 - 0.2415 = 0.7585$$

$$\text{GOR} = \frac{0.7585 \cdot 23.6447 \cdot 828.7}{0.2415 \cdot 173.8} = 354.1 Sm^3/Sm^3$$

2. $(GOR)_j = \frac{(ng)_j \cdot V_m \cdot \rho_{STO}}{n_{STO} M_{STO}} = \frac{(L_1 L_2 \cdots L_{j-1}) V_j V_m \cdot \rho_{STO}}{(L_1 L_2 \cdots L_{j-1})(L_j L_{j+1} L_{j+2} \cdots L_k) M_{STO}} = \frac{V_j V_m \rho_{STO}}{(L_j L_{j+1} L_{j+2} \cdots L_k) M_{STO}}$

$$(GOR)_2 = \frac{V_2 V_m \rho_{STO}}{L_2 \cdot L_3 \cdot M_{STO}} = \frac{0.3254 \cdot 23.6447 \cdot 828.7}{0.6746 \cdot 0.7483 \cdot 1473.8} = 72.67 Sm^3/Sm^3$$